SCIENTIFIC OPINION

Scientific Opinion on the pest categorisation of *Candidatus* Phytoplasma solani[1]

EFSA Panel on Plant Health (PLH)[2,3]

European Food Safety Authority (EFSA), Parma, Italy

ABSTRACT

The Panel on Plant Health performed a pest categorisation of potato stolbur mycoplasma, recently renamed *Candidatus* Phytoplasma solani (CPs), for the European Union (EU) territory. CPs is a well-defined species of the genus *Candidatus* Phytoplasma, for which molecular detection assays are available. It is a regulated harmful organism in the EU, and is listed as potato stolbur mycoplasma in Annex II, Part A, Section II of Council Directive 2000/29/EC. Although CPs can infect a wide range of host plants, this listing concerns only *Solanaceae* plants for planting. CPs is transmitted by grafting and vegetative propagation of infected hosts, and by several insect vector species including *Hyalesthes obsoletus*, *Reptalus panzeri*, *Pentastiridius leporinus* and possibly others. The geographical distributions and population densities of these vectors govern the spread of CPs. CPs can infect a wide range of host plants and has been reported in 14 EU Member States (MSs). CPs can cause yield losses in potato and other solanaceous crops, in grapevine, strawberry, maize and lavender. Because host plants, wild or cultivated, are widely distributed throughout the EU, the distribution of vector populations is the main determinant of CPs establishment and spread; therefore, CPs has the potential to establish and spread in unaffected parts of the EU with the extension of the distribution range of its vectors. There are high annual fluctuations in the impact of CPs, and this is mostly affected by the prevalence of plant reservoirs for CPs and by the size of local vector populations, which cannot easily be controlled. There are uncertainties regarding the precise distribution of CPs and its vectors, the evolution of vector distribution, the long-term impact of emerging CPs genotypes and the extent of impact on the various susceptible crops grown in the EU.

KEY WORDS

potato stolbur mycoplasma, *Hyalesthes obsoletus*, *Reptalus panzeri*, grapevine bois noir disease, grapevine yellows, maize redness, lavender decline

1 On request from the European Commission, Question No EFSA-Q-2014-00254, adopted on 27 November 2014.

2 Panel members: Richard Baker, Claude Bragard, Thierry Candresse, Gianni Gilioli, Jean-Claude Grégoire, Imre Holb, Michael John Jeger, Olia Evtimova Karadjova, Christer Magnusson, David Makowski, Charles Manceau, Maria Navajas, Trond Rafoss, Vittorio Rossi, Jan Schans, Gritta Schrader, Gregor Urek, Irene Vloutoglou, Stephan Winter and Wopke van der Werf. Correspondence: alpha@efsa.europa.eu

3 Acknowledgement: The Panel wishes to thank the members of the Working Group on Directive 2000/29 Viruses, Thierry Candresse, Stephan Winter and Xavier Foissac, for the preparatory work on this scientific opinion, and EFSA staff member, Virág Kertész, for the support provided.

Suggested citation: EFSA PLH Panel (EFSA Panel on Plant Health), 2014. Scientific Opinion on the pest categorisation of *Candidatus* Phytoplasma solani. EFSA Journal 2014;12(12):3924, 27 pp. doi:10.2903/j.efsa.2014.3924

Available online: www.efsa.europa.eu/efsajournal

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

BACKGROUND AS PROVIDED BY THE EUROPEAN COMMISSION

The current European Union plant health regime is established by Council Directive 2000/29/EC 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, 10.7.2000, p. 1).

The Directive lays down, amongst others, the technical phytosanitary provisions to be met by plants and plant products 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, the list of harmful organisms whose introduction into or spread within the Union is prohibited and the control measures to be carried out at the outer border of the Union on arrival of plants and plant products.

The Commission is currently carrying out a revision of the regulatory status of organisms listed in the Annexes of Directive 2000/29/EC. This revision targets mainly organisms which are already locally present in the EU territory and that in many cases are regulated in the EU since a long time. Therefore it is considered to be appropriate to evaluate whether these organisms still deserve to remain regulated under Council Directive 2000/29/EC, or whether, if appropriate, they should be regulated in the context of the marketing of plant propagation material, or be deregulated. The revision of the regulatory status of these organisms is also in line with the outcome of the recent evaluation of the EU Plant Health Regime, which called for a modernisation of the system through more focus on prevention and better risk targeting (prioritisation).

In order to carry out this evaluation, a recent pest risk analysis is needed which takes into account the latest scientific and technical knowledge on these organisms, including data on their agronomic and environmental impact, as well as their present distribution in the EU territory. In this context, EFSA has already been asked to prepare risk assessments for some organisms listed in Annex IIAII. The current request concerns 23 additional organisms listed in Annex II, Part A, Section II as well as five organisms listed in Annex I, Part A, Section I, one listed in Annex I, Part A, Section II and nine organisms listed in Annex II, Part A, Section I of Council Directive 2000/29/EC. The organisms in question are the following:

Organisms listed in Annex II, Part A, Section II:

- *Ditylenchus destructor* Thorne
- *Circulifer haematoceps*
- *Circulifer tenellus*
- *Helicoverpa armigera* (Hübner)
- *Radopholus similis* (Cobb) Thorne (could be addressed together with the IIAI organism *Radopholus citrophilus* Huettel, Dickson and Kaplan)
- *Paysandisia archon* (Burmeister)
- *Clavibacter michiganensis* spp. *insidiosus* (McCulloch) Davis et al.
- *Erwinia amylovora* (Burr.) Winsl. et al. (also listed in Annex IIB)
- *Pseudomonas syringae* pv. *persicae* (Prunier et al.) Young et al.
- *Xanthomonas campestris* pv. *phaseoli* (Smith) Dye
- *Xanthomonas campestris* pv. *pruni* (Smith) Dye
- *Xylophilus ampelinus* (Panagopoulos) Willems et al.
- *Ceratocystis fimbriata* f. sp. *platani* Walter (also listed in Annex IIB)
- *Cryphonectria parasitica* (Murrill) Barr (also listed in Annex IIB)
- *Phoma tracheiphila* (Petri) Kanchaveli and Gikashvili
- *Verticillium albo-atrum* Reinke and Berthold
- *Verticillium dahliae* Klebahn
- Beet leaf curl virus
- Citrus tristeza virus (European isolates) (also listed in Annex IIB)
- Grapevine flavescence dorée MLO (also listed in Annex IIB)
- Potato stolbur mycoplasma
- *Spiroplasma citri* Saglio et al.

- Tomato yellow leaf curl virus

Organisms listed in Annex I, Part A, Section I:

- *Rhagoletis cingulata* (Loew)
- *Rhagoletis ribicola* Doane
- Strawberry vein banding virus
- Strawberry latent C virus
- Elm phloem necrosis mycoplasm

Organisms listed in Annex I, Part A, Section II:

- *Spodoptera littoralis* (Boisd.)

Organisms listed in Annex II, Part A, Section I:

- *Aculops fuchsiae* Keifer
- *Aonidiella citrina* Coquillet
- Prunus necrotic ringspot virus
- Cherry leafroll virus
- *Radopholus citrophilus* Huettel, Dickson and Kaplan (could be addressed together with IIAII organism *Radopholus similis* (Cobb) Thorne)
- *Scirtothrips dorsalis* Hendel
- *Atropellis* spp.
- *Eotetranychus lewisi* McGregor
- *Diaporthe vaccinii* Shear.

TERMS OF REFERENCE AS PROVIDED BY THE EUROPEAN COMMISSION

EFSA is requested, pursuant to Article 29(1) and Article 22(5) of Regulation (EC) No 178/2002, to provide a pest risk assessment of *Ditylenchus destructor* Thorne, *Circulifer haematoceps*, *Circulifer tenellus*, *Helicoverpa armigera* (Hübner), *Radopholus similis* (Cobb) Thorne, *Paysandisia archon* (Burmeister), *Clavibacter michiganensis* spp. *insidiosus* (McCulloch) Davis et al., *Erwinia amylovora* (Burr.) Winsl. et al., *Pseudomonas syringae pv. persicae* (Prunier et al.*)* Young et al. *Xanthomonas campestris* pv. *phaseoli* (Smith) Dye, *Xanthomonas campestris* pv. *pruni* (Smith) Dye, *Xylophilus ampelinus* (Panagopoulos) Willems et al., *Ceratocystis fimbriata* f. sp. *platani* Walter, *Cryphonectria parasitica* (Murrill) Barr, *Phoma tracheiphila* (Petri) Kanchaveli and Gikashvili, *Verticillium albo-atrum* Reinke and Berthold, *Verticillium dahliae* Klebahn, Beet leaf curl virus, Citrus tristeza virus (European isolates), Grapevine flavescence dorée MLO, Potato stolbur mycoplasma, *Spiroplasma citri* Saglio et al., Tomato yellow leaf curl virus, *Rhagoletis cingulata* (Loew), *Rhagoletis ribicola* Doane, Strawberry vein banding virus, Strawberry latent C virus, Elm phloem necrosis mycoplasma, *Spodoptera littoralis* (Boisd.), *Aculops fuchsiae* Keifer, *Aonidiella citrina* Coquillet, Prunus necrotic ringspot virus, Cherry leafroll virus, *Radopholus citrophilus* Huettel Dickson and Kaplan (to address with the IIAII *Radopholus similis* (Cobb) Thorne), *Scirtothrips dorsalis* Hendel, *Atropellis* spp., *Eotetranychus lewisi* McGregor and *Diaporthe vaccinii* Shaer., for the EU territory.

In line with the experience gained with the previous two batches of pest risk assessments of organisms listed in Annex II, Part A, Section II, requested to EFSA, and in order to further streamline the preparation of risk assessments for regulated pests, the work should be split in two stages, each with a specific output. EFSA is requested to prepare and deliver first a pest categorisation for each of these 38 regulated pests (step 1). Upon receipt and analysis of this output, the Commission will inform EFSA for which organisms it is necessary to complete the pest risk assessment, to identify risk reduction options and to provide an assessment of the effectiveness of current EU phytosanitary requirements (step 2). *Clavibacter michiganensis* spp. *michiganensis* (Smith) Davis et al. and *Xanthomonas campestris* pv. *vesicatoria* (Doidge) Dye, from the second batch of risk assessment requests for Annex IIAII organisms requested to EFSA (ARES(2012)880155), could be used as pilot cases for this approach, given that the working group for the preparation of their pest risk assessments has been constituted and it is currently dealing with the step 1 “pest categorisation”. This proposed modification of previous request would allow a rapid delivery by EFSA by May 2014 of the first two outputs for step 1 “pest categorisation”, that could be used as pilot case for this request and obtain a prompt feedback on its fitness for purpose from the risk manager’s point of view.

As indicated in previous requests of risk assessments for regulated pests, in order to target its level of detail to the needs of the risk manager, and thereby to rationalise the resources used for their preparation and to speed up their delivery, for the preparation of the pest categorisations EFSA is requested, in order to define the potential for establishment, spread and impact in the risk assessment area, to concentrate in particular on the analysis of the present distribution of the organism in comparison with the distribution of the main hosts and on the analysis of the observed impacts of the organism in the risk assessment area.

ASSESSMENT

1. Introduction

1.1. Purpose

This document presents a pest categorisation prepared by the EFSA Scientific Panel on Plant Health (hereinafter referred to as the Panel) for the species *Candidatus* Phytoplasma solani in response to a request from the European Commission.

1.2. Scope

The pest categorisation addresses *Candidatus* Phytoplasma solani which was previously named Potato stolbur mycoplasma. The pest risk assessment area is the territory of the European Union (hereinafter referred to as the EU) with 28 Member States (hereinafter referred to as MSs), restricted to the area of application of Council Directive 2000/29/EC, which excludes Ceuta and Melilla, the Canary Islands and the French overseas departments.

2. Methodology and data

2.1. Methodology

The Panel performed the pest categorisation for *Candidatus* Phytoplasma solani following guiding principles and steps presented in the EFSA Guidance on a harmonised framework for pest risk assessment (EFSA PLH Panel, 2010) and as defined in the International Standards for Phytosanitary Measures (ISPM) No 11 (FAO, 2013) and ISPM No 21 (FAO, 2004).

In accordance with the Guidance on a harmonised framework for pest risk assessment in the EU (EFSA PLH Panel, 2010), this work is initiated as result of the review or revision of phytosanitary policies and priorities. As explained in the background of the European Commission request, the objective of this mandate is to provide updated scientific advice to the European risk managers for their evaluation of whether these organisms listed in the Annexes of the Directive 2000/29/EC still deserve to remain regulated under Council Directive 2000/29/EC, or whether they should be regulated in the context of the marketing of plant propagation material, or be deregulated. Therefore, to facilitate the decision making process, in the conclusions of the pest categorisation, the Panel addresses explicitly each criterion for quarantine pest according to ISPM 11 (FAO, 2013) but also for regulated non quarantine pest according to ISPM 21 (FAO, 2004) and includes additional information required as per the specific terms of reference received by the European Commission. In addition, for each conclusion the Panel provides a short description of its associated uncertainty.

Table 1 presents the ISPM 11 (FAO, 2013) and ISPM 21 (FAO, 2004) pest categorisation criteria against which the Panel provides its conclusions. It should be noted that the Panel's conclusions are formulated respecting its remit and particularly with regards to the principle of separation between risk assessment and risk management (EFSA founding regulation[4]), 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, in agreement with the Guidance on a harmonised framework for pest risk assessment (EFSA PLH Panel, 2010).

[4] 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. Official Journal of the European Communities L 31/1, 1.2.2002, p. 1–24.

Table 1: International Standards for Phytosanitary Measures ISPM 11 (FAO, 2013) and ISPM 21 (FAO, 2004) pest categorisation criteria under evaluation

Pest categorisation criteria	ISPM 11 for being a potential quarantine pest	ISPM 21 for being a potential regulated non-quarantine pest
Identity of the pest	The identity of the pest should be clearly defined to ensure that the assessment is being performed on a distinct organism, and that biological and other information used in the assessment is relevant to the organism in question. If this is not possible because the causal agent of particular symptoms has not yet been fully identified, then it should have been shown to produce consistent symptoms and to be transmissible	The identity of the pest is clearly defined
Presence (ISPM 11) or absence (ISPM 21) in the PRA area	The pest should be **absent from all or a defined part of the PRA area**	The pest is **present** in the PRA area
Regulatory status	If the pest is present but not widely distributed in the PRA area, it should be under official control or expected to be under official control in the near future	The pest is under official control (or being considered for official control) in the PRA area with respect to the specified plants for planting
Potential for establishment and spread in the PRA area	The PRA area should have ecological/climatic conditions including those in protected conditions suitable for the establishment and spread of the pest and, where relevant, host species (or near relatives), alternate hosts and vectors should be present in the PRA area	–
Association of the pest with the plants for planting and the effect on their intended use	–	Plants for planting are a pathway for introduction and spread of this pest
Potential for consequences (including environmental consequences) in the PRA area	There should be clear indications that the pest is likely to have an unacceptable economic impact (including environmental impact) in the PRA area	–
Indication of impact(s) of the pest on the intended use of the plants for planting	–	The pest may cause severe economic impact on the intended use of the plants for planting
Conclusion	If it has been determined that the pest has the potential to be a quarantine pest, the PRA process should continue. If a pest does not fulfil all of the criteria for a quarantine pest, the PRA process for that pest may stop. In the absence of sufficient information, the uncertainties should be identified and the PRA process should continue	If a pest does not fulfil all the criteria for an regulated non-quarantine pest, the PRA process may stop

In addition, in order to reply to the specific questions listed in the terms of reference, three issues are specifically discussed only for pests already present in the EU: the analysis of the present EU distribution of the organism in comparison with the EU distribution of the main hosts, the analysis of the observed impacts of the organism in the EU and the pest control and cultural measures currently implemented in the EU.

The Panel will not indicate in its conclusions of the pest categorisation whether to continue the risk assessment process as it is clearly stated in the terms of reference that at the end the pest categorisation the European Commission will indicate if further risk assessment work is required following their analysis of the Panel's scientific opinion.

2.2. Data

2.2.1. Literature search

A literature search on *Candidatus* Phytoplasma solani was conducted at the beginning of the mandate. The search was conducted for the old scientific names of the pest (Potato stolbur mycoplasma and stolbur phytoplasma. Further references and information were obtained from experts, from citations within the references as well as from grey literature.

2.2.2. Data collection

To complement the information concerning the current situation of the pest provided by the literature and online databases on pest distribution, damage and management, the PLH Panel sent a short questionnaire on the current situation at country level, based on the information available in the European and Mediterranean Plant Protection Organization (EPPO) Plant Quarantine Retrieval (PQR) system, to the National Plant Protection Organisation (NPPO) contacts of the 28 EU MSs. A summary table on the pest status based on EPPO PQR and MS replies is presented in Table 2.

Information on distribution of the main host plants was obtained from the EUROSTAT and the Flora Europaea databases, while that of the vector species was collected from Fauna Europaea.

In its analysis, the Panel also considered the recent Rapid Pest Risk Analysis for *Candidatus* Phytoplasma solani (FERA, 2014).

3. Pest categorisation

3.1. Identity and biology of *Candidatus* Phytoplasma solani

3.1.1. Taxonomy

Potato stolbur mycoplasma, recently formally renamed *Candidatus* Phytoplasma solani (CPs) (Quaglino et al., 2013) is a member of the genus *Candidatus* Phytoplasma, a group of pleiomorphic bacteria without a cell wall, which are phloem-obligate parasites of plants transmitted by sap-feeding insect vectors. CPs is responsible for several plant diseases, including the "stolbur" disease of *Solanaceae* (tomato, potato and tobacco, etc.) and the "bois noir" or "yellows" diseases of grapevine.

Phytoplasma taxonomy is largely based on 16S ribosomal DNA sequence. CPs falls within the 16SrXII group, which contains phytoplasmas such as *Candidatus* Phytoplasm australiense, *Ca*. P. japonicum and *Ca*. P. fragariae that infect a wide range of plants. CPs and *Ca*. P. australiense are transmitted by polyphagous planthoppers of the family *Cixiidae*. Sequences of 16S ribosomal RNA (rRNA) genes from CPs isolates are at least 99 % identical, and CPs isolates are identified by a unique signature sequence in their 16S rRNA. CPs is the only phytoplasma known to be transmitted by *Hyalesthes obsoletus*. Phylogenetic analyses of 16S rRNA, *tuf*, *sec*Y and *rpl*V–*rps*C gene sequences show that CPs isolates form a monophyletic subclade within the 16SrXII group and further support the species status granted to CPs. The most closely related species within the group is *Ca*. P. australiense (Quaglino et al., 2013).

Overall, CPs is a well-delineated and clearly defined species.

Taxonomic position

Kingdom: Bacteria; phylum: Tenericutes; class: Mollicutes; order: Acholeplasmatales; family: *Acholeplasmataceae*; genus: *Candidatus* Phytoplasma; species: *Candidatus* Phytoplasma solani.

3.1.2. Biology of *Candidatus* Phytoplasma solani

CPs is a phloem-restricted non-cultivable bacteria that infects a wide range of weeds and cultivated plants in Europe, such as solanaceous crops, grapevine, celery, maize, sugarbeet, strawberry and lavender. CPs is naturally transmitted by polyphagous planthoppers of the family *Cixiidae*, mainly *H. obsoletus* and *Reptalus panzeri* (Fos et al., 1992; Maixner, 1994; Cvrkovic et al., 2014). All affected crops, except lavender, are epidemiological dead-end hosts for CPs, as its planthopper vectors do not develop on these crops. The same situation applies to many weed hosts, but some weeds, such as bindweed (*Convolvulus arvensis* and *Calystegia sepium*) and stinging nettles (*Urtica dioica*), act as plant reservoirs, hosting both CPs and its vector (Langer and Maixner, 2004; Bressan et al., 2007). CPs can also be disseminated through multiplication of vegetatively propagated hosts such as potato, grapevine, strawberry and lavender. There is neither seed transmission in host plants, nor transovarial transfer of CPs from infected female planthopper vectors to their progeny. In Europe, CPs planthopper vectors are monovoltine. The acquisition stage is achieved by overwintering nymphs feeding on infected roots, and the plant-to-plant transmission by flying adults takes place in summer.

3.1.3. Intraspecific diversity

The genetic variability between CPs strains is high and correlates with geographical distribution (Pacifico et al., 2009; Quaglino et al., 2009; Fabre et al., 2011a,b; Johannesen et al., 2012; Foissac et al., 2013). To follow phytoplasma strain distribution and spread, genotyping, by sequencing or restriction fragment length polymorphism analyses of *tuf* or *secY* housekeeping genes and highly regulated genes, such as *stamp* and *vmp1*, is performed (Langer and Maixner, 2004; Cimerman et al., 2009; Pacifico et al., 2009; Fialová et al., 2009; Fabre et al., 2011b).

A second layer of molecular variability has been reported in western Europe. In the EU, the genetic diversity of CPs is influenced by the availability of host plants that can act as reservoirs, and this is the most important determinant of CPs epidemiology. Variations in the *tuf* gene are diagnostic of the particular host plant associations of different CPs strains: *tuf*-type a and the emerging *tuf*-type b2 strains specifically associate with nettle (Langer and Maixner, 2004; Aryan et al., 2014), while *tuf*-type b1 strains typically associate with bindweed. Differences in the host affiliation of CPs strains and the vector populations result in distinct epidemiological cycles based on the different plant species acting as reservoirs. It is currently unknown whether there is specificity in the interactions between plant reservoirs and insect vector ecotypes, or whether the above situation merely reflects independent epidemiological cycles and species diversification. In addition, three lavender-specific CPs *sec*Y genotypes (S14, S16 and S17) are associated with most of the lavender decline cases in south-eastern France (Danet et al., 2010).

3.1.4. Detection and identification of *Candidatus* Phytoplasma solani

Detection of CPs requires molecular diagnosis, although symptoms might be used to indicate its presence. Serological assays lack sensitivity, especially in the case of woody hosts in which phytoplasma titre can be lower than in herbaceaous hosts.

Current detection methods rely on the use of polymerase chain reaction (PCR) assays. Various PCR-based assays have been developed to detect CPs. A widely applied procedure is based on nested PCR amplification with phytoplasma-universal primer pairs, followed by sequencing or restriction fragment length polymorphism (RFLP) analyses (Gundersen and Lee, 1996; Schneider et al., 1995). Biplex nested PCR allows the detection of CPs and allows it to be distinguished from flavescence dorée phytoplasma in grapevine (Clair et al., 2003). Several real-time PCR assays have also been developed for CPs (Angelini et al., 2007; Hren et al., 2007; Pelletier et al., 2009).

3.2. Current distribution of *Candidatus* Phytoplasma solani

3.2.1. Global distribution of *Candidatus* Phytoplasma solani

CPs is endemic in the Euro-Mediterranean area. Outside of the EU, CPs is present in North Africa (Morocco and Egypt (not indicated on the map, Fischer, 1979; Fabre et al., 2011b)), in Asia Minor and the Near East (Turkey, Azerbaijan, Armenia, Lebanon, Israel and Jordan), in the Ukraine and western Russia, and it has been reported to occur on various crops in Iran. Some older reports of CPs occurrence have not been supported by CPs-specific diagnosis methods (1968 in Saudi Arabia; 1988 in Niger). Local occurrences of CPs have recently been reported in China and Chile and these require confirmation.

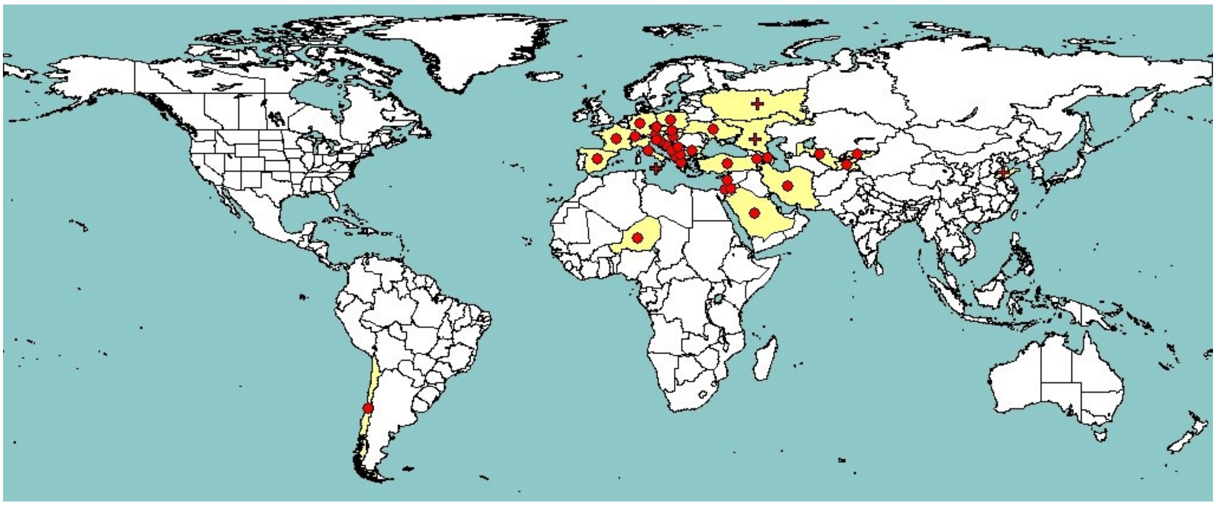

Figure 1: Global distribution map for *Candidatus* Phytoplasma solani (extracted from EPPO PQR, version 5.3.1 accessed on 22 September 2014). Red circles represent national records of pest presence and red crosses represent sub-national records of pest presence (note that this figure combines information from different dates, some of which could be out of date)

3.2.2. Distribution of *Candidatus* Phytoplasma solani in the EU

CPs distribution in the EU extends from Germany and Poland to Spain and Greece, and from Portugal to Romania (not indicated on the map of Figure 1, Ember et al., 2011; Torres et al., 2014).

Table 2: Current distribution of *Candidatus* Phytoplasma solani in the 28 EU MSs, Iceland and Norway, based on answers received via email from the NPPOs or, in the absence of replies, on information from EPPO PQR

Member State	NPPO answer	NPPO comments
Austria	**Present**, few occurrences	
Belgium	**Absent**, pest eradicated	2009–2011 survey on strawberry, grape and potato: no findings. In 2012, positive samples were found in a control field used for seed potato certification (De Jonghe et al., 2013). Eradication measures were applied. Follow-up surveys were carried out in 2013 on weeds in the field and for the two seed potato lots used for multiplication, but no visual symptoms or positive samples were detected. Also, no positives were detected elsewhere in potato production fields
Bulgaria	**Present**, restricted distribution	

Member State	NPPO answer	NPPO comments
Croatia	**Present**	Unclear taxonomic identity of harmful organism. Stolbur group phytoplasmas (16SXII-A) recorded on pear (*Pyrus communis*) and widespread in grapevine (*Vitis vinifera*), causing "bois noir" disease. "Potato stolbur virus" observed on potato (*Solanum tuberosum*) in 1950s, mycoplasma-like organisms confirmed in tomato plants (*Solanum lycopersicum*) with stolbur symptoms in 1970
Cyprus	**Absent**, pest no longer present	
Czech Republic	**Present**, restricted distribution	
Denmark	Not known to occur	
Estonia	**Absent**, no pest records	
Finland	**Absent**, no pest records	
France	**Present**, restricted distribution	
Germany	**Present**	Present only in some parts of the area, few occurrences on potato; present in areas where *Vitis* is grown
Greece [(a)]	**Present**, restricted distribution	
Hungary	**Present**, restricted distribution	
Ireland	**Absent**, no pest records	
Italy	**Present**, restricted distribution Sicily: **present**, no details	Present in some areas, mainly on tomatoes. Has never been found on potatoes
Latvia [(a)]	–	
Lithuania [(a)]	–	
Luxembourg [(a)]	–	
Malta	**Absent**, no pest records	
Netherlands	**Absent**, confirmed by survey	
Poland	**Absent**, pest no longer present	The last reported detection of potato stolbur mycoplasma was in 2002
Portugal	**Absent**	
Romania [(a)]	**Absent**, pest no longer present	
Slovakia	**Present**, only in some areas	
Slovenia	**Absent**, no pest records on potato	
Spain	**Present**, few occurrences	
Sweden	**Absent**, not known to occur	
United Kingdom	**Absent**	
Iceland [(a)]	–	
Norway [(a)]	–	

(a): When no information was made available to EFSA, the pest status in the EPPO PQR (2012) was used.
–, no information available; EPPO PQR, European and Mediterranean Plant Protection Organization Plant Quarantine Data Retrieval System; NPPO, National Plant Protection Organisation.

It must be pointed out that some NPPOs may have restricted their answers to the occurrence of CPs on solanaceous crops so may not reflect the widespread occurrence of CPs in all the European vineyards where bois noir disease is known to occur. For example, surveys have highlighted the common occurrence of CPs in Romania (CPs on grapevine, Ploaie and Chireceanu, 2012; CPs in potato fields, Ember et al., 2011), Slovenia (Petrovic et al., 2004), Portugal (Souza et al., 2013) and Austria (Aryan et al., 2014).

3.2.3. Vectors and their distribution in the EU

The planthopper *H. obsoletus* (Signoret 1865; family *Cixiidae*) was the first CPs vector to be confirmed. In Europe, *H. obsoletus* has a single generation per year with nymphal stages overwintering on the root system of bindweed (*C. arvensis* and *C. sepium*) and stinging nettle (*U.*

dioica). Adults of *H. obsoletus* emerging in early summer transmit CPs from infected field bindweed or stinging nettle to solanaceaous crops (Fos et al., 1992), grapevine (Maixner, 1994; Langer and Maixner, 2004) or other hosts. Under experimental conditions, *H. obsoletus* can transmit CPs to maize, causing the maize redness (MR) disease (Mori et al., 2013), but its role in the epidemiology of this disease, certainly in Serbia, is limited (Jovic et al., 2009). High *H. obsoletus* populations are observed on *U. dioica* and are associated with the emergence of bois noir CPs genotypes of increasing incidence in Germany, the Czech Republic and Austria (Johannesen et al., 2008, 2012; Safarova et al., 2011; Aryan et al., 2014). Finally, *H. obsoletus* is the only vector known to be involved in lavender decline in south-eastern France (Danet et al., 2010). *H. obsoletus* is present in 16 EU MSs (Figure 2).

The planthopper *R. panzeri* (Low 1883; family *Cixiidae*) has been reported as vector of MR isolates of CPs in Serbia (Jovic et al., 2007, 2009), and more recently as a vector of some CPs isolates causing grapevine bois noir cases in Serbia (Cvrkovic et al., 2014). Adult *R. panzer*i lay eggs on infected maize roots, and nymphs living on these roots acquire the phytoplasma. The nymphs overwinter on the roots of wheat planted in maize fields in autumn or on Johnsongrass (*Sorghum halepense*), allowing the emergence of infectious vectors the following July. *R. panzeri* is present in 15 EU MSs (Figure 3). However, contrary to the information in Fauna Europaea used to prepare Figure 3, it is reported to be absent from the UK (FERA, 2014).

The planthopper *Pentastiridius leporinus*, (Linnaeus 1761; family *Cixiidae*), originally misidentified as *P. beiri*, has been reported to transmit CPs to sugar beet (Gatineau et al., 2001). *P. leporinus* is present in all EU MSs except Luxembourg and Bulgaria.

Some other insect species are reported as experimental vectors but their role in the epidemiology of the diseases caused by CPs remains to be determined. These insect species are the planthopper *Reptalus quinquecostatus* (Pinzauti et al., 2008) and the leafhoppers *Anaceratagallia ribauti* (Riedel-Bauer et al., 2008) and *Macrosteles quadripunctulatus* (Batlle et al., 2008).

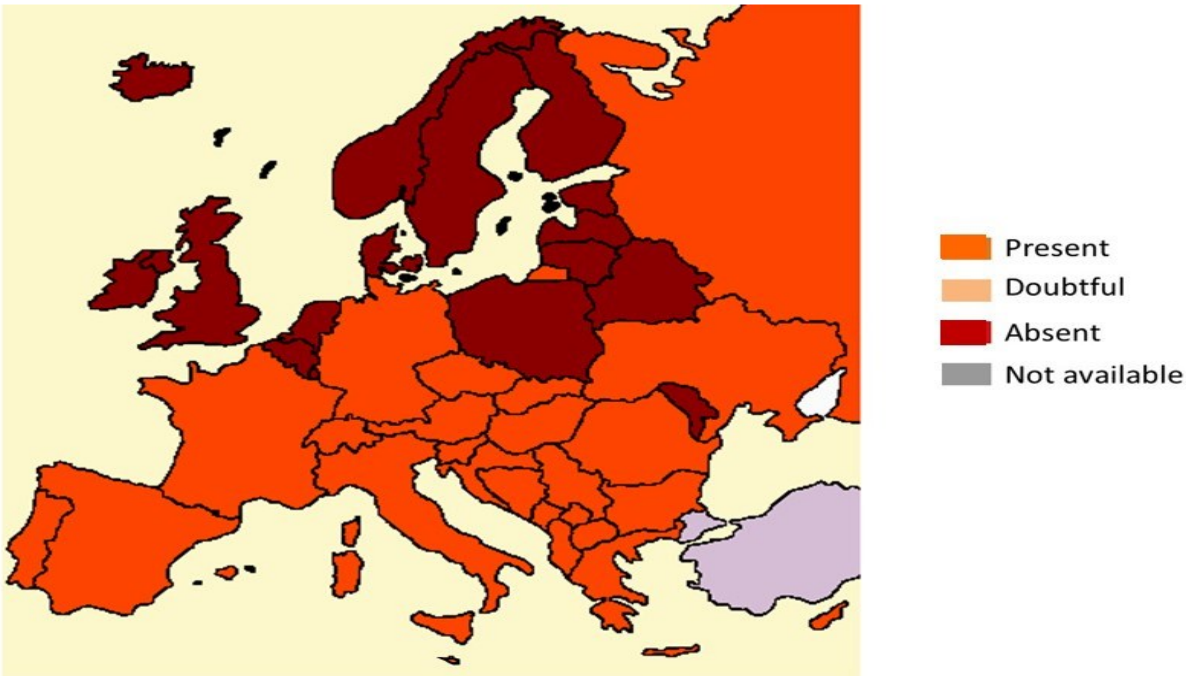

Figure 2: Global distribution map for *Hyalesthes obsoletus* (Signoret, 1865) in Europe (extracted 22 October 2014 from Fauna Europaea, http://www.faunaeur.org)

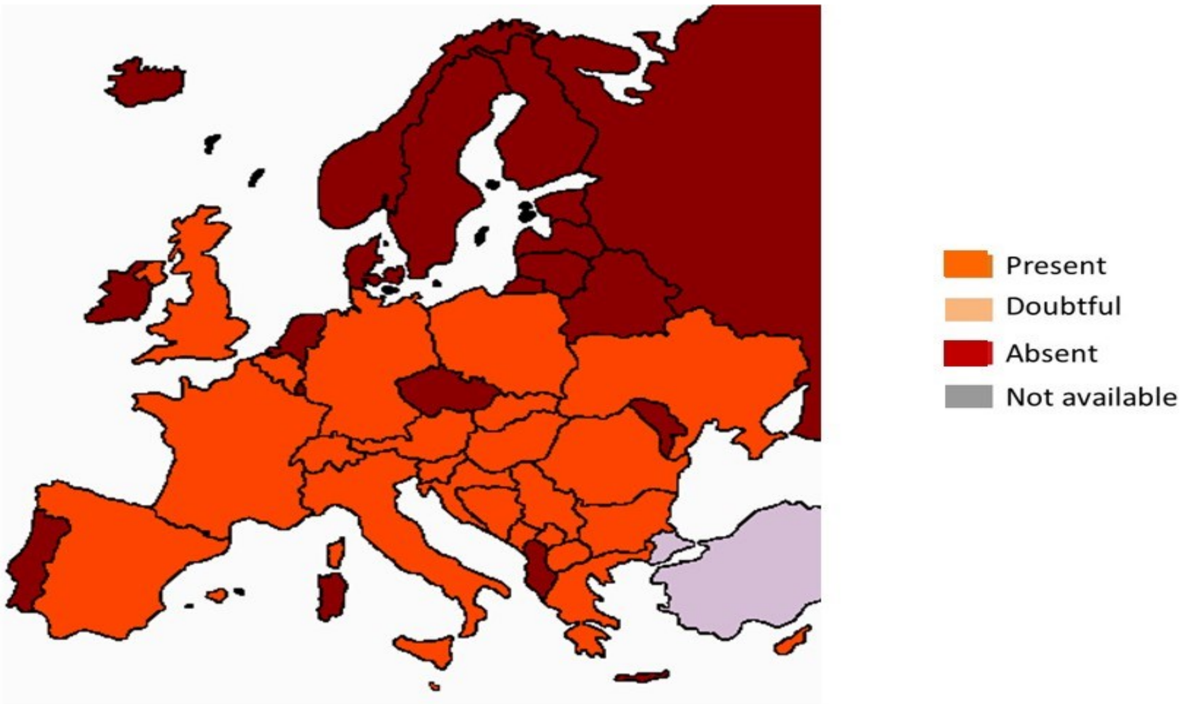

Figure 3: Global distribution map for *Reptalus panzeri* (Low, 1883) in Europe (extracted 22 October 2014 from Fauna Europaea, http://www.faunaeur.org)

3.3. Regulatory status in the EU

3.3.1. Council Directive 2000/29/EC

3.3.1.1. Harmful organism

CPs is a regulated harmful organism in the EU and is listed as potato stolbur mycoplasma in Annex II, Part A, Section II of Council Directive 2000/29/EC (Table 3).

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

Annex II, Part A	Harmful organisms whose introduction into, and spread within, all Member States shall be banned if they are present on certain plants or plant products	
Section II	Harmful organisms known to occur in the community and relevant for the entire community	
(d)	Virus and virus-like organisms	
	Species	Subject of contamination
8	Potato stolbur mycoplasm	Plants of *Solanaceae*, intended for planting, other than seeds

3.3.1.2. Regulated hosts of *Candidatus* Phytoplasma solani

There are more potential CPs hosts than those for which it is regulated in Annex IIAII (see section 3.4.1). In addition, it is important to mention that other specific commodities could also allow the introduction of the pest in the risk assessment area.

Specific requirements of Annexes III, IV and V of Council Directive 2000/29/EC are presented only for the host plants and commodities regulated for CPs in Annex IIAII (Table 4).

Table 4: *Candidatus* Phytoplasma solani host plants in 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	
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
Annex IV, Part A	Special requirements which must be laid down by all Member States for the introduction and movement of plants, plant products and other objects into and within all Member States	
Section I	Plants, plant products and other objects originating outside the Community	
	Plants, plant products and other objects	Special requirements
25.5	Plants of *Solanaceae*, intended for planting, other than seeds, originating in countries where Potato stolbur mycoplasm is known to occur	Without prejudice to the provisions applicable to tubers listed in Annex III(A)(10), (11), (12) and (13), and Annex IV(A)(I)(25.1), (25.2), (25.3) and (25.4), official statement that no symptoms of Potato stolbur mycoplasm have been observed on the plants at the place of production since the beginning of the last complete cycle of vegetation
Section II	Plants, plant products and other objects originating in the Community	
	Plants, plant products and other objects	Special requirements
18.6	Plants of *Solanaceae* intended for planting, other than seeds and other than plants mentioned in Annex IV(A)(II)(18.4) or (18.5)	Without prejudice to the requirements applicable to the plants, listed in Annex IV(A)(II)(18.1), (18.2) and (18.3), where appropriate, official statement that: (a) the plants originate in areas known to be free from Potato stolbur mycoplasm; or (b) no symptoms of Potato stolbur mycoplasm have been observed on the plants at the place of production since the beginning of the last complete cycle of vegetation
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	Plants and plant products	
1.3	Plants of stolon- or tuber-forming species of *Solanum* L. or their hybrids, intended for planting.	
2	Plants, plant products and other objects produced by producers whose production and sale is authorised to persons professionally engaged in plant production, other than those plants, plant products and other objects which are prepared and ready for sale to the final consumer, and for which it is ensured by the responsible official bodies of the Member States, that the production thereof is clearly separate from that of other products	
2.2	Plants of *Solanaceae*, other than those referred to in point 1.3 intended for planting, other than seeds	

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
1	Plants, intended for planting, other than seeds

3.3.2. Marketing directives

Host plants of CPs that are regulated in Annex IIAI of Council Directive 2000/29/EC are explicitly mentioned in the following Marketing Directives:

- Council Directive 2002/55/EC[5]
- Council Directive 2002/56/EC[6].

3.4. Elements to assess the potential for establishment and spread in the EU

3.4.1. Host range

CPs has a wide plant host range comprising species from 17 plant families. CPs was first discovered in *Solanaceae* plants (tobacco, potato, tomato, pepper, aubergine, *Solanum nigrum* and *Datura stramonium*), both cultivated and wild, but also infects several *Asteraceae* (carrot, celery, wild chicory and chervil), grapevine, strawberry, lavender, maize and sugar beet (reviewed in Garnier, 2000; Gatineau et al., 2002; Duduk and Bertaccini, 2006; Jovic et al., 2007). *Prunus* species, such as plum, peach, cherry and almond, have also been described as CPs hosts, mostly in Azerbaijan and Iran (Zirak et al., 2009a,b; Balakishiyeva et al., 2010; Zirak et al., 2010; Avramov et al., 2011).

With the exception of lavender and maize, most crops affected by CPs are dead-end hosts as they are not hosts for the insect vectors. On the contrary, wild plants such as bindweed (*C. arvensis* and *C. sepium*) and stinging nettle (*U. dioica*) host both CPs and its main vector *H. obsoletus* and therefore act as natural reservoirs for CPs. Many other wild dead-end CPs hosts are regularly reported, but these are not known to play any role in CPs epidemiology.

3.4.2. EU distribution of main host plants

Potato, tomato and other cultivated solanaceous hosts are of high economic value and are widely grown both in the field and under protected cultivation (tomato and aubergine) in many EU MSs (Table 5). Similarly, grapevine, strawberry and some other cultivated hosts, such as maize, are widely grown in the EU and are of high economic value.

Table 5: Area of production (in ha) of potato, tomato, grapevine and strawberry in 2012, as extracted from the Eurostat database (crops products—annual data (apro_cpp_crop))

Country	Potato	Tomatoes	Grapevine	Strawberry
Austria	21 800	200	43 600	1 300
Belgium	67 000	500	–	1 600
Bulgaria	14 900	3 400	60 400	700
Croatia	10 200	400	29 300	200
Cyprus	3 900	200	6 800	0
Czech Republic	23 700	400	15 700	500
Denmark	39 500	0	0	1 100
Estonia	5 500	0	–	400

[5] Council Directive 2002/55/EC of 13 June 2002 on the marketing of vegetable seed. Official Journal of the European Union L 193/33, 20.7.2002, p. 33–59).

[6] Council Directive 2002/56/EC of 13 June 2002 on the marketing of seed potatoes. Official Journal of the European Union L 193/60, 20.7.2002, p. 60–73).

Country	Potato	Tomatoes	Grapevine	Strawberry
Finland	20 700	100	–	3 400
France	154 100	5 200	760 900	3 200
Germany	238 300	300	99 500	15 000
Greece	24 200	16 000	99 200	1 100
Hungary	25 100	1 800	75 500	600
Ireland	9 000	0	–	500
Italy	58 700	91 900	697 700	2 000
Latvia	12 200	0	–	300
Lithuania	31 700	600	–	1 000
Luxembourg	600	0	1 200	0
Malta	700	300	600	0
Netherlands	150 000	1 700	0	1 800
Poland	373 000	13 100	500	50 600
Portugal	25 100	15 400	179 500	500
Romania	228 900	29 800	176 500	2 300
Slovakia	8 900	500	10 500	200
Slovenia	3 400	0	16 400	0
Spain	7 200	48 600	943 000	7 600
Sweden	24 700	0	0	2 200
UK	149 000	0	1 000	5 000
EU-28	1 785 000	230 400	3 188 500	103 000

–, data not available.

The reservoir hosts, both wild (nettle and bindweed) and cultivated (lavender), are also widely distributed throughout the EU (Table 6). Lavender is also very widely grown as an ornamental species.

Table 6: Distribution of lavender (*Lavandula angustifola*), a cultivated host of CPs, as well as stinging nettle (*Urtica dioica*) and common bindweed (*Convolvulus arvensis*), wild hosts of CPs, according to the Flora Europaea database

Country	Lavender	Nettle	Bindweed
Austria		×	×
Belgium		×	×
Bulgaria	×	×	×
Croatia	× [(a)]	× [(a)]	× [(a)]
Cyprus			
Czech Republic		×	×
Denmark		×	×
Estonia			
Finland		×	×
France	×	×	×
Germany		×	×
Greece	×	×	×
Hungary		×	×
Ireland		×	×
Italy	×	×	×
Latvia			
Lithuania			
Luxembourg			
Malta		×	×
Netherlands		×	×
Poland		×	×
Portugal		×	×
Romania		×	×

Country	Lavender	Nettle	Bindweed
Slovakia		×	×
Slovenia	× (a)	× (a)	× (a)
Spain	×	×	×
Sweden		×	×
UK		×	×

(a): Presence interpreted from that in Yugoslavia.
× , species presence.

3.4.3. Analysis of the potential distribution of *Candidatus* Phytoplasma solani in the EU

CPs is present in southern and central Europe. Its northern limits correspond to the Czech Republic, southern Germany and the French Alsace region, which correspond to the northern limit of its main insect vector, *H. obsoletus* (Imo et al., 2013; Maixner et al., 2014). As the distribution range of CPs wild plant reservoirs and cultivated hosts largely exceeds this limit (see Tables 5 and 6), the only limitation to CPs spread into northern countries appears to be the absence of *H. obsoletus*. The development of *H. obsoletus* nymphs is temperature dependent, and the adult flight period can be predicted using temperature sums (Maixner and Langer, 2006). The rapid increase in the population of *H. obsoletus* in the northern part of its range over the last two decades correlates with an increase in nettle-associated CPs genotypes, and with an increase in grapevine bois noir disease in south-western Germany (Johannesen et al., 2012). A similar shift to nettle has also been observed in South Moravia (Czech Republic) and in Styria (Austria), promoting a rapid expansion in the distribution range of nettle-associated CPs genotypes (Safarova et al., 2011; Aryan et al., 2014). A recent report of CPs in potato in Belgium (De Jonghe et al., 2013) and other reports of *H. obsoletus* in Germany, up to a latitude corresponding to southern Belgium (Imo et al., 2013), may indicate a continuing northerly range expansion of both CPs and its vector.

The absence of *H. obsoletus* in the UK limits the risk associated with the potential introduction of CPs into this country (FERA, 2014). The same applies to Ireland and other northern European countries.

3.4.4. Spread capacity

CPs can spread through the movement of vegetatively propagated host plants for planting, such as grapevine, strawberry and seed potatoes, despite the fact that these species are dead-end host for CPs, as they do not host insect vectors. Lavender plants for planting can also contribute to the spread of CPs as this species is now widely used as an ornamental plant and can host large populations of *H. obsoletus*.

CPs can also spread through the activity of its insect vectors. Movement of infectious insect vectors can theoretically take place through movement of soil or plant roots contaminated by nymphs, but it has never been observed in practice.

Overall, given the wide availability of reservoir host species and of insect vectors, CPs has the potential to efficiently spread throughout a wide range of EU MSs.

3.5. Elements to assess the potential for consequences in the EU

3.5.1. Potential effects of *Candidatus* Phytoplasma solani

In general, the impact of CPs is variable, depending on yearly variations in insect vector abundance. Annual crops develop symptoms a few weeks after insect inoculation, whereas symptoms on perennial hosts, such as grapevine, can appear one or more years after inoculation.

Symptoms of CPs on potato plants include upward rolling and purplish or red discoloration of the top leaves, shortened internodes, aerial tubers, early senescence and, finally, plant wilt and death. Severe CPs outbreaks have been reported in potato fields in several countries, including the Czech Republic, Hungary, Romania and Russia, causing significant (30 %–80 %) yield loss and a reduction in seed potato quality (Paltrinieri and Bertaccini 2007; Mozhaeva et al., 2008; Girsova et al., 2008; Lindner et al., 2008, 2011; Fialová et al., 2009). In addition, CPs infection increases the sucrose content of tubers by three- to six-fold; this severely affects the suitability of tubers for fried potato processing, as sucrose serves as a substrate in Maillard reactions to produce brown discoloration (Lindner et al., 2011). In severe epidemics, yield losses as high as 60 % in tomato, 93 % in pepper, and 100 % in celery have been reported (Navratil et al., 2009).

CPs infection of grapevine, also known as bois noir disease, produces leaf yellows (in white-berried cultivars) or leaf reddening (in red-berried cultivars), downwards leaf rolling, cane lignification defects, and shrivelling and drying up of berries and bunches. Young plants can die following infection, while older plants tend to recover (Belli et al., 2010). The severity of the symptoms depends on cultivar sensitivity; Chardonnay, Pinot blanc, Pinot noir, Cabernet Sauvignon, Barbera, Sauvignon blanc, Pinot gris and Sémillon are considered the most sensitive. As CPs causes symptoms that cannot be distinguished from those caused by flavescence dorée, high local incidences of CPs infection can severely complicate the surveys for flavescence dorée, which is a quarantine pest.

MR symptoms caused by CPs infection appear in late July, and include reddening of the leaf midrib, followed by reddening of leaves and stalks. Ear development is abnormal and seed set is greatly reduced. No dwarfing is associated with MR. MR has been linked to yield reductions of 40 %–90 % in southern Banat, Serbia (Jovic et al., 2007)

CPs also has a high impact on lavender crops. After displaying early symptoms, characterised by low vigour and leaf yellowing, the canopy of infected lavender dries by sectors and plants eventually die (Boudon-Padieu and Cousin, 1999). Because of epidemic propagation by *H. obsoletus*, able to complete its life cycle on this crop (Sforza et al., 1999), fields of *L. angustifolia* are usually destroyed within 4–5 years in south-eastern France (Foissac et al., 2013). Hybrids between *L. angustifolia* and *L. latifolia*, previously considered to be tolerant, exhibit the same symptoms and can reach an equivalent level of infection (Gaudin et al., 2011).

Impact can also be significant in a range of other hosts. Impact may increase in the future from range-extension and from increase in density of vector populations as a consequence of climate change. Overall, CPs has the potential to cause significant impact in a range of important EU crops.

3.5.2. Observed impact of *Candidatus* Phytoplasma solani in the EU

CPs has been reported to have a high impact on potato fields in eastern parts of the EU, but impact is limited in western parts of the EU. Locally, the impact on other solanaceous crops can be high because of high insect vector populations and the presence of a bindweed reservoir. The incidence of bois noir disease in EU vineyards had been increasing since 2000, but is now decreasing again, except in central Europe where new nettle-specific CPs genotypes have recently emerged (in the Styria region of Austria and the South Moravia region of the Czech Republic, Safarova et al., 2011; Aryan et al., 2014). The French production of lavender essential oil and lavender hybrids is heavily affected, but no impact has yet been reported in Bulgaria or Spain. In the EU, only low incidences of MR have been reported (in Hungary, Acs et al., 2011).

3.6. Currently applied control methods in the EU

Efficient certification systems exist for seed potato tubers (EPPO, 1999), with CPs among the targeted pathogens. This efficiently reduces the spread and impact associated with the plants for planting pathway, but it does not address vector-mediated contamination of potato crops once planted in the field. Certification has recently been developed in France for lavender planting material, but this has not been widely adopted elsewhere. CPs in strawberry is generally not covered by certification, but is efficiently controlled in strawberry nurseries as a result of the strong symptoms exhibited by mother plants when harvesting daughter plants in autumn (Danet et al., 2003).

There are currently no control methods applied against CPs vectors, but the reduction of weeds acting as reservoirs (bindweed and stinging nettles) is under evaluation. Trials conducted to control nettle growth with glyphosate, or a mixture of glyphosate and flazasulfuron, significantly reduced the density of emerging adult vectors. The efficacy of herbicides was highest when applied in autumn or in early spring when the nymphs are not older than the fourth instar. Herbicides applied too close to the beginning of the adult emergence stage reduced numbers only during the late part of the planthopper flight period. Although neonicotinoid insecticides, applied in early spring, gave protection levels comparable to those of herbicide treatments, their use is not advisable because of their potentially negative effects on non-target arthropods (e.g. honeybees, Mori et al., 2014).

3.7. Uncertainty

There are uncertainties on most of the parameters analysed in the present pest categorisation. The long-term impact of emerging CPs genotypes associated with nettle or lavender and their impact on crops other than grapevine and lavender are difficult to evaluate.

There also uncertainties about the evolution of the distribution of insect vectors and changes in their population densities as a consequence of global warming.

CONCLUSIONS

The Panel summarises, in Table 7, its conclusions on the key elements addressed in this scientific opinion in consideration of the pest categorisation criteria defined in ISPM 11 and ISPM 21 and of the additional questions formulated in the terms of reference.

Table 7: The Panel's conclusions on the pest categorisation criteria defined in the International Standards for Phytosanitary Measures (ISPM) No 11 and No 21 and on the additional questions formulated in the terms of reference

Criterion of pest categorisation	Panel's conclusions on ISPM 11 criterion	Panel's conclusions on ISPM 21 criterion	List of main uncertainties
	Provide answers to the questions in the column below!	*Provide answers to the questions in the column below*	*List key uncertainties!*
Identity of the pest	*Is the identity of the pest clearly defined? Do clearly discriminative detection methods exist for the pest?* CPs is a well-defined species, and specific and sensitive detection methods are available		
Absence/presence of the pest in the risk assessment area	*Is the pest absent from all or a defined part of the risk assessment area?* CPs is absent from northern EU MS	*Is the pest present in the risk assessment area?* CPs is present in a wide range of central or southern EU MS	Some uncertainties exist on CPs precise distribution
Regulatory status	*Mention in which annexes of 2000/29/EC and the marketing directives the pest and associated hosts are listed without further analysis. Indicate also whether the hosts and/or commodities for which the pest is regulated in AIIAI or II are comprehensive of the host range* CPs, as potato stolbur mycoplasma, is listed in Annex IIAII of Directive 2000/29/EC, but only regulated in *Solanaceae* plants for planting despite having a larger host range		
Potential establishment and spread	*Does the risk assessment area have ecological conditions (including climate and those in protected conditions) suitable for the establishment and*	*Are plants for planting a pathway for introduction and spread of the pest?* Plants for planting of several vegetatively propagated host	There is uncertainty about the future distribution of insect vectors and changes in their

Criterion of pest categorisation	Panel's conclusions on ISPM 11 criterion	Panel's conclusions on ISPM 21 criterion	List of main uncertainties
	Provide answers to the questions in the column below!	*Provide answers to the questions in the column below*	*List key uncertainties!*
	spread of the pest? *Indicate whether the host plants are also grown in areas of the EU where the pest is absent.* *And, where relevant, are host species (or near relatives), alternate hosts and vectors present in the risk assessment area?* CPs vectors are absent, for geographical or ecoclimatic reasons, from a range of northern EU MS, limiting the capacity for establishment and spread of CPs in these countries Host plants of CPs are cultivated in northern EU MS in which CPs is absent	species constitute a pathway for introduction of CPs, but would not support further natural spread since they do not support insect vector multiplication and cannot therefore serve as reservoirs. Lavender plants for planting can contribute both to introduction and spread of CPs as they support both CPs and vector multiplication	population densities as a consequence of global warming There is uncertainty about the long-term impact of emerging CPs genotypes associated with nettle or lavender
Potential for consequences in the risk assessment area	*What are the potential for consequences in the risk assessment area?* *Provide a summary of impact in terms of yield and quality losses and environmental consequences* CPs has the potential to cause significant yield losses in a range of important EU crops such as potato, tomato, grapevine, lavender, maize and strawberry	*If applicable is there indication of impact(s) of the pest as a result of the intended use of the plants for planting?* Despite the fact that the vector cannot multiply on most cultivated hosts, so that plants for planting of these species are dead-end hosts, impact is expected on the yield of these plants. Plants for planting of lavender can serve as reservoir and besides direct impact on lavender can result in impact in other crops in MS where vectors are present	Impact is mostly affected by the local existence of reservoirs and by the size of vector populations Uncertainties exist on the extent of impact in the various susceptible crops grown in the EU
Conclusion on pest categorisation	*Provide an overall summary of the above points* CPs is a well-defined species with available assays for its detection. CPs is reported as absent from 14 EU MS, mostly from northern Europe where the vectors are absent. Establishment and spread are mostly limited by vector populations and CPs has therefore the potential to establish and spread in unaffected parts of the EU territory with the extension of the range of its vectors. CPs host plants, cultivated or wild, are present all over the EU, and	*Provide an overall summary of the above points* Infected plants for planting of several vegetatively propagated hosts represent a pathway of CPs dissemination. With the exception of lavender these plants for planting will not contribute to the spread of CPs, as they represent dead-end hosts on which insect vectors do not multiply. Plants for planting of lavender can serve as a reservoir and, besides direct impact on lavender, can result in impact in other crops in MSs where vectors are present	There is uncertainty about the precise distribution of CPs and its vectors, and about the future distribution of vectors as a consequence of global warming There is uncertainty about the long-term impact of emerging CPs genotypes associated with nettle or lavender Uncertainties exist on the extent of

Criterion of pest categorisation	Panel's conclusions on ISPM 11 criterion	Panel's conclusions on ISPM 21 criterion	List of main uncertainties
	Provide answers to the questions in the column below!	*Provide answers to the questions in the column below*	*List key uncertainties!*
	CPs has the potential to cause yield losses in a range of important EU crops		impact in the various susceptible crops grown in the EU

Conclusion on specific ToR questions	*If the pest is already present in the EU, provide a brief summary of:* – *the analysis of the present distribution of the organism in comparison with the distribution of the main hosts, and the distribution of hardiness/climate zones, indicating in particular if, in the risk assessment area, the pest is absent from areas where host plants are present and where the ecological conditions (including climate and those in protected conditions) are suitable for its establishment,* CPs is present in 14 EU MS where its insect vectors are well established. CPs vectors are absent, for geographical or eco-climatic reasons, from a range of northern EU MS, limiting the capacity for establishment and spread of CPs in these countries *and* – *the analysis of the observed impacts of the organism in the risk assessment area* Impact is mostly affected by the local existence of reservoirs and by the size of vector populations. Where CPs does occur, its impact can be significant but shows high yearly fluctuations associated with fluctuations in the population densities of insect vectors and of wild plant reservoirs that cannot be easily controlled	There is uncertainty about the precise distribution of CPs and its vectors. There is uncertainty about the long-term impact of emerging CPs genotypes associated with nettle or lavender Uncertainties exist on the extent of impact in the various susceptible crops grown in the EU

REFERENCES

Acs Z, Jović J, Ember I, Cvrković T, Nagy Z, Talaber C, Gergely L, Toševski I and Kolber M, 2011. First report of Maize redness disease in Hungary. Bulletin of Insectology 64, 229–230.

Angelini E, Bianchi GL, Filippin L, Morassutti C and Borgo M, 2007. A new TaqMan method for the identification of phytoplasmas associated with grapevine yellows by real-time PCR assay. Journal of Microbiological Methods, 68, 613–622.

Aryan A, Brader G, Mörter J, Pastar M and Riedle-Bauer M, 2014. An abundant “Candidatus Phytoplasma solani” tuf b strain is associated with grapevine, stinging nettle and Hyalesthes obsoletus. European Journal of Plant Pathology, 140, 213–227.

Avramov Z, Contaldo N, Bertaccini A and Sakalieva D, 2011. First report of stolbur phytoplasmas in Prunus avium in Bulgaria. Bulletin of Insectology, 64, S71–S72.

Balakishiyeva G, Danet JL, Qurbanov M, Mamedov A, Khey-Pour A and Foissac X, 2010. First report of phytoplasma infections in several temperate fruit trees and vegetable crops in Azerbaijan. Journal of Plant Pathology, 92 (S4), 115.

Batlle A, Altabella N, Sabate J and Lavina A, 2008. Study of the transmission of stolbur phytoplasma to different crop species, by *Macrosteles quadripunctulatus*. Annals of Applied Biology, 152, 235–242.

Belli G, Bianco P and Conti M, 2010. Grapevine yellows in Italy: past, present and future. Journal of Plant Pathology, 92, 303–326.

Boudon-Padieu E and Cousin MT, 1999. Yellow decline of *Lavandula hybrida* Rev and *L. vera* DC. International Journal of Tropical Plant Diseases, 17, 1–34.

Bressan A, Turata R, Maixner M, Spiazzi S, Boudon-Padieu E and Girolami V, 2007. Vector activity of *Hyalesthes obsoletus* living on nettles and transmitting a stolbur phytoplasma to grapevines: a case study. Annals of Applied Biology, 150, 331–339.

Cimerman A, Pacifico D, Salar P, Marzachì C and Foissac X, 2009. Striking diversity of vmp1, a variable gene encoding a putative membrane protein of the Stolbur phytoplasma. Applied and Environmental Microbiology, 75, 2951–2957.

Clair D, Larrue J, Aubert G, Gillet J, Cloquemin G and Boudon-Padieu E, 2003. A multiplex nested-PCR assay for sensitive and simultaneous detection and direct identification of phytoplasma in the Elm yellows group and Stolbur group and its use in survey of grapevine yellows in France. Vitis, 42, 151–157.

Cvrkovic T, Jovic J, Mitrovic M, Krstic O and Tosevski I, 2014. Experimental and molecular evidence of Reptalus panzeri as a natural vector of bois noir. Plant Pathology, 63, 42–53.

Danet JL, Foissac X, Zreik L, Salar P, Verdin E, Nourrisseau JG and Garnier M, 2003. “Candidatus Phlomobacter fragariae” is the prevalent agent of marginal chlorosis of strawberry in French production fields and is transmitted by the planthopper *Cixius wagneri* (China). Phytopathology, 93, 644–649.

Danet JL, Sémétey O, Gaudin J, Verdin E, Chaisse E and Foissac X, 2010. Lavender decline is caused by several genetic variants of the Stolbur phytoplasma in south eastern France. Paper read at First meeting of COST FA0807 Integrated management of phytoplasma epidemics in different crop systems, at Sitges, Spain.

De Jonghe K, Tahzima R and Maes M, 2013. First occurrence of *Candidatus* Phytoplasma solani associated with seed potato in Belgium. Abstract book 65th ISCP.

Duduk B and Bertaccini A, 2006. Maize with symptoms of reddening: new host of stolbur phytoplasma. Plant Disease, 90, 1313–1319.

EFSA Panel on Plant Health (PLH), 2010. PLH Guidance on a harmonised framework for pest risk assessment and the identification and evaluation of pest risk management options by EFSA. EFSA Journal 2010;8(2):1495, 66 pp. doi:10.2093/j.efsa.2010.1495.

Ember I, Acs Z, Munyaneza JE, Crosslin JM and Kolber M, 2011. Survey and molecular detection of phytoplasmas associated with potato in Romania and southern Russia. European Journal of Plant Pathology, 130, 367–377.

EPPO (European and Mediterranean Plant Protection Organization) PQR (Plant Quarantine Data Retrieval System), 2012. EPPO database on quarantine pests. Available online: http://www.eppo.int.

EPPO (European and Mediterranean Plant Protection Organization) Standards, 1999. Certification schemes. Seed potatoes. Paris: EPPO/OEPP, PM 4/28(1). Bulletin OEPP/EPPO Bulletin.

Fabre A, Balakishiyeva G, Ember I, Omar A, Acs Z, Koelber M, Kauzner L, Bartola MD, Danet JL and Foissac X, 2011b. StAMP encoding the antigenic membrane protein of stolbur phytoplasma is useful for molecular epidemiology. Bulletin of Insectology, 64, S21–S22.

Fabre A, Danet JL, and Foissac X, 2011a. The stolbur phytoplasma antigenic membrane protein gene stamp is submitted to diversifying positive selection. Gene, 472, 37–41.

FAO (Food and Agriculture Organization), 2004. ISPM 21: International Standards for Phytosanitary Measures; pest risk analysis of regulated non-quarantine pests. FAO, Rome. Available online:

https://www.ippc.int/sites/default/files/documents//1323945746_ISPM_21_2004_En_2011-11-29_Refor.pdf.

FAO (Food and Agriculture Organization), 2013. ISPM 11: International Standards for Phytosanitary Measures; pest risk analysis for quarantine pests. FAO, Rome. Available online: https://www.ippc.int/sites/default/files/documents/20140512/ispm_11_2013_en_2014-04-30_201405121523-–494.65%20KB.pdf.

FERA (The Food and Environment Research Agency), 2014. Rapid Pest Risk Analysis for *Candidatus* Phytoplasma solani. Available online: http://www.fera.defra.gov.uk/plants/plantHealth/pestsDiseases/documents/candidatusPhytoSolani.pdf.

Fialová R, Válová P, Balakishiyeva G, Danet JL, Šafářová D, Foissac X and Navrátil M, 2009. Genetic variability of stolbur phytoplasma in annual crop and wild plant species in south Moravia (Czech Republic). Journal of Plant Pathology, 91, 411–416.

Fischer HU, 1979. Stolbur a new threat to tomato production in Marocco. Zeitschrift Fur Pflanzenkrankheiten Und Pflanzenschutz-Journal of Plant Diseases and Protection, 86, 336–340.

Foissac X, Carle P, Fabre A, Salar P, Danet JL and STOLBUR-EUROMED consortium, 2013. “Candidatus Phytoplasma solani” genome project and genetic diversity in the Euro-Mediterranean basin. Invited conference. In: Third European Bois Noir Workshop. Eds Torres E, Lavina A and Batlle A. Barcelona, Spain.

Fos A, Danet JL, Zreik L, Garnier M and Bové JM, 1992. Use of a monoclonal-antibody to detect the stolbur mycoplasma-like organism in plants and insects and to identify a vector in France. Plant Disease, 76, 1092–1096.

Garnier M, 2000. The stolbur phytoplasma: an ubiquitous agent. Comptes Rendus de l’Academie d’Agriculture de France, 86, 27–33.

Gatineau F, Larrue J, Clair D, Lorton F, Richard-Molard M and Boudon-Padieu E, 2001. A new natural planthopper vector of stolbur phytoplasma in the genus *Pentastiridius* (Hemiptera: Cixiidae). European Journal of Plant Pathology, 107, 263–271.

Gatineau F, Jacob N, Vautrin S, Larrue J, Lherminier J, Richard-Molard A and Boudon-Padieu E, 2002. Association with the syndrome “basses richesses” of sugar beet of a phytoplasma and a bacterium-like organism transmitted by a *Pentastiridius* sp. Phytopathology, 92, 384–392.

Gaudin J, Semetey O, Foissac X and Eveillard S, 2011. Phytoplasma titre in diseased lavender is not correlated to lavender tolerance to stolbur phytoplasma. Paper read at Second International Congress of Phytoplasmologists (IPGW), Neustadt, Germany.

Girsova N, Bottner KD, Mozhaeva KA, Kastalyeva TB, Owens RA and Lee IM, 2008. Molecular detection and identification of group 16SrI and 16SrXII phytoplasmas associated with diseased potatoes in Russia. Plant Disease, 92, 654. doi.org/10.1094/PDIS-92-4-0654A.

Gundersen DE and Lee IM, 1996. Ultrasensitive detection of phytoplasmas by nested-PCR assays using two universal primer pairs. Phytopathologia Mediterranea, 35, 114–151.

Hren M, Boben J, Rotter A, Kralj P, Gruden K and Ravnikar M, 2007. Real-time PCR detection systems for Flavescence doree and Bois noir phytoplasmas in grapevine: comparison with conventional PCR detection and application in diagnostics. Plant Pathology, 56, 785–796.

Imo M, Maixner M and Johannesen J, 2013. Sympatric diversification vs. immigration: deciphering host-plant specialization in a polyphagous insect, the stolbur phytoplasma vector *Hyalesthes obsoletus* (Cixiidae). Molecular Ecology, 22, 2188–2203.

Johannesen J, Lux B, Michel K, Seitz A and Maixner M, 2008. Invasion biology and host specificity of the grapevine yellows disease vector *Hyalesthes obsoletus* in Europe. Entomologia Experimentalis Et Applicata, 126, 217–227.

Johannesen J, Foissac X, Kehrli P and Maixner M, 2012. Impact of vector dispersal and host-plant fidelity on the dissemination of an emerging plant pathogen. PLoS ONE, 7, e51809.

Jovic J, Cvrkovic T, Mitrovic M, Kmjaji S, Redinbaugh MG, Pratt RC, Gingery RE, Hogenhout SA and Tosevski I, 2007. Roles of stolbur phytoplasma and *Reptalus panzeri* (Cixiinae, Auchenorrhyncha) in the epidemiology of maize redness in Serbia. Phytopathology, 97, S54–S54.

Jovic J, Cvrkovic T, Mitrovic M, Krnjajic S, Petrovic A, Redinbaugh MG, Pratt RC, Hogenhout SA and Tosevski I, 2009. Stolbur phytoplasma transmission to maize by *Reptalus panzeri* and the disease cycle of maize redness in Serbia. Phytopathology, 99, 1053–1061.

Langer M and Maixner M, 2004. Molecular characterisation of grapevine yellows associated phytoplasmas of the stolbur-group based on RFLP-analysis of non-ribosomal DNA. Vitis, 43, 191–199.

Lindner K, Maixner M and Roman M, 2008. Climate change as a potential cause of the occurrence of potato stolbur in Germany. Parasitology Research, 103, S157–S157.

Lindner K, Haase NU, Roman M and Seemueller E, 2011. Impact of stolbur phytoplasmas on potato tuber texture and sugar content of selected potato cultivars. Potato Research, 54, 267–282.

Maixner M, 1994. Transmission of German grapevine yellows (Vergilbungskrankheit) by the planthopper *Hyalesthes obsoletus* (Auchenorrhyncha:Cixiidae). Vitis, 33, 103–104.

Maixner M and Langer M, 2006. Prediction of the flight of *Hyalesthes obsoletus*, vector of stolbur phytoplasma, using temperature sums. Bulletin OILB/SROP, 29(11), 161–166.

Maixner M, Albert A and Johannesen J, 2014. Survival relative to new and ancestral host plants, phytoplasma infection, and genetic constitution in host races of a polyphagous insect disease vector. Ecology and evolution, 4, 3082–3092.

Mori N, Mitrovic J, Smiljkovic M, Duduk N, Paltrinieri S, Bertaccini A and Duduk B, 2013. Hyalesthes obsoletus in Serbia and its role in the epidemiology of maize reddening. Bulletin of Insectology, 66, 245–250.

Mori N, Pavan F and Maixner M, 2014. Control of Hyalesthes obsoletus nymphs based on chemical weeding and insecticides applied on *Urtica dioica*. Vitis, 53, 103–109.

Mozhaeva KA, Girsova NV, Kastal’eva TB and Bogoutdinov DZ, 2008. Studying phytoplasma diseases of potato. Zashchita i Karantin Rastenii, 11, 38–41.

Navratil M, Valova P, Fialová R, Lauterer P, Safarova D and Stary M, 2009. The incidence of stolbur disease and associated yield losses in vegetable crops in South Moravia (Czech Republic). Crop Protection, 28, 898–904.

Pacifico D, Alma A, Bagnoli B, Foissac X, Pasquini G, Tessitori M and Marzachi C, 2009. Characterization of bois noir isolates by restriction fragment length polymorphism of a stolbur-specific putative membrane protein gene. Phytopathology, 99, 711–715.

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

Pelletier C, Salar P, Gillet J, Cloquemin G, Very P, Foissac X and Malembic-Maher S, 2009. Triplex real-time PCR assay for sensitive and simultaneous detection of grapevine phytoplasmas of the 16SrV and 16SrXII-A groups with an endogenous analytical control. Vitis, 48, 87–95.

Petrovic N, Boben J and Ravnikar M, 2004. Laboratory testing of grapevine yellows in Slovenia indicates a widespread presence of Bois noir. Acta Agriculturae Slovenica, 83, 313–321.

Pinzauti F, Trivellone V and Bagnoli B, 2008. Ability of *Reptalus quinquecostatus* (Hemiptera: Cixiidae) to inoculate stolbur phytoplasma to artificial feeding medium. Annals of Applied Biology, 153, 299–305.

Ploaie PG and Chireceanu C, 2012. Experimental proofs regarding the association of cell wall deficient bacteria (mycoplasmalike organisms, phytoplasmas) with grapevine yellows disease in Romania. Romanian Biotechnological Letters, 17, 7260–7269.

Quaglino F, Zhao Y, Bianco PA, Wei W, Casati P, Durante G and Davis RE, 2009. New 16Sr subgroups and distinct single nucleotide polymorphism lineages among grapevine Bois noir phytoplasma populations. Annals of Applied Biology, 154, 279–289.

Quaglino F, Zhao Y, Casati P, Bulgari 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.

Riedle-Bauer M, Sara A and Regner F, 2008. Transmission of a Stolbur phytoplasma by the Agalliinae leafhopper *Anaceratagallia ribauti* (Hemiptera, Auchenorrhyncha, Cicadellidae). Journal of Phytopathology, 156, 687–690.

Safarova D, Lauterer P, Korbasova Z, Stary M, Valova P and Navratil M, 2011. *Hyalesthes obsoletus*, a vector of stolbur phytoplasma: current situation in South Moravia, Czech Republic. Bulletin of Insectology, 64, S127–S128.

Schneider B, Seemüller E, Smart CD and Kirkpatrick BC, 1995. Phylogenetic classification of plant pathogenic mycoplasmalike organisms or phytoplasmas. In: Molecular and diagnostic procedures in mycoplasmology. Eds Razin S and Tully JG. Academic Press, San Diego, CA, USA. pp. 369–380.

Sforza R, Bourgoin T, Wilson SW and Boudon-Padieu E, 1999. Field observations, laboratory rearing and descriptions of immatures of the planthopper *Hyalesthes obsoletus* (Hemiptera: Cixiidae). European Journal of Entomology, 96, 409–418.

Sousa E, Mimoso C and Cardoso F, 2013. Bois noir identification on grapevine in Portugal. In: Third European Bois Noir Workshop. Eds Torres E, Lavina A and Batlle A. Barcelona, Spain.

Torres E, Batlle A, Lavina A, Bech J, Bertaccini A and Sousa E, 2014. Review of occurrence of phytoplasmas in Spain, Portugal and Malta. In: Phytoplasma and phytoplasma disease management: how to reduce their economic impact. Ed. Bertaccini A. COST Action FA0807, IPWG, Bologna, Italy. pp. 58–61.

Zirak L, Bahar M and Ahoonmanesh A, 2009a. Characterization of phytoplasmas associated with almond diseases in Iran. Journal of Phytopathology, 157, 736–741.

Zirak L, Bahar M and Ahoonmanesh A, 2009b. Molecular characterization of phytoplasmas related to peanut witches'broom and stolbur groups infecting plum in Iran. Journal of Plant Pathology, 91, 713–716.

Zirak L, Bahar M and Ahoonmanesh A, 2010. Molecular characterization of phytoplasmas associated with peach diseases in Iran. Journal of Phytopathology, 158, 105–110.

ABBREVIATIONS

CPs	*Candidatus* Phytoplasma solani
EFSA	European Food Safety Authority
EPPO	European and Mediterranean Plant Protection Organization
EPPO-PQR	European and Mediterranean Plant Protection Organization Plant Quarantine Retrieval System
EU	European Union
ISPM	International Standards for Phytosanitary Measures
MR	maize redness
MS	Member State
NPPO	National Plant Protection Organisation
PLH Panel	Plant Health Panel
PRA	pest risk analysis
RFLP	restriction fragment length polymorphism
rRNA	ribosomal RNA