The Food & Environment Research Agency

Rapid Pest Risk Analysis for *Candidatus* Phytoplasma solani

STAGE 1: INITIATION

1.What is the name of the pest?

Candidatus Phytoplasma solani (Quaglino et al., 2013). The pathogen may also be referred to as *Phytoplasma solani* and (according to its phylogenetic grouping) as *Phytoplasma* 16SrXII-A. Disease names include stolbur, bois noir (of grapevine), 'grapevine yellows' (a non-specific name), potato stolbur, potato stolbur mycoplasm and maize redness (corn reddening). In this PRA the pathogen is abbreviated as CPs.

2. What is the pest's status in the EC Plant Health Directive (Council Directive 2000/29/EC[1]) and in the lists of EPPO[2]?

EC IIAII (on plants of *Solanaceae*, intended for planting, other than seeds) and EPPO A2 listed.

3. What is the reason for the rapid assessment?

The need for a rapid PRA was identified during the assessment of CPs for inclusion in the UK Plant Health Risk Register in order to help inform the decision on whether statutory action against future interceptions is justified.

STAGE 2: RISK ASSESSMENT

4. What is the pest's present geographical distribution?

A phylogenetic study (Quaglino et al., 2013, see Appendix 1) has confirmed that CPs is widespread in Europe and the pathogen has been found in France (Burgundy and Rhone Valley including the Alsace region), Serbia, Bulgaria, Croatia, Montenegro, Spain, Germany , Switzerland, Italy, Republic of Macedonia, Poland, Romania, Czech Republic, Turkey, Greece, Lebanon, Cuba, Iran, Russia and China (Genov et al., 2014, Lotus et al., 2013, Daire et al., 1997 and Mitrev et al., 2007). Recently, CPs has been reported in potato from Belgium (De Jonge et al., 2013).

5. Is the pest established or transient, or suspected to be established/transient in the UK?

Candidatus Phytoplasma solani is not established in the UK and there has been only a single confirmed UK case, which occurred in mid-2014 in strawberry plants introduced from another member state (Peter Reed). Further investigations including tracing of plants from the same batch grown at other locations is being carried out.

6. What are the pest's natural and experimental host plants; of these, which are of economic and/or environmental importance in the UK?

CPs has a wide host range and has been isolated from Grapevine, maize, pea, clover, potato, red pepper, *Convolvulus arvenis* (field bindweed), *Calystegia sepium* (hedge

[1] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2000L0029:20100113:EN:PDF
[2] http://archives.eppo.int/EPPOStandards/PM1_GENERAL/pm1-02(21)_A1A2_2012.pdf

bindweed), stinging nettle, periwinkle, rhododendron, apple, apricot, peach, *Prunus meme*, *Capsicum annum*, *Solanum glaucophylla*, tomato, strawberry, celery, evening primrose, paeony (*Paeonia tenuifolia*) cultivated blackberry, *Datura stramonium* and *Catharanthus roseus* (Murolo et al., 2010; Quaglino et al., 2013, Kuzmanovic et al., 2011; Langer and Maixner, 2004; Lotus et al., 2013 and Adamovic et al., 2014).

Important UK CPs crop hosts include potato, grapevine, maize, strawberry, pea, clover and tomato. Significant damage to stinging nettle, field bindweed and hedge bindweed has not been reported, though the first two CPs host species are very important as infection reservoirs (Maniyar et al., 2013) and all three are widespread in the UK.

7. If the pest needs a vector, is it present in the UK?
(Chris Malumphy has contributed to this section)

Transmission of CPs requires an insect vector and the occurrence of a vector determines the extent of the threat from the pathogen. Species of Hemiptera within the suborder Auchenorrhyncha, comprise the principle vectors. In Europe *Hyalesthes obsoletus* (a polyphagous plant hopper) is the most important vector of CPs but this vector is absent from the UK.
H. obsoletus vectors stolbur diseases of vine (bois noir), potato, maize and other hosts (Lessio et al., 2007; Sabate et al., 2014; Mori et al., 2013). A CPs infection incidence in *H. obsoletus* of up to 76% has been reported in Spain (Sabate et al., 2014). It has not been possible to find primary reports delineating the geographical range of *H. obsoletus*, though the study reported by Imo et al., (2013) refers to the vector as a 'predominantly Mediterranean species' with a north easterly range as south-west Germany and the Alsace region of (central-eastern) France. However, this study also reports *H. obsoletus*, in central western Germany (at a latitude equivalent to southern Belgium and Luxembourg). The study also reports a rapid increase of *H. obsoletus* over the past two decades in favourable vine producing valleys associated with stinging nettle in the north easterly part of its distribution, where previously the vector was rare. The increase in population in the region has been attributed to the evolution of a new 'nettle-preferring race' of *H. obsoletus* (Kessler et al., 2011). Recent genetic analysis has confirmed the distinctiveness and evolution of the new race (Imo et al., 2013). The new host range race has been responsible for vectoring the tuf-a strain of CPs, which has caused significant production losses from bois noir in central eastern France, western Germany and northern Switzerland (Imo et al., 2013).

Host plants on which *H. obsoletus* nymphs can complete their development vary according to region. As well as stinging nettle, field bindweed and hedge bindweed (see section 7), hosts on which the vector can complete its development include lavander (Sforza et al., 1999), monks pepper- *Vitex agnus-castus*, (Sharon et al., 2005), mugwort- *Artemisia vulgaris,* (Mori et al., 2013) and dead nettle (Forte et al., 2010). Stinging nettle and field bindweed are perennials that are important European environmental reservoirs for CPs and are the primary hosts used by *H. obsoletus.*

Reptalus panzer has been reported to vector both maize redness and bois noir in Serbia (Jovic et al., 2009; Cvrkovic et al., 2014). Whilst *R. panzer* is absent from the UK, another *Reptalus* species, *R. quinquecostatus*, occurs rarely in the UK (see systematic lists of British Auchenorrhyncha available at http://www.britishbugs.org.uk). Other recorded vectors are *Anaceratagallia ribauti* (Riedle-Bauer et al., 2008) and *Macrosteles quadripunctulatus* (Batlle et al., 2008) that are present in the UK but (respectively), occur rarely or locally. Another recorded vector, *Pentastiridius bieri* (Gatineau et al., 2001), is also absent from the UK. A study of maize redness and *R. panzer* in Serbia found evidence for a crop-based disease cycle where adults infect maize with CPs in the summer and then utilise winter wheat planted after harvesting of the maize as a nymphal host, which enables the vector to over winter and complete its life cycle (Jović et al., 2009).

CPs has been detected in a sample of tarnished plant bug *Lygus* spp. (Breizikova and Linhartova, 2007) and members of this genus have been shown to vector stolbur experimentally to tomato and pepper (Neklyudova and Dikii 1973). *Lygus* speciation is difficult and not all specimens can be identified to species level (Nau, 2004) see also the British bugs website available at: http://www.britishbugs.org.uk/heteroptera/Miridae/lygus_rugulipennis.html). *Lygus cf. pratensis* species have increased rapidly in recent years and have become widespread in southern England (Nau, 2004). *L. rugulipennis* is a common UK species found on many common weed species (Nau, 2004)

8. What are the pathways on which the pest is likely to move and how likely is the pest to enter the UK?

Entry of CPs in the absence of vector

Infected Plants for planting	Very unlikely		Unlikely		Moderately likely		Likely	X	Very likely	

CPs has a very wide host range which increases entry risks from infected plants for planting. Potential hosts that may be imported as plants for planting include lavender, strawberry, cultivated blackberry, grapevine, *Convolvulaceae* and *Solanaceae* (including potato tubers). Given the wide host range of *H. obsoletus*, other imported plants could provide an entry pathway for the pathogen. Taking into account the import of grapevine and lavender plants for planting entry and is scored as likely.

Entry of *H. obsoletus* with CPs

Infected vector	Very unlikely		Unlikely		Moderately likely	X	Likely		Very likely	

Many crop hosts of CPs are infected incidentally from reservoirs maintained in stinging nettle and field bindweed that have not been recorded as feeding hosts for vector nymphs. The risks of entry with infected adult vectors from imported crops including grapevine and potato are scored as unlikely because adult vectors would not be expected to associate with transported crops. Natural reservoir hosts are not traded and entry through stinging nettle or bindweed can be ignored. Minor hosts such as lavender or dead nettle may pose an entry risk for the nymphal stages of vector, which is scored as moderately likely. There is some uncertainty in the scoring because of the possibility that unreported hosts could be used as a food plant by *H. obsoletus* nymphs.

Additionally, hitch hiking of infected adult *H. obsoletus* on cross-channel passenger baggage or in vehicles used by tourists and holiday-makers who have visited areas where the vector is common constitutes an additional entry pathway. Whilst adult vectors would only rarely associate with vehicles and tents etc the vector can reach high population densities. This factor coupled with the high number of tourists in regions where the vector is common, and the speed of cross-channel links, increases the likelihood of *H. obsoletus* entry via hitch hiking which is rated as unlikely, though there is considerable uncertainty in the assessment.

9. How likely is the pest to establish outdoors or under protection in the UK?

Outdoors:	Very unlikely		Unlikely	X	Moderately likely	X	Likely		Very likely	
Under protection:	Very unlikely		Unlikely	X	Moderately likely		Likely		Very likely	

Establishment depends on the presence of indigenous UK vectors or the introduction of alien vectors, principally *H. obsoletus*. As the known principal vectors are absent from the UK establishment risks can be considered as unlikely, however there is some uncertainty because of the potential presence of unknown vectors, which could transmit the disease in the UK. Stinging nettle and field bindweed occur commonly in the UK and are important reservoir hosts for CPs in Europe vectored by *H. obsoletus*, which increases potential establishment risks if *H. obsoletus* were to enter the UK.

The rapid increase in population of *H. obsoletus* in its northern range in the last two decades, associated with 'nettle preferring race' and the accompanying increase in bois noir disease (from CPs strain tuf-a) is of concern. The recent report of CPs in potato in Belgium (De Jonghe et al., 2013) and reports of *H. obsoletus* in Germany, up to a latitude equivalent to southern Belgium (Imo e al., 2013), may be a continuing northerly range increase of both CPs disease and vector. Additionally, the potential for CPs to be transmitted in the UK by species in the same genus as known vectors increases uncertainty and both the unlikely and likely boxes are ticked. Establishment in protected cultivation is unlikely because members of the vector genera rarely occur here and risks are rated as unlikely.

10. How quickly could the pest spread in the UK?

	Very slowly	Slowly	Moderate pace	Quickly	Very quickly
Natural spread:		X			
In trade:			X		

The speed of natural spread is scored as slowly because the vectors do not fly long distances. Extensive colonisation of parts of Germany by the 'nettle preferring race' of *H. obsoletus* and associated tuf-a CPs strain has occurred over the past two decades (Imo et al., 2013), which probably occurred via natural spread associated with utilisation of nettle. CPs could be spread through trade of infected plants for planting, though without a vector crop infections would largely be self-limiting.

11. What is the area endangered by the pest?
Southern England where suitable vectors are more likely to be found.

12. What is the pest's economic, environmental or social impact within its existing distribution?

Very small	Small	Medium	Large	Very large
		X	X	

Disease in crop plants is dependent on significant vector populations, which preferentially use non-crop plants as hosts, especially field bindweed and stinging nettle. Disease in crops occurs incidentally when adult vectors that originate from preferred natural hosts feed on growing crops.

In potato, CPS causes spongy tubers which produce a brown discoloration on cooking in oil and so are unfit for processing and cannot be used as seed tubers (Linder et al., 2011; Ember et al., 2011). Aerial symptoms are variable and include premature wilting and death (Photo 1). Occasionally, when vector populations have been very high, substantial yield losses to potato production have been reported from Turkey, Romania, southern Russia and the Czech Republic (Citir, 1985; Eroglu et al., 2010; Ember et al., 2011a; Ember et al 2011 b; Fialová et al., 2009). In southern Romania Ember et al., (2011) found that16.7% and of potato tuber sampled contained CPs, whilst between 22.1 and 44.2% of potato tuber samples from southern Russia during 2008 and 2009 were infected with the pathogen.

Bois noir disease of vine has caused substantial economic losses in several European countries. Cps incidence is greatest at the boundary of fields, close to CPS environmental

reservoirs from which the pathogen is transmitted by *H. obsoletus* (Bressan et al., 2007). Typical symptoms include leaf yellowing or reddening (Photo 2) and shrivelled berry formation. A survey of Czech Republic regions found sporadic infections and reported that 14 localities within the Moravian region where found to be infected with CPs (Stary et al., 2013). The highest infection level (68% of vines) resulted in the vineyard being removed. In another vineyard in the region the incidence of infection ranged between 9.31 and 13.98% over a three year period. Despite observations of recovery from symptoms by some vine stems, yield losses of 25-30% and reduction in fruit clusters of 25% have been reported (Morone et al., 2007). Significant losses to grapevine have been recorded in France (Burgundy and Rhone Valley including the Alsace region), Germany and northern Switzerland from CPs tuf-a type vectored by the emerging 'nettle preferring race' of *H. obsoletus* (see section 7).
Maize redness which produces red colouration of midrib, leaf and stalk and has caused significant economic losses, for example outbreaks in the South Banat District of Serbia resulted in yield reductions of between 40 to 90% (Jorvic et al., 2009).

CPs has been reported in strawberry production areas in north and south Italy where affected plants showed pronounced stunting and a poor root system, though yield losses were not reported (Terlizzi et al., 2006, Credi et al., 2006). Similar symptoms of poor establishment and stunting were found in the UK outbreak (Peter Reed). The report from northern Italy describes surveys during 2004 and 2005, which found CPs in strawberry plants from nurseries but not production fields. Similarly in France CPs has also been reported in mostly in strawberry nurseries rather than production fields (Zreik et al., 2001). The vector of CPs in strawberry has not been confirmed.

13. What is the pest's potential to cause economic, environmental or social impacts in the UK?

A) In the absence of an efficient vector

Very small	Small	Medium	Large	Very large
X	X			

Crop damage by CPs is dependent on the presence of vector and its population density. The absence of the principal efficient vectors in the UK and very low populations of minor recorded vectors will limit economic damage from CPs to UK grown crops. In the absence of establishment of an efficient vector, damage to grapevine, maize, potato and tomato is scored as very small or small.

B) In the presence of an efficient vector

Very small	Small	Medium	Large	Very large
		X	X	

The development of an associated CPs infection reservoir in an environmental host (most likely in stinging nettle or bindweed) would increase risks of economic damage to crop plants. The development of the new 'nettle preferring race' of *H. obsoletus* in a new more northerly distribution in France and Germany (see sections 7) is a cause for concern, but the recent report (2012) of the CPs in potato in Belgium (De Jonghe et al., 2013) is particularly significant. Economic impacts to crops following establishment of *H. obsoletus* though are scored lower than that reported in east Europe because the UK is probably close to boundary of the distribution range of the vector and consequently comparatively lower vector populations would be expected. Potato, grapevine and maize are the most significant UK hosts to CPs.

The low (0.5%) vertical transmission rate of CPs to daughter potato tubers severely limits potential for disease to occur in the absence of vector (Ember et al 2011b). Potatoes grown for processing or supermarkets under contract, may incur disproportionate economic losses from CPs compared to the number of tubers affected, if the crop fails contractual quality control standards. CPs infection in potato may also result in reputational losses, which could result in reduced market access.

Taking into account these factors and the management options available (see section 15), economic damage to potato is scored as medium. There is however, some uncertainty and in some instances higher losses could be anticipated and therefore two boxes are scored for economic impact. Grapevine is vulnerable to CPs infection because this plant is maintained in vineyards over many years, though impacts may be reduced because of the potential for grapevine to clear infection (see section 12). Impacts to grapevine in the presence of *H. obsoletus* are scored as medium, providing management measures are undertaken (see section 15). Losses to maize production in the presence of the vector are scored as medium though there is considerable uncertainty.

14. What is the pest's potential as a vector of plant pathogens?
CPs cannot vector.

STAGE 3: PEST RISK MANAGEMENT

15. What are the risk management options for the UK? *(Consider exclusion, eradication, containment, and non-statutory controls; under protection and/or outdoors).*

(Peter Reed and Sharon Matthews-Berry are additional authors in this section)

The results of surveys should indicate if the infection originates from a local environmental reservoir source or from imported plants for planting. Removal of symptomatic plants will reduce intra crop transmission and risks of transmission to an environmental host. Control of vectors present in the crop or in weeds growing in the crop or adjoining field margins would also reduce damage (Janse, 2012). Rogueing of infected potato plants would reduce disease incidence in tubers. Establishment in bindweeds or nettle will be difficult to eradicate because of the widespread occurrence of these hosts in the UK. However, given that *H. obsoletus* in the UK would be close to the northern most latitude of its range, control of local nettle or bindweed populations might be effective in reducing vector numbers below a viable population. The use of herbicides to control local nettle and *H. obsoletus* populations have been recently been reported (Mori et al., 2014).

The key to excluding CPs from the UK is the exclusion of its vector. CPs is present in certain parts of the EU in potato crops but transmission via seed tubers is very limited. CPs is listed in Directive 2000/29/EU in Annex IIAII (as potato stolbur mycoplasma) and seed potatoes must either have originated in an area free from CPs and have been inspected are found free. Additionally, seed potatoes are produced under compulsory certifications schemes and will have been inspected under the requirements if the certification scheme. Therefore there is no need to put in place any further requirements in association with potatoes.

The CPs entry risks associated with ‘plants for planting’ from non-potato hosts is limited in the absence of the vector as infection will be restricted to the infected plants and will not spread. Therefore there is no need to put in place any entry requirements in association with these plants for planting.

The principle hosts of *H. obsoletus* (nettle and bindweed) are not traded and so there is little entry risk from these hosts. The low reporting of CPs and vector in commercial lavender production and other minor hosts, together with the long time period over which trade in this host has been permitted in Europe without introduction of the vector suggests that this pathway is not significant and therefore does not warrant additional control. However, further consideration may be justified if in the future evidence for increasing CPs infections or *H. obsoletus* infestations is reported in lavender or another traded host.

There is a risk of the vector hitchhiking but it is not possible to put in place requirements, which will mitigate this pathway.

16. Summary and conclusion of rapid assessment.

This rapid assessment shows:
Crop diseases from CPs are the result of vector transmission from disease reservoirs maintained in non-crop environmental hosts, principally stinging nettle and field bindweed. The absence of efficient vectors in the UK will limit disease losses from CPs. Over the last two decades a new ‘nettle favouring race’ of *H. obsoletus* has become established to high population levels in central Western Europe, away from its normal Mediterranean centre, which is a cause for concern. The new *H. obsoletus* race has caused significant damage to grapevine in its new range. Southern parts of England, which have similar climatic conditions to this region are most at risk from establishment of this vector and associated CPs, though population densities and associated crop damage would be less than in warmer climates. No additional regulation of imported plants is proposed.

Risk of entry

The wide host range of CPs constitutes an entry risk from infected plants for planting, especially grapevine, which is scored as moderately likely. Adult vectors are unlikely to associate with crop hosts during transportation to the UK and major hosts on which nymphs feed (bindweeds and nettle) are not traded in significant volumes and risks from this pathway are scored as unlikely. The large number of tourist and holidaymakers from Britain that visit regions where the vector is common, and the speed of cross-channel transport links, constitute an entry risk for adult vectors, which could 'hitch hike' in cars and camping equipment etc. This entry risk is scored as moderately likely.

Risk of establishment
Establishment risks for CPs are dependent on the presence of vector species. As the principal vector *H. obsoletus* is absent from the UK establishment is scored as unlikely. The establishment score for CPs in the presence of *H. obsoletus* is scored as moderately likely. This reflects concerns from the recent emergence and establishment of the new 'stinging nettle favouring race' of *H. obsoletus* in central Western Europe and which may explain the recent occurrence of CPs in Belgium, which is the most northerly report of the pathogen. There is considerable uncertainty in predicting establishment.

Economic impact
In Europe significant losses have been reported from infections of grapevine (bois noir disease), maize (maize redness) and potato (stolbur) however, impacts are dependent on the presence of significant populations of efficient vectors that can transmit the disease from environmental host reservoirs (mainly field bindweed and stinging nettle). The absence of efficient vectors in the UK will limit economic impacts in these crop hosts, which are scored as very small or small. However, in the presence of *H. obsoletus* economic impact is scored as medium and large, reflecting uncertainty in predicting vector populations.

Endangered area
Southern England, where establishment of *H. obsoletus* is more likely, is at greatest risk.

Risk management
Removal of symptomatic plants will reduce intra-crop transmission and risks of CPs transmission to an environmental host. Control of vectors present in the crop or in weeds growing in the crop or adjoining field margins would also reduce damage (Janse, 2012). Rogueing of infected potato plants would reduce disease incidence in tubers. Establishment in bindweeds or nettle may be difficult to eradicate because of the widespread occurrence of these hosts in the UK. However, the use of herbicides to control local nettle and associated populations of *H. obsoletus* to reduce disease incidence have been reported recently (Mori et al., 2014).

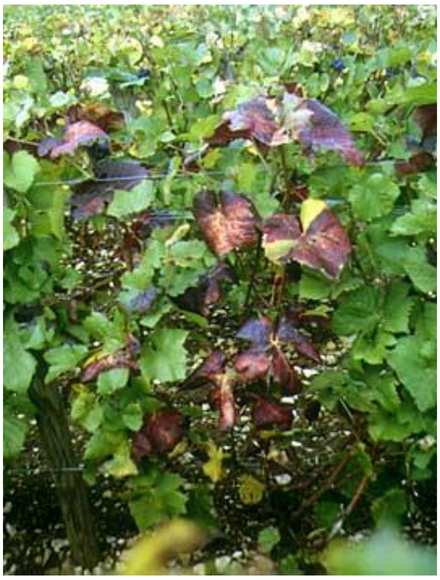
17. Is there a need for a detailed PRA? If yes, select the PRA area (UK or EU) and the PRA scheme (UK or EPPO) to be used. *(for PH Risk Management Work stream to decide)*

No*	X

Yes		PRA area: UK or EU		PRA scheme: UK or EPPO	

*A separate PRA for CPs vectors could be considered.

18. IMAGES OF PEST

Potato stolbur	*Bois Noir*
	
Photo courtesy Ministry of Agriculture and Rural Affairs Turkey. (Bugwood images).	Photo courtesy INRA France

19. Given the information assembled within the time scale required, is statutory action considered appropriate / justified?

Yes Statutory action	X	No Statutory action	

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Appendicies

Appendix 1 *Candidatus* Phytoplasma solani hosts and country of origin identified by 16S rRNA sequence analysis (Quaglino et al 2013).

Reference	Host	Country
VK (X76428)	*Vitis vinifera L.*	Germany
YSL1 (AY725233)	*Macroptilium lathyriodes*	Cuba
BN-Ma193 (FJ409897)	*Convolvulus arvensis*	Italy
BN-Ma 192 (FJ409896)	*Convolvulus arvensis*	Italy
GrlIRAN8 (GQ403235)	*Vitis vinifera L.*	Iran
2005/02 (DQ222972)	*Zea mays*	Serbia
Iranian purple top phytoplasma(EU661607)	*Solanum tuberosum*	Iran
Rus -PPT 124 (EU344890)	*Solanum tuberosum*	Russia
STOL11 (AF248959)	*Capsicum annuum*	Serbia
3-21-36 (EU814645)	*Trifolium pratense*	Czech Republic
BN-Op224 (EU836658)	*Vitis vinifera L.*	Italy
G64 (GU060495)	*Pisum sativum*	Poland
Apple stolbur phytoplasma (FJ685752)	*Malus domestica*	China
Turkish potato stolbur (HM 485579)	*Solanum tuberosum*	Tukey
RHOD 1 -CZ (DQ160245)	*Rhododendron*	Czech Republic
RHOD -CZ (DQ160244)	*Rhododendron*	Czech Republic
BN-Ma 198 (FJ409898)	*Vitis vinifera L.*	Italy (Marche)
BN-Op30 (EU836652)	*Vitis vinifera L.*	Italy (Lombardy)
Apricot stolbur phytopasma (FJ685753)	*Prunus armeniaca*	China
2642BN (AJ 964960)	*Vitis vinifera L.*	Spain
BN-Fc213 (EU836644)	*Vitis vinifera L.*	Italy (Lombardy)
BN-Op261 (EU836650)	*Vitis vinifera L.*	Italy (Lombardy)
134/04 (EU14780)	*Vitis vinifera L.*	Italy / France
PP49 (FJ204394)	*Prunus persica*	Iran
BN-Fc3 (EU836647)	*Vitis vinifera L.*	Italy (Lombardy)
425/05 (EU010010)	*Vitis vinifera L.*	Italy / France
BN-Op123(EU836657)	*Vitis vinifera L.*	Italy (Lombardy)
BN-Ab175 (FJ409894)	*Vitis vinifera L.*	Italy (Abruzzi)
PJ151 I (FJ409624)	*Prunus mume*	Iran

Appendix 2. Candidatus phytoplasma solani hosts identified using sequence analysis of *tuf* gene locus (Qualino et al., 2013).

Table 2	Host	Country
DRC5 (EU717129)	*Vitis vinifera L.*	Croatia
M1V (DQ418457)	*Fragaria*	Italy
R47/5 (FJ394552)	*Vitis vinifera L.*	Italy
6MN (FJ441242)	*Vitis vinifera L.*	Montenegro

DRC1 (EU717127)	*Vitis vinifera L.*	Croatia
26-16-33 (EU814643)	*Trifolium pratense*	Czech Republic
1-38-40 (EU552455)	*Trifolium pratense*	Czech Republic
25-5-48 (EU814641)	*Trifolium pratense*	Czech Republic
IL13-4 (EU717131)	*Vitis vinifera L.*	Croatia
IL14-5 (EU717133)	*Vitis vinifera L.*	Croatia
F11(DQ418459)	*Fragaria X ananassa*	Italy
Solmal (EF153635)	*Solanum glaucophyllum*	Italy
IL11-3(EU717130)	*Vitis vinifera L.*	Croatia
25-17-14 (EU814638)	*Trifolium pratense*	Czech Republic
BN-Op37 (GU220562)	*Vitis vinifera L.*	Italy (Lombardy)
F9 (DQ418456)	*Fragaria X ananassa*	Italy
BN-Ma 202 (GU220564)	*Vitis vinifera L.*	Italy (Marche)
IL 11-4 (EU717124)	*Vitis vinifera L.*	Croatia
BN-Si238 (GU220565)	*Vitis vinifera L.*	Italy(Sicily)
DRC3 (EU717128)	*Vitis vinifera L.*	Croatia
STOL 11 (JQ797670)	*Capsicum annuum*	Serbia
R1V(DQ418460)	*Fragaria X ananassa*	Italy
IL 13-3 (EU717122)	*Vitis vinifera L.*	Croatia
IL14-6 (EU717134)	*Vitis vinifera L.*	Croatia
IL 14-4 (EU717132)	*Vitis vinifera L.*	Croatia
IL14-3 (EU717123)	*Vitis vinifera L.*	Croatia
R49/15(FJ394551)	*Vitis vinifera L.*	Italy
JSK10-2 (EU717126)	*Vitis vinifera L.*	Croatia
BN Fc6 (GU220558)	*Vitis vinifera L.*	Italy (Lombardy)
BN-Fc15 (GU220559)	*Vitis vinifera L.*	Italy (Lomabrdy)
4MN (FJ441241)	*Vitis vinifera L.*	Montenegro
BN-Fc76 (GU220560)	*Vitis vinifera L.*	Italy (Lombardy)
BN-Ab170 (GU220561)	*Vitis vinifera L.*	Italy (Abruzzi)
F5(DQ418458)	*Fragaria X ananassa*	Italy