

Distribution of ‘*Candidatus Phytoplasma prunorum*’ and its vector *Cacopsylla pruni* in European fruit-growing areas: a review

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European stone fruit yellows (ESFY) is an EU-listed I/AII disease affecting *Prunus* spp. caused by ‘*Candidatus Phytoplasma prunorum*’. This paper reports the results from a systematic literature review approach that sought to determine the geographic distribution of ‘*Ca. Phytoplasma prunorum*’ in European fruit-growing areas. Evidence for the presence of the phytoplasma was found for 15 of the 27 EU countries. It is prevalent in the most important stone fruit production areas of Central and Southern Europe, where it causes substantial impact in apricots (*Prunus armeniaca*), Japanese plums (*P. salicina*) and peaches (*P. persica*). In Northern European areas where these hosts are not produced, it is occasionally found on tolerant species (*P. domestica*). However, because surveys of the disease status of tolerant hosts are not performed, it remains unclear whether the pathogen is absent in Northern Europe or survives in tolerant cultivated or wild hosts. No reports of ESFY were found from the southernmost part of Europe: Portugal, Spain (Andalucia, Castile-La Mancha), Italy (Sicily, Puglia), Greece (Crete), Cyprus and Malta. This may be explained by the absence of the favoured wild hosts of the vector. Moreover, it remains unclear if the vector finds suitable conditions for aestivation and overwintering in these regions.

Introduction

European stone fruit yellows (ESFY) is an important disease affecting *Prunus* spp., which is caused by ‘*Candidatus Phytoplasma prunorum*’. This pathogen is currently regulated in Annex I/AII of the EC directive 2000/29 as ‘apricot chlorotic leafroll mycoplasma’ and requirements for the movement of *Prunus* plants are set out in Annex IV.

ESFY symptoms were first observed in France on apricot (*P. armeniaca*), and described as ‘dépérissement de l’abricotier par apoplexie’ (Chabrolin, 1924). Then ‘plum leptonecrosis’ (PLN) was described on Japanese plum (*P. salicina*) in Italy (Goidanich, 1934). In 1965, Morvan and Castelain named the disease ‘enroulement chlorotique de l’abricotier’ (ECA) (‘apricot chlorotic leafroll’, ACLR). Symptoms of ‘peach yellowing’ were also associated with severe declines on *P. persica* (Poggi Pollini *et al.*, 1993). Finally, all these symptoms on *Prunus* have been associated with genetically very similar phytoplasma, and the name ‘European stone fruit yellows’ was proposed for the disease (Lorenz *et al.*, 1994). Phylogenetic analyses revealed that the ESFY agent is closely related to the Pear Decline and Apple Proliferation pathogens, constituting the 16SrX group, and the name ‘*Candidatus Phytoplasma prunorum*’ was proposed (Seemüller & Schneider, 2004).

Symptoms of ESFY are obvious only in *P. armeniaca*, *P. salicina* and *P. persica*, whereas other important stone

fruit species are either tolerant, usually not showing symptoms (e.g. *P. domestica*); or are highly resistant (e.g. sweet cherry, *P. avium*) (Jarausch *et al.*, 1999). Wild *P. spinosa* and *P. cerasifera* rarely show symptoms.

The phloem-sucking insect *Cacopsylla pruni* (Hemiptera: Psyllidae) was shown to be the vector of ‘*Ca. Phytoplasma prunorum*’ (Carraro *et al.*, 1998a). It is a univoltine species that migrates in early summer to conifers in highland areas for aestivation and overwintering (Thébaud *et al.*, 2009). The mature adults move back to *Prunus* hosts for oviposition in early spring. They generally do not reproduce on cultivated *Prunus*, except on European and Japanese plum, on which high-density populations can be observed. They reproduce essentially on wild hosts, in particular on blackthorn (*P. spinosa*) and myrobalan (*P. cerasifera*), which also appear to be an important reservoir for the phytoplasma (Carraro *et al.*, 2002; Fialova *et al.*, 2004; Yvon *et al.*, 2004). Most transmissions occur only after an effective latency of 8 months, following vector migrations in spring (Thébaud *et al.*, 2009). Recently, Sauvion *et al.* (2007, 2010a) found that *C. pruni* is a complex of two cryptic species. Preliminary studies show that the two species overlap over a large geographical area in France. Detailed data on the European distribution of the cryptic species is not available, therefore the species are analysed jointly in this review.

‘*Ca. Phytoplasma prunorum*’ is a case-study pest examined in ‘Prima phacie’, a European Food Safety

Authority (EFSA)-funded project to compare approaches to pest risk assessment and assess techniques to evaluate the effectiveness of risk reduction options (MacLeod *et al.*, 2010). Obtaining up-to-date information on the geographic distribution of a pest, by countries and areas within countries, helps to reduce uncertainty within a pest risk assessment. At present, the disease is reported from 11 EU countries (Austria, Belgium, the Czech Republic, France, Germany, Greece, Hungary, Italy, Romania, Slovenia, Spain) and six non-EU countries (Albania, Azerbaijan, Bosnia and Herzegovina, Serbia, Switzerland, Turkey; EPPO-PQR, 5.0, 2012). None of these countries declares the disease to be 'widespread'. The distribution within the countries is often stated as 'restricted' or 'few occurrences'. This suggests that the pest has potential for further spread. However, details on the distribution of the pathogen and the vector have not been systematically prepared so far. The objective of this study was to collate information on the distribution of '*Ca. Phytoplasma prunorum*' and *C. pruni* to determine their current geographic status (presence/absence) in European fruit-growing areas.

Materials and methods

Evidence on the pest's distribution was collected through a systematic literature review approach, which largely followed the principles of the EFSA Guidance on application of systematic review methodology (EFSA, 2010), to answer the question: 'What is the distribution of '*Ca. Phytoplasma prunorum*' and its vector in the fruit-growing areas of Europe?'. Two sets of search terms were defined (set 1: 'European Stone Fruit Yellows' OR 'ESFY' OR 'Phytoplasma prunorum' OR 'Chlorotic leafroll' OR 'Apricot dieback' OR 'Plum leptonecrosis' OR 'Japanese plum decline' OR 'Peach decline' OR 'Peach vein clearing' OR 'Peach vein enlargement' OR 'Italian rosette' OR '*Cacopsylla pruni*' OR '*Psylla pruni*'; set 2: 'occur*' OR 'distribut*' OR 'presen*' OR 'spread', OR 'monitor*' OR 'survey'). Sets 1 and 2 were combined to search for articles in scientific abstract databases (AGRICOLA, Agris and CAB Abstracts, Web of Science). The searches were not restricted concerning language, and were traced back to the first findings of the disease in the early 20th century. As not all relevant literature was expected to be included in electronic databases, a manual search was conducted. The following sources were used: EPPO Reporting Service (http://archives.eppo.org/EPPORreporting/Reporting_Archives.htm); CIRCA database (<http://circa.europa.eu/>); EUROPHYT database (http://ec.europa.eu/food/plant/europhyt/index_en.htm); EPPO-PQR (version 4.6; 07-2007); COST Action FA0807 (<http://costphytoplasma.eu/>); IOBC (<http://www.iobc-wprs.org/>). Furthermore, in 2010 a questionnaire regarding the distribution of '*Ca. Phytoplasma prunorum*' in different fruit-growing areas was sent to the delegates of EFSA's scientific network for risk assessment in plant health (<http://www.efsa.europa.eu/en/plh/plhnetworks.htm>).

The information on the disease and vector distribution that emerged from all sources was aggregated at regional level NUTS 2 (Nomenclature of Territorial Units for Statistics) and compared with the actual production area of the sensitive hosts *P. armeniaca* and *P. persica* (Appendix, Table A1). This data was then imported to a geographic information system (ArcGIS, ver. 9.3) to create a distribution map (Fig. 1).

Results and discussion

The present study systematically collected scientific and other evidence on the distribution of '*Ca. Phytoplasma prunorum*' and its vector *C. pruni* in European fruit-growing areas to determine their current status (presence/absence). The results show that ESFY is widespread and the disease is particularly prevalent in the main stone fruit production areas of Central Europe and the Mediterranean countries (Fig. 1; Appendix, Table A1). Currently, the disease is reported from 15 out of the 27 EU countries as well as from the Balkan States (Croatia, Serbia, Bosnia and Herzegovina), Albania and Turkey, Switzerland, and the Ukraine. Further records outside Europe are available from Northern Africa (Egypt and Tunisia) and Western Asia (Azerbaijan).

Northern Europe

In Ireland and Finland, stone fruits are not cultivated at all (EUROSTAT, 2007; FAOSTAT, 2010). In Belgium, Denmark, Estonia, Latvia, Lithuania, Luxembourg, the Netherlands, Sweden, and the UK, the sensitive hosts: apricot and peach are not produced, and with the exception of Belgium and the UK, the disease is not reported in these countries. In the UK, ESFY was found on *P. domestica* and *P. armeniaca* of a 30-year-old *Prunus* variety fruit collection in Kent grafted on *P. domestica* rootstocks (Davies & Adams, 2000). In Belgium, '*Ca. Phytoplasma prunorum*' was detected in a 20-year-old *P. domestica* tree in a private garden (Olivier *et al.*, 2004). However, as surveys on tolerant hosts are not available, '*Ca. Phytoplasma prunorum*' may be more widely spread in the northern countries than is currently known. In areas where the vector and its preferred wild hosts (*P. spinosa*, *P. cerasifera*) are present (Scandinavian countries, the Netherlands, Belgium, the UK), it is difficult to judge whether '*Ca. Phytoplasma prunorum*' is absent or present, surviving in wild or cultivated tolerant hosts. It is more likely that the disease is absent from the Baltic countries as *P. spinosa*, *P. cerasifera* and the vector are not known to occur there (<http://linnaeus.nrm.se/>; <http://www.gbif.org/>).

The IPPC defines the term 'endangered area' as 'an area where ecological factors favour the establishment of a pest whose presence in the area will result in economically important loss' (IPPC, 2010). Following this definition, it can be concluded that Northern European countries in which sensitive stone fruit crops are not produced are not included in the endangered area. For '*Ca. Phytoplasma*

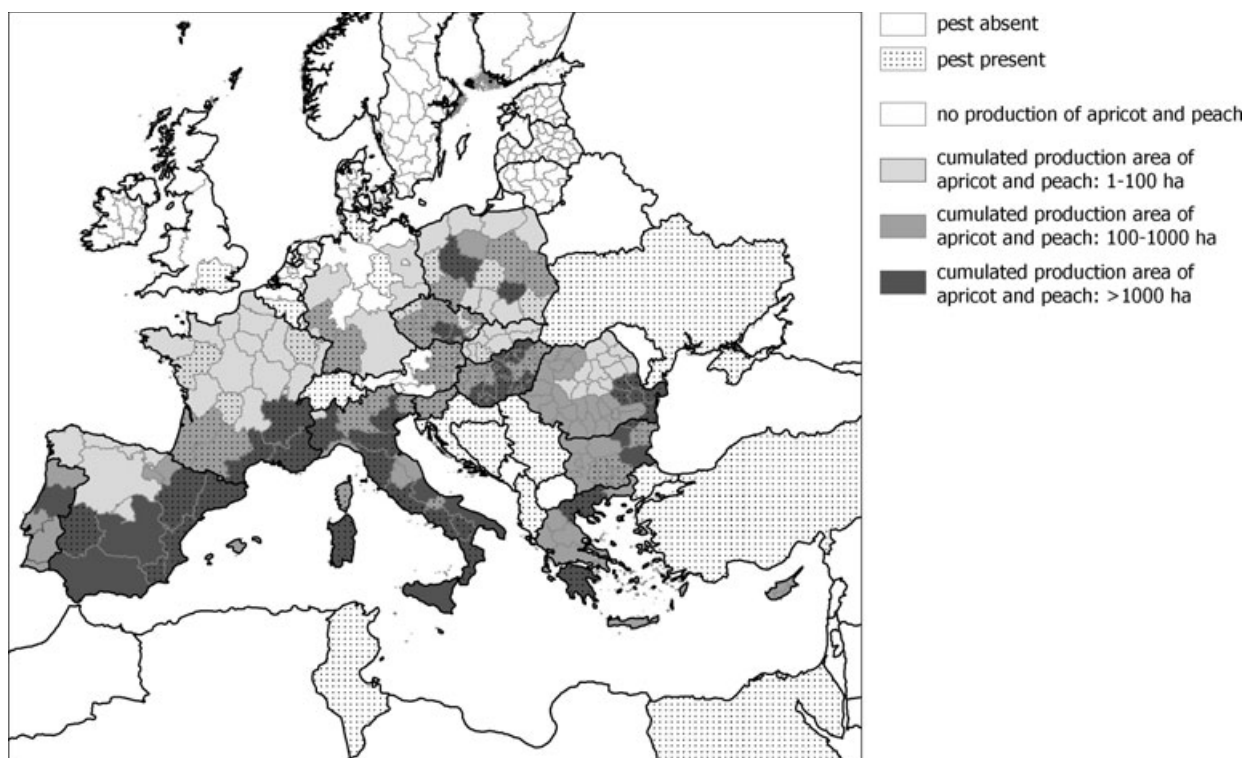


Fig. 1 Prevalence of *Ca. Phytoplasma prunorum* in Europe. Note that the production area of apricot and peach is only shown for NUTS 2 regions of the European Union.

prunorum, the endangered area is therefore restricted to commercial production areas where sensitive hosts are grown in Central and Southern Europe.

Central and Southern Europe

Sensitive hosts are grown in Central and most parts of Southern Europe. The northern limit of the geographical distribution of '*Ca. Phytoplasma prunorum*' is in Germany, where the disease was found on *P. armeniaca*, *P. persica* and *P. pumila* in a nursery in Schleswig-Holstein (CIRCA database, 2009) and Saxony-Anhalt (CIRCA database, 2011), and in Poland, where '*Ca. Phytoplasma prunorum*' was detected in seven (of 16) provinces, the northernmost being Lubuski, Wielkopolski and Mazowiecki (Cieślińska & Morgaś, 2011).

The disease is widespread in most central and Mediterranean countries, where evidence of EFSY presence was found for many NUTS 2 regions. A closer examination of the subnational presence, and a comparison with data on crop area of apricots and peach in the different regions, revealed that EFSY is present in most of the main apricot- and peach-producing countries (Spain, France, Italy, Greece, Czech Republic, Hungary, Romania, Germany, Austria; Appendix, Table A1). Although some 'white areas' remain in Fig. 1, these regions are – with a few exceptions

in the southernmost parts – minor apricot- and peach-growing regions, with <100 ha production area.

Southernmost parts of Europe

No reports of disease and vector occurrence were found for the southernmost part of Europe: Portugal, Spain (Andalucía, Castile–La Mancha), Italy (Sicily, Puglia), Greece (Crete), Cyprus and Malta. In the southernmost parts, a favoured wild host (*P. spinosa*) for reproduction of the vector is largely absent (<http://linnaeus.nrm.se/>). *Prunus spinosa* was shown to be a key factor in the life cycle of the vector in other regions (e.g. Carraro *et al.*, 2002).

In these parts of Europe, the vector may not find suitable conditions for aestivation and overwintering. *Cacopsylla pruni* completes one generation per year, reproducing on the summer host (*Prunus* spp.) and overwintering as adults on conifers such as *Picea abies*, *Abies alba*, *Abies nordmannia* and different conifers of the genera *Pinus*. The abundance of the vector appears to be much higher on conifers in mountain areas (at altitudes between 700–1400 m) than on conifers in the plain. Aerial ascending currents are likely to be responsible for long-distance transport of psyllids in the long day period (June–August) (Yvon *et al.*, 2004; Cermak & Lauterer, 2008; Thébaud *et al.*, 2009; Ulubas-Serçe *et al.*, 2011).

The vector's winter host (conifers) are widespread in Europe (Flora Europaea; EUFORGEN), including the southernmost parts. However, there is uncertainty as to whether the presence of pine forests is necessary, and whether these pine forests have to be located in mountainous areas to enable a sustainable migration pattern between overwintering sites and reproductive sites. Moreover, the conifer species allowing survival of the psyllid in central European regions are not present in this southernmost part. In Malatya, the most important apricot production area of Turkey, conifers are not present. The nearest forests are 100–120 km away, which is considered to be the reason why the vector does not survive in this province (Ulubas-Serçe *et al.*, 2011).

Conclusions

'*Ca. Phytoplasma prunorum*' causes diseases in stone fruits summarized as European Stone Fruit Yellows. The pathogen is currently listed in Annex I AII(d) of Council Directive 2000/29. Phytosanitary measures are applicable to all *Prunus* spp. However, this review shows that both vector and disease are very widespread in European fruit-growing areas on many cultivated and wild *Prunus* species, which form a reservoir for the phytoplasma. Therefore eradication and containment of the disease is not possible, and it does not qualify as a quarantine pest. Nevertheless, in regions where the disease and the vector are abundant, '*Ca. Phytoplasma prunorum*' may easily become associated with plants at the place of production. In such cases, the intended use of sensitive host plants is affected and the disease may have significant economic impact in orchards. Thus rather than be regarded as a quarantine pest, risk managers could reconsider *Ca. Phytoplasma prunorum* as regulated non-quarantine pest.

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Répartition géographique de '*Candidatus Phytoplasma prunorum*' et de son vecteur *Cacopsylla pruni* dans les zones de production de fruits en Europe

L'European stone fruit yellows (ESFY) est une maladie listée par l'UE en tant qu'organisme I/AII. Elle est causée par '*Candidatus Phytoplasma prunorum*' et affecte les *Prunus* spp. Cet article rapporte les résultats d'une revue bibliographique systématique qui visait à déterminer la

répartition géographique de '*Ca. Phytoplasma prunorum*' dans les zones de production de fruits en Europe. Des preuves de la présence du phytoplasme ont été trouvées pour 15 des 27 pays de l'UE. Il est prévalent dans la plupart des grandes zones de production de fruits à noyaux en Europe centrale et méridionale, où il cause d'important dégâts sur abricots (*Prunus armeniaca*), prunes japonaises (*P. salicina*) et pêches (*P. persica*). Dans le nord de l'Europe, ces hôtes ne sont pas cultivés, il est trouvé occasionnellement sur des espèces tolérantes (*P. domestica*). Cependant, comme il n'y a pas de prospections pour déterminer la situation de la maladie sur les hôtes tolérants, il reste difficile de savoir si l'agent pathogène est absent dans le nord de l'Europe ou survit dans des hôtes tolérants cultivés ou sauvages. Aucun signalement de l'ESFY n'a été trouvé pour la partie la plus méridionale de l'Europe: Portugal, Espagne (Andalucía, Castilla-La Mancha), Italie (Sicilia, Puglia), Grèce (Crète), Chypre et Malte. Ceci peut être expliqué par l'absence des hôtes sauvages privilégiés du vecteur. En outre, on ne sait pas si le vecteur trouve des conditions propices à l'estivation et l'hivernation dans ces régions.

Обзор распространенности '*Candidatus Phytoplasma prunorum*' и его переносчика *Cacopsylla pruni* в зонах производства фруктов в Европе

European stone fruit yellows (ESFY) является заболеванием из перечня ЕС I/AII, которое затрагивает *Prunus* spp. и вызывается '*Candidatus Phytoplasma prunorum*'. В статье сообщается о результатах систематического обзора литературы с целью определить географическую распространенность '*Candidatus Phytoplasma prunorum*' в зонах производства фруктов в Европе. Доказательства присутствия фитоплазмы были найдены в 15 из 27 стран-членов Европейского Союза. Это заболевание распространено в самых крупных зонах производства косточковых в центральной и южной Европе, где оно приводит к существенному ущербу на абрикосах (*Prunus armeniaca*), японских сливах (*P. salicina*) и персиках (*P. persica*). В тех зонах северной Европы, где эти растения-хозяева не выращиваются, это заболевание иногда обнаруживается на толерантных видах (*P. domestica*). Однако, в силу того, что обследования на определение статуса болезни на толерантных видах не выполняются, остается неясным, отсутствует ли этот вредный организм в Северной Европе или выживает на толерантных культурных или диких хозяевах. Никаких сообщений об ESYF не было получено из южной Европы: Португалии, Испании (Андалузии, Кастилии-Ла-Манчи), Италии (Сицилии, Пуглии), Греции (Крита), Кипра и Мальты. Это может объясняться отсутствием подходящих диких хозяев переносчика. Кроме того, остается неясным, находит ли переносчик подходящие условия для сезонного покоя и перезимовки в этих районах.

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- 2002/167: Detection of plant diseases in Greece from 1981 to 1990.
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- 1996/003: Decline diseases of *Prunus* in Europe are now considered as due to European stone fruit yellows phytoplasma.

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Appendix

Table A1 Distribution of European Stone Fruit Yellows (ESFY) and *Cacopsylla pruni* in European fruit-growing regions (information on the vector is given in square brackets)

Country and region	Apricot (ha)	Peach (ha)	Plum sloes (ha)	Status of ESFY*	Reference and comments
Belgium	0.00	0.00	242.00	Limited	Single record in a private garden (<i>Prunus domestica</i>) near Gembloux (Olivier <i>et al.</i> , 2004) [Vector is present (Bagnée <i>et al.</i> , 2002; Bagnée, 2003)]
Bulgaria	2 610.40	3 488.03	16 400.00	Widespread	[Vector is present (Klimaszewski, 1965; Harisanov, 1966; Etropolska <i>et al.</i> , 2011)]
Severozapaden	49.78	223.52		Unclear	
Severen tsentralen	2 197.90	553.46		Unclear	
Severoiztochen	218.77	207.76		Present	Laginova (Questionnaire, 2010)
Yugoiztochen	57.84	1 823.12		Unclear	
Yugozapaden	18.46	351.62		Present	Europhyt notification (Nov. 2011): Kyustendil province; detected in a peach mother plant
Yuzhen tsentralen	67.65	328.55		Present	Topchiiska & Sakalieva (2002)
Czech Republic	1 788.41	1 148.94	1 094.00	Widespread	[Vector is present (first citation by Šulc, 1909)]
Střední Čechy	66.83	157.47		Present	Polak <i>et al.</i> (2007)
Severozápad	175.78	35.45		Present	Navrátil <i>et al.</i> (1998)
Severovýchod	16.52	32.81		Present	Navrátil <i>et al.</i> (1998)
Jihovýchod	1 448.81	879.04		Present	Navrátil <i>et al.</i> (1998), Navrátil <i>et al.</i> (2001) and Fialova <i>et al.</i> (2004)
Střední Morava	79.67	42.47		Present	Ruzicka (Questionnaire, 2010)
Moravskoslezsko	0.09	0.25		Present	Ruzicka (Questionnaire, 2010)
Jihozápad	0.71	1.45		Present	Ruzicka (Questionnaire, 2010)
Denmark	0.00	0.00	60.00	Unknown	Scheel (Questionnaire, 2010) [Vector is present (Ossiannilsson, 1992)]
Germany	54.00†	110.00†	4 539.00	Widespread	[Vector is present, see below]
Rhineland-Palatinate				Present	Schrader (Questionnaire, 2010); Neuwieder Becken, Rheinland, Rheinhessen, Vorderpfalz, Südpfalz (Jarausch <i>et al.</i> , 2007a, 2007b, 2008); [Vector is present (Nicolas Sauvion, INRA Montpellier, unpublished data)]
Thuringia				Unclear	[Vector is present (Schrader Questionnaire, 2010)]
Baden-Württemberg				Present	Schrader (Questionnaire, 2010), EPPO RS 2009/099; Baden (Ortenau), (Jarausch <i>et al.</i> , 2007b, 2008)
Schleswig-Holstein				Present	Schrader (Questionnaire, 2010); no apricots or peaches cultivated in SH detected in symptomless propagation material (EPPO RS 2009/099); [Vector is present (Jarausch <i>et al.</i> , 2007a,b)]
Saxony-Anhalt				Present	Detected in a mother plant nursery of <i>P. armeniaca</i> (CIRCA database, 08/2011). [Vector is present (Jarausch <i>et al.</i> , 2007a,b)]
Bavaria				Unclear	[The vector was found on different <i>Prunus</i> species. No tests for the presence of ESFY were conducted (Jarausch <i>et al.</i> , 2007a, 2007b)]
Saarland				Unclear	[The vector was found on different <i>Prunus</i> species. No tests for the presence of ESFY were conducted (Jarausch <i>et al.</i> , 2007a,b)]
Estonia	0.00	0.00	569.00	Unknown	(Koidumaa Questionnaire, 2010) [Vector: no data]
Ireland	0.00	0.00	0.00	No hosts	[Vector is present (Aulmann, 1913)]
Greece	3 928.53	34 126.58	1 400.00	Widespread	(Syrgianidis <i>et al.</i> , 1976; Rumbos & Bosabalidis, 1985; Syrgianidis, 1989) [Vector: no data]

Table A1 (Continued)

Country and region	Apricot (ha)	Peach (ha)	Plum sloes (ha)	Status of ESFY*	Reference and comments
Greece (continued)					
Macedonia	1 282.50	32 902.23		Present	Kouloura (peach), prefecture of Imathia; Agia Paraskevi (almond), Tsotili (plum) prefecture of Kozani (EPPO RS 2002/167, Maria Holeva, BPI Athens, unpublished data)
Thessalia	0.00	858.41		Unclear	
Greece – other regions	203.81	323.07		Unclear	
Peloponnisos	2 418.08	0.00		Present	Mikros Valtos (apricot), prefecture of Korinthos (EPPO RS 2002/167, Maria Holeva, BPI Athens, unpublished data pers. comm.)
Spain	18 699.90	75 118.22	19 791.00	Widespread	[Vector is widely distributed; present in Extremadura, Cataluña, Aragón and Valencia (Sabate <i>et al.</i> , 2007)]
Aragón	1 296.78	15 995.05		Present	Llácer <i>et al.</i> (1976), Sabate <i>et al.</i> (2007)
Extremadura	12.11	5 516.50		Present	Lavina <i>et al.</i> (2004), Sabate <i>et al.</i> (2007)
Cataluña	480.45	18 878.66		Present	Lavina <i>et al.</i> (2004), Torres <i>et al.</i> (2004), Sabate <i>et al.</i> (2007)
Comunidad Valenciana	3 986.00	6 212.93		Present	Sánchez-Capuchino & Forner (1975); Sabate <i>et al.</i> (2007)
Región de Murcia	10 479.00	15 640.66		Present	Llácer <i>et al.</i> (1976)
Pais Vasco	0.00	3.56		Unclear	
Comunidad Foral de Navarra	39.94	481.23		Unclear	
La Rioja	13.09	780.72		Unclear	
Castilla y León	3.59	27.11		Unclear	
Castilla-la Mancha	1 457.84	210.16		Unclear	
Illes Balears	565.89	31.52		Unclear	
Andalucía	364.24	11 290.54		Unclear	
Canarias (ES)	1.06	49.58		Unclear	
France	13 804.30	14 308.28	17 165.00	Widespread	[Vector is widely distributed in all regions (Sauvion <i>et al.</i> , 2010a, 2010b)]
Pays de la Loire	0.00	0.00		Present	Department Maine et Loire (Jarausch <i>et al.</i> , 1998)
Lothringen	0.00			Present	Jarausch <i>et al.</i> (1998)
Aquitaine	0.00‡	315.92		Present	Departments Gironde, Landes, Lot et Garonne (Jarausch <i>et al.</i> , 1998)
Midi-Pyrénées	0.00‡	551.84		Present	Department Tarn et Garonne (Jarausch <i>et al.</i> , 1998)
Rhône-Alpes	7 768.89	3 702.51		Present	Drôme (Jarausch <i>et al.</i> , 1998)
Languedoc-Roussillon	3 761.70	6 449.95		Present	Pyrénées-Orientales (Jarausch <i>et al.</i> , 1998)
Provence-Alpes-Côte d'Azur	1 951.66	2 912.67		Present	Canton La Crau; Vaucluse, Alpes maritime (Jarausch <i>et al.</i> , 1998; Thébaud <i>et al.</i> , 2004, 2006)
Corse	34.52	206.62		Present	Jarausch <i>et al.</i> (1998); CIRCA database (2010)
Limousin	0.00‡	35.50		Present	Nicolas Sauvion, INRA Montpellier, unpublished data
Ile de France, Centre, Poitou-Charentes	10.73	81.04		Unclear	
France not registered by region	32.73	52.23		Unclear	
Italy	15 648.90	63 753.83	13 081.00	Widespread	[Vector is present (Conci <i>et al.</i> , 1996; Carraro <i>et al.</i> , 1998a, 2004; Tedeschi <i>et al.</i> , 2009; Ermacora <i>et al.</i> , 2011)]
Veneto	285.12	4 315.55		Present	Pastore <i>et al.</i> (1999), Poggi Pollini <i>et al.</i> (2001), Vicchi <i>et al.</i> (Questionnaire, 2010)
Friuli-Venezia Giulia	10.43	313.41		Present	Carraro <i>et al.</i> (1992, 1998a,b); Vicchi <i>et al.</i> (Questionnaire, 2010)
Emilia-Romagna	4 386.16	22 074.10		Present	Pastore <i>et al.</i> (1999); Poggi Pollini <i>et al.</i> (2001); Landi <i>et al.</i> (2007); Vicchi <i>et al.</i> (Questionnaire, 2010)

Table A1 (Continued)

Country and region	Apricot (ha)	Peach (ha)	Plum sloes (ha)	Status of ESFY*	Reference and comments
Italy (continued)					
Lazio	167.25	1 757.59		Present	Serrone <i>et al.</i> (1998), Ferretti <i>et al.</i> (2007), Vicchi <i>et al.</i> (Questionnaire, 2010)
Molise	103.52	549.64		Present	Ferretti <i>et al.</i> (2007)
Campania	4 452.15	8 893.51		Present	Pastore <i>et al.</i> (1999), Scaglione & Ragozzino (2000), Vicchi <i>et al.</i> (Questionnaire, 2010)
Calabria	558.05	3 051.38		Present	Marcone <i>et al.</i> (2002), Ferretti <i>et al.</i> (2007)
Sardegna	215.68	1 311.61		Present	Bissani <i>et al.</i> (2002)
Val Padana e Trentino-Alto Adige	142.58	3.87		Present	Pignatta <i>et al.</i> (2008); Vicchi <i>et al.</i> (Questionnaire, 2010)
Piedmont	369.69	7 116.63		Present	Vicchi <i>et al.</i> (Questionnaire, 2010)
Toscana	237.03	1 065.81		Present	Vicchi <i>et al.</i> (Questionnaire, 2010)
Lombardy	38.24	693.23		Present	Vicchi <i>et al.</i> (Questionnaire, 2010)
Valle d'Aosta/ Vallée d'Aoste	1.43	1.06		Unclear	
Liguria	87.07	115.66		Unclear	
Umbria	32.77	97.78		Unclear	
Marche	154.04	777.44		Unclear	
Abruzzo	134.58	1 611.77		Unclear	
Puglia	420.66	1 788.99		Unclear	
Basilicata	3 363.56	3 519.10		Present	Marcone <i>et al.</i> (2002)
Sicilia	488.90	4 695.67		Unclear	
Cyprus	269.00	614.00	479.00	Unknown	No surveys have been performed (Margarita Hadjistylli, Ministry of Agriculture, Lefkosia unpublished data); ESFY has been found in Cyprus but did not establish (EPPO RS 96/003). [Vector: no data]
Latvia	0.00	0.00	179.00	Unknown	(Bulavs Questionnaire, 2010); no surveys have been performed [Vector: no data]
Malta	2.00	60.00	0.00	Unknown	(Gatt & Muscat Questionnaire, 2010) [Vector: no data]
Lithuania	0.00	0.00	1 042.00	Unknown	Phytoplasmas of four groups were detected: 16SrI, 16SrIII, 16SrV, and 16SrXII (not 16SrX) (Valiunas <i>et al.</i> , 2009) [Vector: no data]
Luxembourg	0.00	0.00	795.00	Unknown	[Vector: no data]
Hungary	4 999.37	5 578.25	6 667.00	Widespread	[Vector is present (Ripka, 2008)]
Közép-Magyarország	898.28	1 408.48		Present	Lorenz <i>et al.</i> (1994); Süle <i>et al.</i> (1997); Viczián <i>et al.</i> (1997); Varga <i>et al.</i> (2000); Mergenthaler (2004)
Közép-Dunántúl	516.98	425.66		Present	Süle <i>et al.</i> (1997); Viczián <i>et al.</i> (1997); Mergenthaler (2004)
Nyugat-Dunántúl	93.39	33.99		Present	Süle <i>et al.</i> (1997); Viczián <i>et al.</i> (1997)
Dél-Dunántúl	739.61	714.43		Present	Mergenthaler (2004); Nemeth <i>et al.</i> (2000)
Észak-Magyarország	1 773.28	477.20		Present	Süle <i>et al.</i> (1997); Viczián <i>et al.</i> (1997)
Észak-Alföld	84.54	483.83		Present	Süle <i>et al.</i> (1997); Viczián <i>et al.</i> (1997)
Dél-Alföld	893.29	2 034.66		Present	Süle <i>et al.</i> (1997); Viczián <i>et al.</i> (1997)
Netherlands	0.00	0.00	300.00	Unknown	[Vector is present (Blöte, 1926)]
Austria	593.95	211.40	242.00	Widespread	Present in Lower Austria, Styria and Burgenland: Richter (2002); Laimer da Máchado <i>et al.</i> (2001) [Vector is present (Löw, 1876)]
Poland	1 059.65	2 907.52	21 129.00	Widespread	[Vector is widely distributed in all regions (Klimaszewski, 1971, 1975)]
Lódzkie	12.05	253.33		Present	Karnkowski (Questionnaire, 2010); Lódź (Cieślińska & Morgaś, 2011)
Mazowieckie	16.38	413.91		Present	In Warszawa (commercial orchards with peach) (Cieślińska & Morgaś, 2011)
Malopolskie	30.21	37.19		Not present	Karnkowski (Questionnaire, 2010)

Table A1 (Continued)

Country and region	Apricot (ha)	Peach (ha)	Plum sloes (ha)	Status of ESFY*	Reference and comments
Poland (continued)					
Slaskie	12.37	36.35		Not present	Karnkowski (Questionnaire, 2010)
Lubelskie	14.97	16.19		Present	Karnkowski (Questionnaire, 2010); Lublin (commercial orchards with sweet cherry, peach) (Cieślińska & Morgaś, 2011)
Podkarpackie	29.53	56.95		Present	Karnkowski (Questionnaire, 2010)
Swietokrzyskie	671.36	646.78		Present	Karnkowski (Questionnaire, 2010): Kielce (commercial orchards with peach, apricot, nectarine) (Cieślińska & Morgaś, 2011)
Podlaskie	1.62	1.14		Not present	Karnkowski (Questionnaire, 2010)
Wielkopolskie	117.90	880.00		Present	Karnkowski (Questionnaire, 2010); Poznań (commercial orchards with sour cherry, peach, apricot) (Cieślińska & Morgaś, 2011)
Zachodniopomorskie	2.64	5.86		Not present	Karnkowski (Questionnaire, 2010)
Lubuskie	2.41	59.55		Present	In Zielona Góra (commercial orchards with peach, Japanese plum) (Cieślińska & Morgaś, 2011)
Dolnoslaskie	58.19	274.50		Present	Karnkowski (Questionnaire, 2010); Wrocław (commercial orchards with sweet cherry, peach) (Cieślińska & Morgaś, 2011)
Opolskie	9.95	34.48		Not present	Karnkowski (Questionnaire 2010)
Kujawsko-Pomorskie	70.62	185.25		Not present	Karnkowski (Questionnaire, 2010)
Warmińsko-Mazurskie	5.56	2.97		Not present	Karnkowski (Questionnaire, 2010)
Pomorskie	0.13	3.08		Not present	Karnkowski (Questionnaire, 2010)
Portugal	282.86	2 424.25	2 000.00	Unknown	No surveys have been performed (Serra Questionnaire, 2010; C. Serra; pers. comm., 2011) [Vector: no data]
Norte	4.81	269.40		Unclear	
Centro (PT) (NUTS95)	141.13	1 488.05		Unclear	
Lisboa e Vale do Tejo (NUTS95)	25.99	125.23		Unclear	
Alentejo (NUTS95)	27.28	349.50		Unclear	
Algarve	83.65	192.07		Unclear	
Região Autónoma Açores	0.00	0.00		Unclear	
Região Autónoma Madeira	0.00	0.00		Unclear	
Romania	3 434.19	1 897.25	75 292.00	Widespread	(Ploaie, 1980; Ionica, 1985) [Vector is present (Aulmann, 1913; Fauna Europae)]
Bucuresti – Ilfov	460.29	130.04		Present	Ploaie (1980)
Nord-Vest	168.13	380.47		Unclear	
Centru	57.70	8.20		Unclear	
Nord-Est	44.62	0.10		Unclear	
Sud-Est	1 416.65	875.56		Present	Trandafirescu <i>et al.</i> (2011)
Sud-Vest Oltenia	283.26	153.73		Unclear	
Vest	576.89	198.85		Unclear	
Sud – Muntenia	426.65	150.30		Unclear	
Slovenia	22.86	431.47	27.00	Widespread	(Brzin <i>et al.</i> , 2003; Ambrozic Turk <i>et al.</i> , 2008; EPPO RS 2002/158); present at low prevalence in East and West Slovenia (Pomurska, Podravska, Savinjska, Spodnjeposavska, Goriška, Obalno-kraška), not known in Central Slovenia (Koroška, Zasavska, Osrednjeslovenska, Gorenjska) (Knapič & Pajk Questionnaire, 2010) [Vector is present (Knapič & Pajk Questionnaire, 2010)]
Slovakia	227.34	733.92	594.00	Limited	(NPPO of Slovakia considered EFSY absent (EPPO Reporting Service 2005/074); an outbreak was recorded in two municipalities in south Slovakia (CIRCA database, 08/2005) [Vector is present (Fauna Europea)]

Table A1 (Continued)

Country and region	Apricot (ha)	Peach (ha)	Plum sloes (ha)	Status of ESFY*	Reference and comments
Finland	0.00	0.00	0.00	No hosts	[Vector is present (Ossiannilsson, 1992)]
Sweden	0.00	0.00	120.00	Unknown	[Vector is present (Thomson, 1877; Ossiannilsson, 1992)]
United Kingdom	0.00	0.00	880.00	Limited	<i>P. domestica</i> tree in the National Fruit Collection in Kent (Davies & Adams, 2000); surveys were not performed. [Vector is present (Edwards, 1894; Hodgetts & Malumphy Questionnaire, 2010)]
Europe – outside EU					
Switzerland	660.00	13.00	331.00	Widespread	(Genini & Ramel, 2004; Ramel & Gugleri, 2004; Ackermann <i>et al.</i> , 2006) [Vector is present (Burckhardt, 1983; Schaub and Monneron, 2003)]
Norway	0.00	0.00	407.00	Unknown	[Vector is present (Thomson, 1877; Ossiannilsson, 1992)]
Bosnia and Herzegovina	300.00	1 700.00	70 000.00	Widespread	(Delic <i>et al.</i> , 2007, 2008) [Vector is present (Delic <i>et al.</i> , 2008; Sauvion, pers. comm.)]
Serbia	2 500.00	10 000.00	180 000.00	Widespread	In the Vojvodina and Central Serbia (Senta area, Paraćin, Pančevo, Radmilovac, Grocka) (Duduk <i>et al.</i> , 2008) [Vector is present (Sauvion, pers. comm.)]
Croatia	630	1 536.00	24 300.00	Widespread	In the main stone fruit areas of Croatia (Križanac <i>et al.</i> , 2010) [Vector: no data]
Albania	400.00	800.00	2 500.00	Widespread	In Central and South Eastern Albania (Korçë, Pogradec, Elbasan) (Myrta <i>et al.</i> , 2003) [Vector: no data]
Turkey	62 500.00	41 446.00	19 400.00	Widespread	Present in the Aegean and Mediterranean region (Sertkaya <i>et al.</i> , 2005; Ulubas-Serce <i>et al.</i> , 2006) [Vector is present (Ulubas-Serce <i>et al.</i> , 2011)]
Ukraine	9 400.00	6 700.00	20 200.00	Limited	The NPPO of Poland detected <i>Ca. Phytoplasma prunorum</i> in plants for planting of <i>P. persica</i> originating from the Ukraine (EPPO RS 2009/056) [Vector is present (Fauna Europea)]
Moldavia	2 013.00	5 641.00	19 357.00	Unknown	[Vector is present (Fauna Europea)]
Africa					
Tunisia	8 200.00	16 800.00	3 000.00	Limited	Detected in almond (<i>Prunus dulcis</i>) (Khalifa & Fakhfakh, 2011) [Vector: no data]
Egypt	6 546.00	33 604.00	1 029.00	Limited	Detected in apricot- and peach samples collected in Al Giza Governate (Al Khazindar & Abdel Salam, 2011) [Vector: no data]
Asia					
Azerbaijan	2 269.00	2 406.00	3 554.00	Limited	(Danet <i>et al.</i> , 2008) [Vector is present (Gegechkori, 1977)]
Georgia	400.00	3 400.00	2 800.00	Unknown	[Vector is present (Gegechkori & Djibladzne, 1976; Ossiannilsson, 1992)]
Iran	61 000.00	51 311.00	10 683.00	Unknown	[Vector is present (Burckhardt & Lauterer, 1993)]

*ESFY status definitions: (i) At National (country) level: widespread = reported to be present in more than one administrative unit of a country; limited = present in only one administrative unit of a country or single record of ESFY in a country; not present = countries where ESFY is not present based on survey data; unknown = countries with unclear pest status; surveys were not available or have not been performed; no hosts = countries where stone fruits are not produced. (ii) At subnational (administrative unit) level: present; not present; unclear. Data on crop area: Eurostat, 2007: apricots, peach (all countries except Malta); http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database. FAOSTAT, 2008: plums (all countries) apricots and peach (Malta); <http://faostat.fao.org/site/567/default.aspx#ancor> data extracted: April 2010. †(Germany) As Eurostat indicated no apricot and peach production in Germany, national data on the harvested area of these crops was retrieved from FAOSTAT. ‡(France) In France South West (NUTS 1) 244.11 ha of apricot production.