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Update of the *Xylella* spp. host plant database

European Food Safety Authority (EFSA)

Abstract

Following a request from the European Commission, EFSA periodically updates the database on the host plants of *Xylella* spp. While previous editions of the database (2015 and 2016) dealt with the species *Xylella fastidiosa* only, this database version addresses the whole genus *Xylella*, including therefore both species *X. fastidiosa* and *Xylella taiwanensis*. The database now includes information on host plants of *Xylella* spp. retrieved from scientific literature up to November 2017 and from EUROPHYT notifications up to May 2018. An extensive literature search was performed to screen the scientific and technical literature published between the previous database update conducted in December 2015 and December 2017. The literature screening was supported by the DistillerSR software platform. The applied protocol for the extensive literature review and extensive information search, together with examples of data extraction, are described in detail in this report. This report also includes published information on resistance or tolerance of plant varieties to *Xylella* spp. The current database includes 563 plant species reported to be infected by *X. fastidiosa*, of which for 312 plant species the infection has been determined with at least two different detection methods. These species cover hundreds of host plant genera in 82 botanical families (61 botanical families when considering only records with at least two different detection methods). The update of this database of host plants of *Xylella* spp. reported world-wide provides a key tool for risk management, risk assessment and research on this polyphagous bacterial plant pathogen.

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Keywords: data extraction, host plants database, literature review, sequence type, ST, subspecies, *Xylella fastidiosa*, *Xylella taiwanensis*

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1. Introduction

Xylella spp. is a well-studied plant pathogenic bacterium (Janse and Obradovic, 2010; Purcell, 2013; Almeida and Nunney, 2015). *Xylella fastidiosa* is listed as one of the top 10 plant pathogenic bacteria in *Molecular Plant Pathology* based on a survey among the international community (Mansfield et al., 2012). It is known to cause many different diseases like Pierce's disease of grapes in California, citrus variegated chlorosis in Brazil, bacterial leaf scorch in shaded trees in North America, oleander leaf scorch in California, olive diseases in Europe. *Xylella* spp. are polyphagous pathogens. They can cause severe diseases, but might also remain asymptomatic, without causing any serious damage. To understand a host range and host–bacteria relationship, it is necessary to review existing studies and ongoing research with new techniques of identification of the pathogen (Baldi and La Porta, 2017).

The first list of host plant species of *X. fastidiosa* published by the European Food Safety Authority (EFSA) was compiled in 2013 on the basis of the online list provided by the University of Berkeley in California (EFSA, 2013) and it was focused mostly on the strains/subspecies related to Pierce's disease – disease of grapevine.

In January 2015, EFSA published a Scientific Opinion of the EFSA PLH Panel on the risk to plant health posed by *X. fastidiosa* in the EU territory (EFSA PLH Panel, 2015), which included a table (Appendix B in EFSA PLH Panel, 2015) listing known host plants of *X. fastidiosa* together with the relevant references for each of them. This table provided information on host plant species, their botanical family, the country and location of the records, the detection methods used and also the subspecies (recorded from the publication and putatively assigned on the basis of the strain, host plant and location). In 2015, EFSA published an electronic version of the database of the host plants of *X. fastidiosa*, together with a categorisation of plants for planting on the risk of introduction of *X. fastidiosa* (EFSA, 2015). EFSA updated its *X. fastidiosa* host plant database at the end of 2015 (EFSA, 2016). Some preliminary results from the current EFSA *Xylella* spp. host plant database were presented at the European Conference on *Xylella fastidiosa*¹ held in Palma de Mallorca in November 2017 (Figure 1).

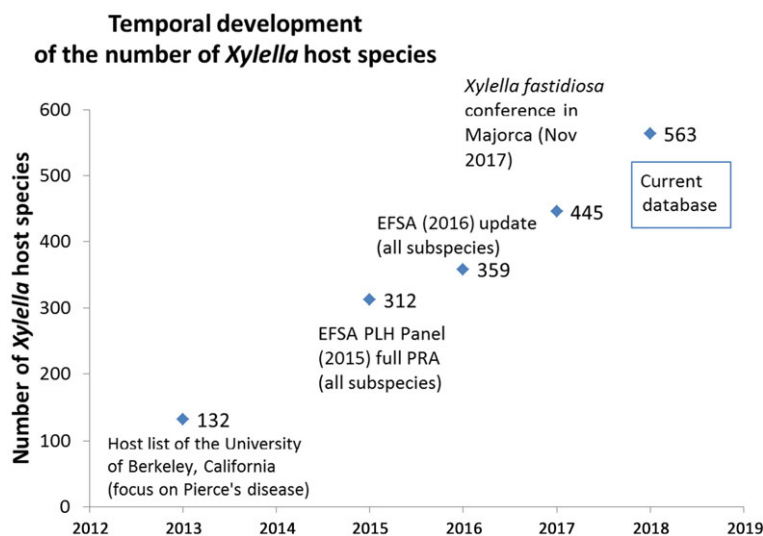


Figure 1: Temporal pattern of the total number of reported *Xylella* spp. host plants (2013–2018)

The increase in the total number of hosts of *Xylella* spp. reported in the database from 2013 to 2018 is particularly related to the new plant species reported being infected by *X. fastidiosa* in Europe since 2013. However, it also reflects the most extensive coverage of scientific literature in all languages and the inclusion of reports on the other species *Xylella taiwanensis*.

1.1. Background

The extensive literature search (ELS) protocol was used in the context of the EFSA mandate M-2013-0321 on urgent technical assistance on the regulated harmful organism *Xylella* spp. periodical updates of a database of host plants of *Xylella* spp. (EFSA-Q-2017-00215). This update integrates the list of *X. fastidiosa* host plants, published on 20 November 2016.

¹ <https://www.efsa.europa.eu/en/events/event/171113>

1.2. Terms of Reference as provided by the requestor

EFSA was asked to deliver by the end of March 2017 a preliminary report on the hosts of the Apulian strain of *Xylella fastidiosa* subsp. *pauca*, which was delivered within the deadline (EFSA, 2017).

EFSA is asked to further specify and update the host plants database of *Xylella fastidiosa* currently available, taking into account the different *Xylella fastidiosa* subspecies and strains (with particular reference to the European isolates), with inclusion of information on non-susceptible host plants and varieties and negative results of diagnostic tests when available. EFSA is asked to maintain and update this database periodically and to make new releases available on the EFSA website, together with a report. Such report should specify the list of plants confirmed to be infected by at least two detection methods in field conditions or via vector transmission under experimental conditions and be published at least annually.

1.3. Interpretation of the Terms of Reference

This scientific report provides a description of the methodology of the review undertaken, approach made to list the hosts and results obtained from this review (sample size, time span cover of the literature extracted, exclusion criteria for publications, etc.), as well as a detailed view on the different host plants listed (diagnostic tests used – including negative tests, isolates, subspecies and sequence types, susceptibility/resistance information retrieved from the publications on different hosts). This edition of the database covers both species *Xylella fastidiosa* and *Xylella taiwanensis*.

2. Data and methodologies

The process was divided into the following steps:

- An extensive literature search to identify the relevant references.
- A selection of the identified studies based on titles, abstracts and full text.
- Data extraction of the relevant information from the selected references for the creation of an updated global database of *Xylella* host plants.
- Data analysis and reporting (EFSA data warehouse).

2.1. Extensive literature search

During the search process, two main aspects were considered: the sources of information (literature databases) to be consulted (Table 1) and the development of the search strategy (Table 2).

The review question (i.e. 'which plant species can host *Xylella/Xylella-associated* diseases?') was broken down into key stages using the P/O conceptual model listed in the EFSA systematic review guidance (EFSA, 2010):

- Population of interest (P)

The population of interest is that of plant species, world-wide.

- Outcome (condition of interest) (O)

The outcome (condition of interest) is that of *Xylella* infection.

2.1.1. Information sources

The established search strategy was run in all the databases listed in Table 1 via the Web of Science platform (Clarivate Analytics). No language, date or document type restrictions were applied to retrieve as many relevant publications as possible.

Table 1: Sources of information

Database	Time coverage	Platform
Web of Science Core Collection	1975–present	Web of Science
CABI: CAB Abstracts	1973–present	Web of Science
BIOSIS Citation Index	1926–present	Web of Science
Chinese Science Citation Database	1989–present	Web of Science

Database	Time coverage	Platform
Current Contents Connect	1998–present	Web of Science
Data Citation Index	1900–present	Web of Science
FSTA	1969–present	Web of Science
KCI-Korean Journal Database	1980–present	Web of Science
Russian Science Citation Index	2005–present	Web of Science
MEDLINE	1950–present	Web of Science
SciELO Citation Index	1997–present	Web of Science
Zoological Record	1864–present	Web of Science

2.1.2. Search terms

The search strategy was designed combining the different terms describing both the pathogen and the diseases caused in the different host plants. The established search string is detailed in Table 2. The search was run in all the selected information sources (Table 1) on 16 May 2017 and 3,544 potentially relevant references were retrieved.

Table 2: Search string applied

Search string	Platform: Web of Science
	Results
TS=(xylella OR xyllala OR xylela OR (pierce* NEAR/2 disease) OR (((Plum OR plums) AND "leaf scald*")) OR ((Phony NEAR/2 (peach* OR disease*))) OR ((citrus AND variegat* AND chlorosis)) OR crespers OR "almond leaf scorch*" OR "bacterial leaf scorch*" OR "coffee leaf scorch*" OR "mulberry leaf scorch*" OR "oleander leaf scorch*" OR "sycamore leaf scorch*" OR "Periwinkle wilt" OR "Ragweed stunt" OR ((Olive NEAR "quick decline syndrome")) OR "Xylem inhabiting bacteri*" OR "Xylem limited bacteri*" OR FXIB OR FXJB OR "rickettsialike bacteri*" OR "rickettsia like bacteri*")	3,544

The search string was run again on 24 November 2017 and 51 additional references were obtained.

The collected records were downloaded and imported into the EndNote X8 bibliographic management software (Clarivate Analytics). Duplicate entries were removed using EndNote and the remaining records were uploaded on DistillerSR online² together with the full texts in portable document format (pdf). Additional redundant references were excluded by the Duplicate Detection function of DistillerSR.

Nineteen references (e.g. from grey literature, information obtained via official requests to the different research groups, national authorities, references cross-check in publications, conference proceedings) were included at a later stage of the process. Moreover, additional information was retrieved consulting the EUROPHYT outbreak notification database on 8 May 2018. Some data were also provided through personal communications by experts.

2.2. Study selection

The collected references were screened for relevance in two steps in the DistillerSR Web-Based Systematic Review Software (Evidence Partners):

- 1) Title/abstract screening of all the references.
- 2) Full-text screening of those references that passed the previous step.

Specific inclusion/exclusion criteria (described in Tables 3 and 4, respectively) were applied at each step and two reviewers worked in parallel screening all the references. Whenever a discrepant outcome was identified by the software, the reviewers had to solve the conflict and reach a common agreement on that reference.

The first step required the reviewers to reply to two questions (Table 3) considering only the title and abstract (if available) of the reference. The aim of this step was to include only the publications presenting original research data (i.e. primary research studies) on *Xylella* or *Xylella*-associated disease. So, in both questions, a positive answer was needed to select the reference.

² <https://distillercer.com>

A negative reply to one of the two questions was enough to exclude the reference. Whenever the information provided in the title and abstract was insufficiently clear, the reference was accepted and passed to the following step for further consideration.

Table 3: Inclusion criteria for the title/abstract screening

Question text	Type of answer	Answer text	Exclusion criteria
Is <i>Xylella</i> /a <i>Xylella</i>-associated disease/ a <i>Xylella</i> synonym the topic of the study?	Only one of the possible alternative answers can be selected	Yes	Included
		No	Excluded
Is it a primary research study?	Only one of the possible alternative answers can be selected	Yes	Included
		No	Excluded

All publications that passed the title/abstract screening were subjected to the full-text screening (second step), except for 10 publications for which the full text was not retrieved (despite best efforts to carry this out).

This step required the reviewers to reply to four questions (Table 4): the first three questions were descriptive (neutral), whereas the fourth question had an inclusion/exclusion role. The descriptive questions were added to collect information about the type of reference. On the fourth question, only publications describing *Xylella* studied in association with a host plant (i.e. *in vivo*) were selected for the data extraction phase.

Table 4: Inclusion criteria for the full-text screening

Question text	Type of answer	Answer text	Exclusion criteria
Is an English abstract present?	Only one of the possible alternative answers can be selected	Yes	Neutral
		No	Neutral
Which is the type of the publication?	Only one of the possible alternative answers can be selected	Peer-reviewed article	Neutral
		Article	Neutral
		Book	Neutral
		Conference proceedings	Neutral
		Abstract	Neutral
		Technical publication/Report	Neutral
		Other	Neutral
Is the <i>Xylella</i> host plant the main scope of the study?	Only one of the possible alternative answers can be selected	Yes	Neutral
		No	Neutral
Is <i>Xylella</i> /a <i>Xylella</i>-associated disease/a <i>Xylella</i> synonym studied in association to a host plant?	Only one of the possible alternative answers can be selected	Yes	Included
		No	Excluded

2.3. Data extraction

The last step of the procedure was the extraction of informative data from the selected references. The data extraction covered the information listed in Table 5. For each reference, one or more forms were filled to extract all relevant data reported in the publication. Each form represents a unique combination of data.

Two reviewers worked in sequence: the first reviewer performed the data extraction whereas the second reviewer conducted the quality control of the extracted data.

There was no language limit in the search and also publications written in different languages than English, such Chinese, French, German, Italian, Portuguese, Slovenian, Spanish and Russian, were retrieved. Those publications were sent for an official translation and some of these were included in the data extraction step.

Table 5: Data extraction structure

Extracted data	Description
General information	<i>In this section, the general information about the study is reported</i>
RecordID	Unique number allocated to each row
RefID	Unique number allocated to each reference within the DistillerSR software
Reference	Full reference
Publication year	Year of the publication
Starting year	Starting year of the study, as reported in the publication
Ending year	Ending year of the study, as reported in the publication
Botanical identification	<i>The botanical identification of the plant, both as reported in the publication and according to the updated taxonomy of the EPPO Global Database, is reported in this section</i>
Plant EPPO code	EPPO code of the plant species, from the EPPO global database ^(a)
Plant family	Plant family, from the EPPO global database ^(a)
Plant genus	Plant genus, from the EPPO global database ^(a)
Plant species	Plant species, from the EPPO global database ^(a)
Reported plant species	Name of the plant species as reported in the publication
Common name	Common name of the plant species, as reported in the publication
Cultivar	Cultivar or plant variety, as reported in the publication
Infection information	<i>Detailed information about the infection and location of the plant is reported in this section</i>
Infection method (Level 1)	The infection of the plant can be natural, artificial or not specified
Infection method (Level 2)	Subcategories of natural infection: during survey activity, during research activity. 'Research activity' is used when plants are planted under natural inoculum pressure and infection development was monitored without interfering. Subcategories of artificial infection: mechanical inoculation (detailed at level 3a), vector transmission (detailed at level 3b)
Mechanical inoculation (Level 3a)	Subcategories of mechanical inoculation: budding, grafting, needle, root uptake, stem absorption, syringe
Infection vector species (Level 3b)	Insect species used in the artificial vector transmission
Location type	The place where the plant was placed or found: natural habitat, greenhouse, screenhouse, interception, not specified
Geographical information	<i>In this section, the geographical location of the plant is reported, as detailed as possible. In case of intercepted plant, the reported location is the geographical origin of the plant and not the country and location where it was intercepted</i>
Country code	From the EFSA catalogue
Country	From the EFSA catalogue
Location	From the EFSA catalogue, with additional detailed information as reported in the publication
Coordinates explanation	The reported coordinates (latitude and longitude) can represent the centroid of the area (region or country), or the exact location XY coordinates of the point of sample, or the near location XY coordinates based on village, town or identifiable geographical features (national park, lake, river etc.), or XY of study site coordinates indicates the centroid of the area sampled
Latitude	Latitude as reported in the publication or derived from Google maps (use WGS84, decimal format)
Longitude	Longitude as reported in the publication or derived from Google maps (use WGS84, decimal format)
Pest description	<i>Information about the pest is reported in this section, together with genetic data</i>
Pest EPPO code	EPPO code of the pest, from the EPPO global database ^(a)
Pest species	Name of <i>Xylella</i> spp. as reported in the publication (from 1930 up to now): Alfalfa dwarf virus, Morus suffodiens virus, Phony peach bacterium, Pierce's disease bacterium, Pierce's disease virus, <i>Rickettsia</i> -like bacteria, Rod-shaped bacteria, <i>Xylella fastidiosa</i> , <i>Xylella taiwanensis</i> , Xylem-inhabiting bacteria

Extracted data	Description
Pest subspecies	<i>Xylella fastidiosa</i> subspecies reported in the publication: <i>fastidiosa</i> , <i>morus</i> , <i>multiplex</i> , <i>pauca</i> , <i>sandyi</i> , <i>tashke</i>
Reported pest	Name of <i>Xylella</i> spp. as reported in the publication (from 1930 up to now).
Disease	Name of the disease caused by <i>Xylella</i> spp., as reported in the publication: Alfalfa dwarf, Almond leaf scorch, Bacterial leaf scorch, Blueberry bacterial leaf scorch, Citrus variegated chlorosis, Coffee leaf scorch, Cressera, Elm leaf scorch, Leaf scorch disease, Mulberry leaf scorch, Oleander leaf scorch, Olive quick decline syndrome, Pear leaf scorch, Pecan bacterial leaf scorch, Periwinkle wilt, Phony peach disease, Pierce disease, Plum leaf scald, Potato purple top disease, Ragweed stunt, Sweetgum dieback, Sycamore leaf scorch
Strain	Name of the strain of <i>Xylella</i> spp., as reported in the publication
MLST (multilocus sequence type)	Sequence type (ST) of <i>Xylella fastidiosa</i> , as reported in the publication. If the ST is inferred from another publication, a note is added in the genotyping comment
Genotyping comment	Additional information retrieved in the publication about the <i>Xylella</i> spp. strain or sequence type
Methods of identification	<i>In this section, the identification methods applied to detect a Xylella spp. infection are listed. Eight detection methods were considered and for each of them the outcome of the analysis (positive or negative), together with the number of infected plants and the total number of analysed plants, were reported. Moreover, additional information could be added in the comment column beside each detection method</i>
Symptoms	Observation of symptoms in the plant, as reported in the publication
Symptoms expression in test plants	Observation of symptom development in test plants after an attempt to transmit the pathogen through vectors
Culture	Isolation of cultivable bacteria from tissue samples on solid culture media
Microscopy	Observation of <i>Xylella</i> bacteria through microscopic analysis techniques
ELISA	Enzyme-linked immunosorbent assay
Other immunological techniques	Immunological techniques other than ELISA
PCR-based methods	Polymerase chain-reaction-based methods (PCR, nested PCR, qPCR, etc.)
Sequencing	Sequencing technique (Sanger, next generation sequencing, etc.) and sequence analysis (MLST, phylogenetic tree, etc.)
Host status	<i>Information about the tolerance and resistance response of the plant</i>
Tolerance/Resistance reported	Tolerant/Resistant status of the plant, as reported in the publication
Tolerance/Resistance category	Categories describing the response of the tolerant/resistant plant: lack of infection or negative reading, Lack of systemic movement, Lack or reduction of symptoms, Lack or reduction of symptoms – Lower bacterial population, Lack or reduction of symptoms – Lower bacterial population – Lower disease incidence, Lack or reduction of symptoms – Lower disease incidence, Lower bacterial population, Lower bacterial population – Lower disease incidence, Lower disease incidence, Infection not persistent, Reported as tolerant/resistant (no details)
Tolerance/Resistance comment	Comment reporting detailed information about the tolerant/resistant response of the plant, as reported in the publication
General comment	<i>General comment on the study</i>
Comment	Additional relevant information

(a): EPPO (2018) EPPO Global Database (available online). <https://gd.eppo.int>

2.4. Data warehouse

The *Xylella* spp. host plant database has been considered a good candidate for the prototyping of a pest in the plant data repository within the EFSA Scientific Data Warehouse (S-DWH).

A harmonised data model has been established, also taking into account the feedback of a previous pilot focusing on the creation of a database about pests in apple. The aim was to establish a

harmonised data flow for the collection and the collation of an extensive literature review generated data in the plant health domain.

2.4.1. Data management

Data have been collected through DistillerSR and then submitted to the EFSA Data Collection Framework (DCF). DCF is the upfront system in the EFSA pipeline of data collection tools and allows a first step of harmonisation against the EFSA controlled reference terminology (as known as EFSA catalogues). Data have been then included in the S-DWH by means of a standardised Extract Transform Load (ETL) procedure and they have been further analysed and managed to generate needed statistics.

Raw data and related metadata are published in Zenodo in the EFSA Knowledge Junction community (<https://doi.org/10.5281/zenodo.1339344>).

Data will be available soon as interactive reports at the following link (expected to be active by end September 2018): <https://www.efsa.europa.eu/en/microstrategy/xylella>

2.4.2. Data reporting

Data reporting was designed to distinguish the *Xylella* spp. host plant species, based on the number and type of detection methods applied for each finding. Different combinations of detection methods were considered:

- A) Plant species positive with at least two detection methods (among: symptoms observation on the test plant in experimental vector transmission, enzyme-linked immunosorbent assay (ELISA), other immunological techniques, polymerase chain reaction (PCR)-based methods, sequencing and culture) or positive with one method (between: sequencing, culture).
- B) The same as point A, but also including microscopy: plant species positive with at least two detection methods (among: microscopy, symptoms observation on the test plant in experimental vector transmission, ELISA, other immunological techniques, PCR-based methods, sequencing and culture) or positive with one method (between: sequencing, culture).
- C) Plant species positive with at least one detection method (among: symptoms observation on the test plant in experimental vector transmission, ELISA, other immunological techniques, PCR-based methods, sequencing and culture).
- D) Plant species positive with at least one detection method including microscopy (microscopy, symptoms observation on the test plant in experimental vector transmission, ELISA, other immunological techniques, PCR-based methods, sequencing and culture).
- E) All positives plant species reported, regardless of the detection methods (positive records but without the detection method specified, symptom observations, microscopy, symptoms observation on the test plant in experimental vector transmission, ELISA, other immunological techniques, PCR-based methods, sequencing, culturing).

3. Results

3.1. Results of the literature review

3.1.1. Collected literature and screening for relevance

The literature search was conducted twice, in May and in November 2017, and 3,595 references were obtained. Nineteen additional references were retrieved by other sources.

All the collected references were uploaded in DistillerSR and 3,098 references were selected after the removal of duplicates. These references were then screened (Figure 2).

In the first step, the title and abstract screening, 1,565 references were excluded because they either did not focus on *Xylella* or *Xylella*-associated diseases and/or because they were not primary research studies.

The accepted 1,533 references went through to the second step, the full-text screening. Ten references were not evaluated as the full text was not retrieved and 670 references were excluded at this step.

The 853 references in which *Xylella* or *Xylella*-associated diseases were studied in association with a host plant (i.e. *in vivo*) were selected for the data extraction phase. To catch the latest available information on the topic, the EUROPHYT outbreak database was consulted on 8 May 2018 and

additional information was provided by scientific experts and national authorities. The full list of the selected references used for data extraction step is reported in Appendix E.

In total, 8,391 data extraction forms were filled in with informative data and subsequently analysed to retrieve the list of *Xylella* host plants.

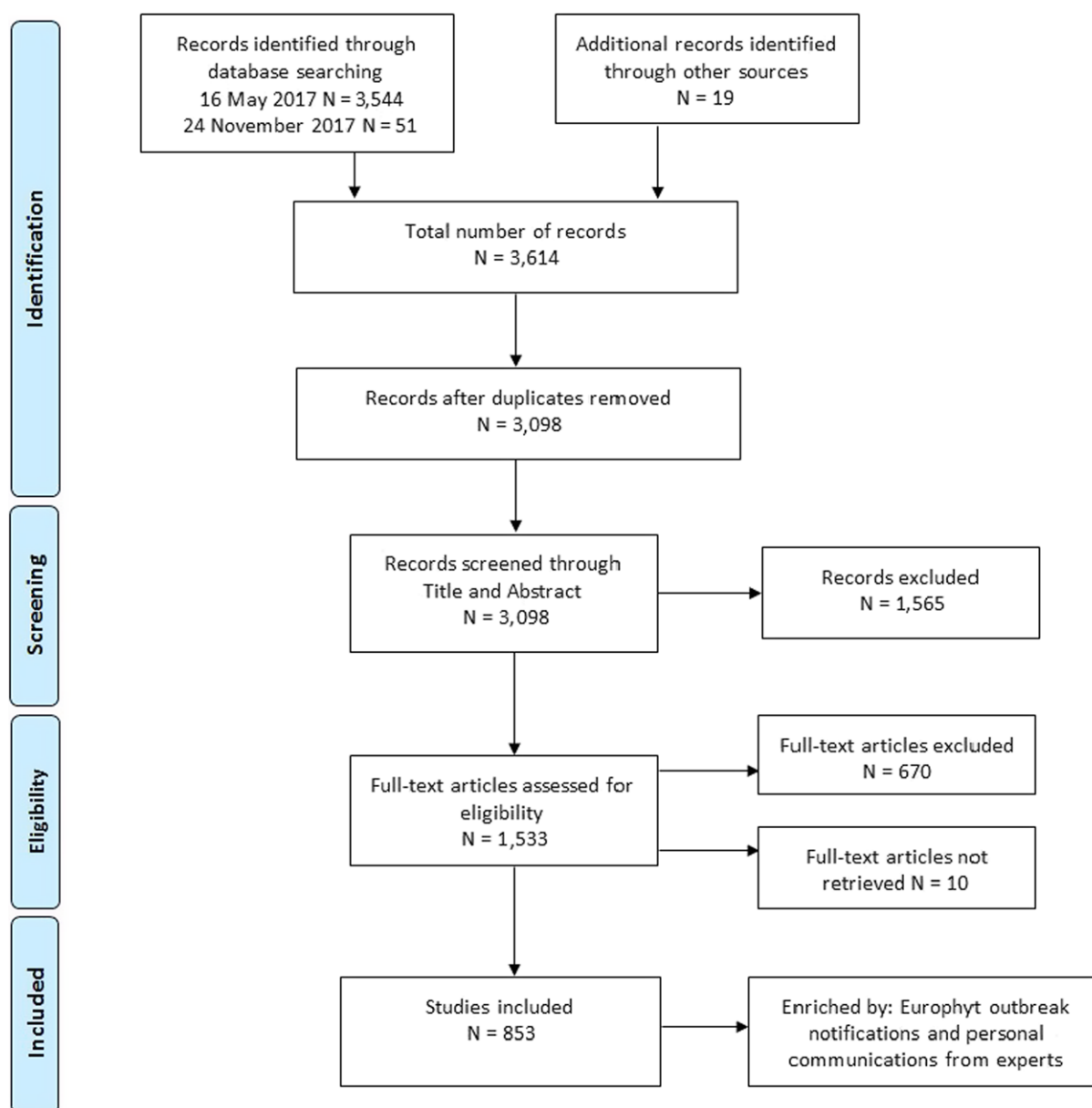


Figure 2: Flow diagram of the screening process in the DistillerSR tool

3.1.2. Trend of publications

The oldest publications retrieved through the literature search and included in the data extraction step were published in the USA in 1930 on the phony disease of peach (Hutchins, 1930). The publication of Saponari et al. (2017) that describes the isolation and pathogenicity of *X. fastidiosa*-associated with the olive quick decline syndrome in southern Italy was published in December 2017 and it is the most recent publication retrieved through the literature search.

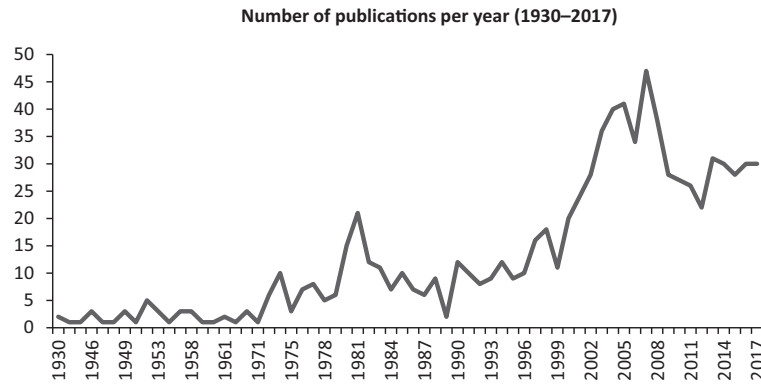


Figure 3: Number of publications published per year from 1930 to 2017 and used for data extraction

The temporal trend of published publications about *Xylella* spp. and related diseases is shown in Figure 3. The number of publications used to extract data for this database stayed more or less constant between 1930 and the 1960s, increased to 10–20 per year between the 1970s and the 1990s, increased again in the period 2000–2010, with the highest number of publications in 2007 (47 publications).

3.1.3. Unconfirmed records

A subset of unconfirmed studies (or of dubious relevance) or single records, included in the data extraction, was excluded from the data analysis. The records excluded from the data analysis are as follows:

- Berisha et al. (1996, 1998) were considered unconfirmed/dubious. The EPPO Global Database states: 'Absent, invalid record. EPPO Reporting Service (98/006): in an abstract (Berisha et al., 1996), it was claimed that *X. fastidiosa* had been isolated from diseased grapevine grown in Kosovo. The authors of the abstract have not, when requested, provided any details to substantiate this claim, which can only be regarded as dubious. EPPO Reporting Service (98/157): a fuller report (Berisha et al., 1998) stated that the material came from Cermjan, Kosovo (near Albanian border). Isolations and further study were undertaken in the USA. Lack of further study in the concerned area leaves considerable doubt about the nature of the original material. So the report remains dubious'.
- Fliege (1974) was considered unconfirmed/dubious as the symptoms described in roots of *Erica gracilis* do not resemble those of *X. fastidiosa*.
- Güldür et al. (2005) was considered unconfirmed/dubious. The EPPO Global Database states: 'Absent, invalid record. EPPO Reporting Service (2016/192): the results of the study by Güldür et al. (2005) which suggested the occurrence of almond leaf scorch in Turkey have not been confirmed by any other studies or surveys. The NPPO of Turkey confirmed in 2014 that this record should be considered as invalid, and restated its declaration in 2016'.
- Gutierrez-Ibanez et al. (2009) was considered unconfirmed/dubious for *Solanum tuberosum* in Mexico as for the described disease (potato purple top disease or 'zebra chip') there are no further reports or publications associating it with *X. fastidiosa*.
- The publications of Sadovskii (1985), Sadovskii and Shevchenko (1991) and Gvozdyak et al. (1990) were considered unconfirmed/dubious as the presence of *X. fastidiosa* has never been confirmed in Russia and Ukraine and the given publications describe only symptoms of the disease on plums.
- The record by Jindal and Sharma (1987) in India was considered unconfirmed/dubious. The EPPO Global Database states: 'Unreliable record. The identification requires confirmation by modern techniques'.
- Temsah et al. (2015) was considered an unconfirmed/dubious record, as a later publication (Habib et al., 2016) stated that *X. fastidiosa* does not occur in Lebanon. The EPPO Global Database states: 'Absent, invalid record. EPPO Reporting Service (2016/037): in 2015, a publication suggesting the presence of *Xylella fastidiosa* (EPPO A1 List) in Lebanon was published (Temsah et al., 2015). However, later studies confirmed that the ELISA-positive samples initially obtained were false-positive'.

- The report stating the presence of *Pyrus* sp. infected by *X. fastidiosa* in Oregon (United States Department of Agriculture (USDA) National Clonal Germplasm Repository – Corvallis, Oregon/*Xylella fastidiosa* response plan, 2015) is not confirmed so far, as no further information has been published or released about this finding since the first reporting.
- In Wendland et al. (2003), the Australian origin of the *X. fastidiosa* strain (9715 (755/95)) isolated from *Vitis vinifera* was considered unconfirmed/dubious according to a personal communication of Rui P. Leite Junior (Instituto Agronomico do Paraná, Brazil).
- The record of *Rosa floribunda* infected by *X. fastidiosa* in Corsica reported in Cabassut (2015) and Denancé et al. (2017) was considered unconfirmed/dubious, according to a personal communication of Marie-Agnès Jacques (INRA, France).
- The record of *Malus domestica* infected by *X. fastidiosa* in France reported in Denancé et al. (2017) was considered unconfirmed/dubious as the same publication reported that ‘The contamination of this apple tree appeared transient, as subsequent samplings of the same tree maintained in containment conditions failed to reveal any contamination.’

In addition to the above unconfirmed records, some publications report findings of *Xylella* ST types which are divergent from previous analyses performed by other laboratories. Such is the case for example of the paper by Denancé et al. (2017) which reports from four samples from Corsica (France) a complete MLST profile while stating that the samples were not detected positive based on the EPPO protocol for MLSA used by the French National Laboratory of Reference. Such cases are included in the database and the stated divergences are reported in the column ‘Comment_PCR’ of the ‘observation’ spreadsheet of the Excel in Zenodo.

3.2. Host plants of *Xylella* spp. – data analysis

3.2.1. Identity of *Xylella* spp. – different aspects

Xylella spp. – the agent of many plant diseases – has been known by researchers and agronomists from the end of 19th and beginning of 20th century (Hutchins, 1930; Anonymous, 1984) when it was called by various names (Table 6). Very often the name followed the host plant name, e.g. ‘phony peach virus’ in peaches or ‘alfalfa dwarf virus’ in alfalfa plants. Sometimes the name of the agent was related to the outbreak zone or the person who first described the disease phenomenon, e.g. Anaheim disease in California (Anonymous, 1984), which was later called Pierce’s disease after Newton B. Pierce (a Californian plant pathologist). The currently recognised taxonomic description and nomenclature of this organism were given by Wells et al. in 1987 with the name of *Xylella fastidiosa*. In 2016, *X. taiwanensis* – a new species within the *Xylella* genus – was proposed (Su et al., 2016). The *X. fastidiosa* species is divided into at least six genetically different subspecies but only the subspecies *fastidiosa* and *multiplex* are officially considered viable by the International Society of Plant Pathology Committee on the Taxonomy of Plant Pathogenic Bacteria (ISPP-CTPPB) (Bull et al., 2012). The other remaining subspecies are: *morus*, *pauca*, *sandyi* and *tashke*. All the subspecies are listed in the *Xylella* spp. host plant database and a list of hosts for each subspecies is shown in Appendices A and B.

Table 6: Temporal development of the nomenclature for *Xylella* spp.

Decades	Names of the disease/causal agent	Selected references
1920s	Phony peach virus	Hutchins (1930); Hutchins and Rue (1949)
1930s	Alfalfa dwarf virus, Phony peach virus, Xylem-inhabiting bacteria	Hewitt et al. (1946); Hutchins et al. (1953); Hutchins and Rue (1949); Millikan (1955); Turner and Pollard (1958); Turner (1949)
1940s	Alfalfa dwarf virus, Phony peach virus, Pierce’s disease virus, Xylem-inhabiting bacteria	Cochran (1951); Hewitt et al. (1946); Hutchins et al. (1953); Hutchins and Rue (1949); Kenknight (1951); Turner (1949)
1950s	Morus suffodiens virus, Phony peach virus, Pierce’s disease bacterium, Pierce’s disease virus, Xylem-inhabiting bacteria	Bruer (1951); Cochran (1951); Hewitt (1958); Loomis (1961); Millikan and Anderson (1954); Millikan (1955); Mortensen et al. (1977); Stoner (1953a,b); Stoner et al. (1951); Wester and Jylkka (1959)

Decades	Names of the disease/causal agent	Selected references
1960s	Pierce's disease bacterium, Pierce's disease virus, <i>Rickettsia</i> -like bacteria	Goheen et al. (1973); Mortensen and Knight (1968); Mortensen (1968); Mortensen et al. (1977)
1970s	Pierce's disease bacterium, <i>Rickettsia</i> -like bacteria, Rod-shaped bacteria, Xylem-inhabiting bacteria	Auger et al. (1974); Brlansky and Timmer (1982); Davis et al. (1980); Evert et al. (1981); Feldman (1984); French (1977); Goheen et al. (1973); Hearon et al. (1980); Hopkins and Adlerz (1980); Hopkins and Mollenhauer (1975); Hopkins and Mortensen (1974); McCoy et al. (1978); Purcell (1975); Raju et al. (1983); Weaver et al. (1980); Wells and Weaver (1980)
1980s	Phony peach bacterium, Pierce's disease bacterium, <i>Rickettsia</i> -like bacteria, Xylem-inhabiting bacteria, <i>Xylella fastidiosa</i>	Evert (1987); Hopkins (1984); Hopkins and Thompson (1984); Jimenez (1985); Kostka et al. (1984); Yonce and Chang (1987); Wells et al. (1981, 1987)
1990s onwards	<i>Xylella fastidiosa</i>	Chang and Donaldson (1993); Laranjeira et al. (1998); Leite et al. (1997); McElrone et al. (1999); Purcell and Saunders (1995); Su and Leu (1995)

3.2.2. Host plant species in artificial vs natural infections for different *Xylella* species and subspecies

The EFSA *Xylella* spp. host plant database contains data from different types of studies. Some of the studies reported natural infections (e.g. surveys in the fields) and some were performed under controlled artificial conditions (laboratory or controlled conditions screenhouses).

Following the classification of the species into A, B, C, D, E detection categories (see Section 2.4.2), two lists of host plant species were created:

- Appendix A and Table 9 – *Xylella fastidiosa* subspecies in experimentally infected plants.
- Appendix B and Table 10 – *Xylella fastidiosa* subspecies in naturally infected plants.

Both appendices show the results for the subspecies *fastidiosa*, *multiplex* and *pauca*, as they are the most studied in the database. Few records are available for the subspecies *sandyi*, *morus* and *tashke*, which are presented in the tables below (Tables 7 and 8).

Table 7: *Xylella fastidiosa* subspecies in experimentally infected plants (subspecies: *sandyi* and *tashke*)

<i>Xylella</i> subspecies	<i>sandyi</i>					<i>tashke</i>				
	A	B	C	D	E	A	B	C	D	E
<i>Nerium oleander</i>	6	6	6	6	9					
<i>Nicotiana benthamiana</i>						0	0	1	1	1
<i>Prunus dulcis</i>	1	1	1	1	1					
<i>Vinca major</i>	2	2	2	2	2					

Table 8: *Xylella fastidiosa* subspecies in naturally infected plants (subspecies: *morus* and *sandyi*)

<i>Xylella</i> subspecies	<i>morus</i>					<i>sandyi</i>				
	A	B	C	D	E	A	B	C	D	E
<i>Nandina domestica</i>	1	1	1	1	1	1	1	1	1	1

The total number of positive host plant species of *X. fastidiosa* was counted, regardless of the detection method (Category E: 563 species, 264 genera, 82 families). Excluding the records with only symptoms observation or when the detection method was not specified (Category D), the total number of host plant species recorded was reduced to 554. When microscopy was also excluded (Category C), 543 host plant species were recorded. When considering only records determined with at least two detection methods (excluding only symptoms and unspecified detection method) or by

sequencing or culturing (Category B), 316 host plant species remained. When microscopy was also excluded (Category A), the number of host plants resulted in 312 species, 152 genera and 61 families (Figure 4). The sample size for this calculation was 853 scientific publications published between 1930 and 2017, with 6,464 records (positive findings) in the extraction table.

Artificial inoculations were positive in 122 plant species while 234 plant species were reported positive in natural infections (according to the classification A described in Section 2.4.2).

The number of the host plant species was calculated according to the reporting system, described in Section 2.4.2 and it is presented in the triangle scheme below (Tables 9 and 10).

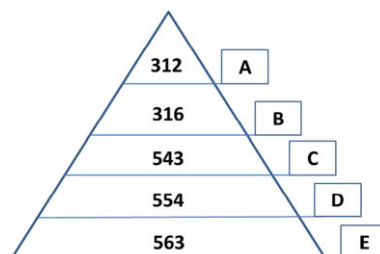


Figure 4: Number of host plant species according to different classification systems described in Section 2.4.2

Table 9: Number of host plant species, experimentally infected, susceptible to the different *X. fastidiosa* subspecies

Category	<i>fastidiosa</i>	<i>multiplex</i>	<i>pauca</i>	<i>sandyi</i>	<i>tashke</i>	Unknown
A	35	12	7	3	0	93
B	35	12	7	3	0	98
C	41	17	17	3	1	209
D	41	17	17	3	1	215
E	42	18	17	3	1	224

Table 10: Number of host plant species, naturally infected, susceptible to the different *X. fastidiosa* subspecies

Category	<i>fastidiosa</i>	<i>fastidiosa/sandyi</i>	<i>morus</i>	<i>multiplex</i>	<i>pauca</i>	<i>sandyi</i>	<i>tashke</i>	Unknown
A	32	2	4	108	41	6	1	148
B	32	2	4	108	41	6	1	154
C	32	2	4	116	43	7	1	345
D	32	2	4	116	43	7	1	353
E	33	2	4	117	43	7	1	363

Xylella taiwanensis was recorded only in one publication (Su et al., 2016) naturally infecting *Pyrus pyrifolia* in Taiwan.

Host plants of *X. fastidiosa* were detected using different methods and some of the results were contradictory. Those contradicting host plant species were compared with all other host plant species in the database and if there was the same host plant species in the other studies without contradiction positive, we counted it as positive. If the host plant species occurred in the extraction table only once and it was contradictory, the species was not counted in the total number of species but is listed in Table 11. In most cases, contradictions of results occurred for positive ELISA and negative PCR-based methods, but in a few cases three detection methods were used.

Table 11: Contradictory results^(a)

Plant species	Contradicting methods	Citation
<i>Heteromeles arbutifolia</i> (Rosaceae)	ELISA POS vs PCR-based methods NEG	Costa et al. (2004)
<i>Hibiscus syriacus</i> (Malvaceae)	ELISA POS vs PCR-based methods NEG	McGaha et al. (2007)
<i>Juglans californica</i> (Juglandaceae)	ELISA POS vs PCR-based methods NEG	Costa et al. (2004)
<i>Phyla nodiflora</i> (Verbenaceae)	ELISA and PCR-based methods POS vs Other immunological technique NEG	Buzombo et al. (2006)
<i>Pistacia vera</i> (Anacardiaceae)	ELISA POS vs PCR-based methods NEG	Costa et al. (2004)
<i>Platanus racemosa</i> (Platanaceae)	ELISA POS vs PCR-based methods NEG	Costa et al. (2004)
<i>Rubus trivialis</i> (Rosaceae)	ELISA and PCR-based methods POS vs Other immunological technique NEG	Buzombo et al. (2018)
<i>Schinus molle</i> (Anacardiaceae)	ELISA POS vs PCR-based methods NEG	Costa et al. (2004)
<i>Solanum elaeagnifolium</i> (Solanaceae)	ELISA POS vs PCR-based methods NEG	Costa et al. (2004)
<i>Tillandsia usneoides</i> (Bromeliaceae)	ELISA POS vs PCR-based methods NEG and Other immunological technique NEG	Buzombo et al. (2006)

(a): Complete list of contradicting results is available in Appendix D.

3.2.3. Geographical distribution of *Xylella* spp. host plant species

The geographical distribution of plant species infected by *Xylella* spp. is shown in Figure 5.

Confirmed findings of *X. fastidiosa* have been reported in several countries of North, Central and South America, in Asia (only in Iran) and more recently in Europe (Italy, France and Spain). The species *Xylella taiwanensis* has been reported so far only in Taiwan (China).

Unconfirmed findings (Section 3.1.3), such as in Kosovo, Turkey and India, are also shown on the map.

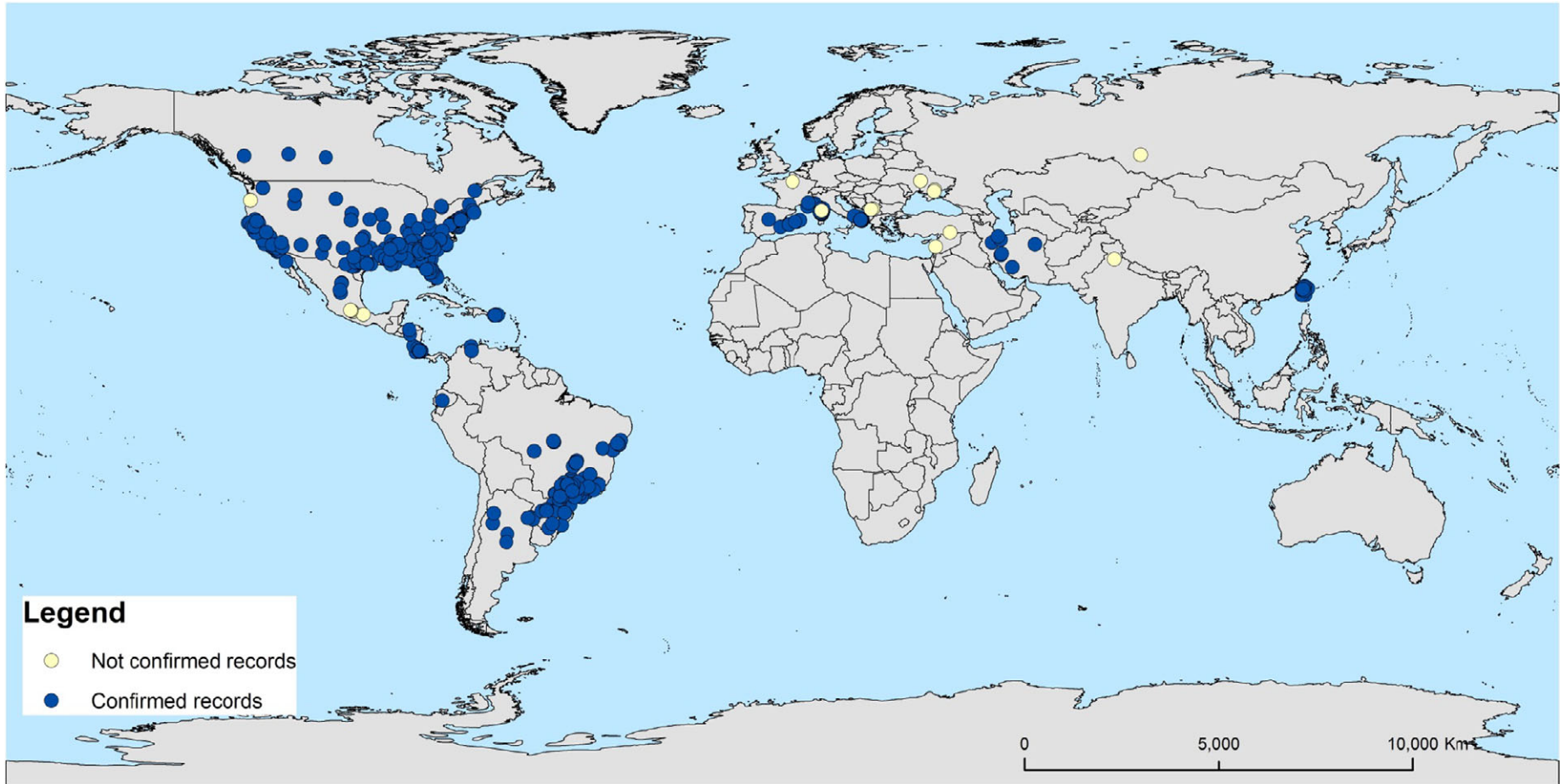


Figure 5: Geographical distribution of *Xylella* spp.

3.2.4. Host plants and *Xylella fastidiosa* sequence type association

Information about the genetic characterisation, such as the sequence type (ST), has also been recorded from all the selected publications. The full list of records of plant species infected by the different STs in artificial and natural conditions is shown in Appendix C. The country has been reported for plant species that have been found naturally infected.

In total, 889 records have been reported in the database, describing 176 plant species in which the *X. fastidiosa* ST has been characterised. Actually, 81 different STs have been described world-wide.

The highest number of records refers to plant species in which the detected *X. fastidiosa* STs belong to the subspecies *pauca*. Those plants have been identified in Central and South America (Argentina, Brazil, Costa Rica and Ecuador) and in European countries (Italy, France and Spain).

STs of subspecies *multiplex* have been found in plant species distributed in USA, France, Spain and Brazil. In USA, Costa Rica, Spain and Mexico several plant species have been identified as infected by STs of subspecies *fastidiosa*.

The plant species with more reported records are *Olea europaea*, *Prunus dulcis* and *V. vinifera*, whereas the most recorded STs are ST53 (subspecies *pauca*) and ST1 (subspecies *fastidiosa*).

Experiments of artificial infection have been especially performed using *X. fastidiosa* STs belonging to subspecies *fastidiosa*, with 89 records reported in the table.

3.2.5. Botanical characterisation of the hosts

The most abundant families in different plant species are: Fabaceae, Asteraceae, Vitaceae, Poaceae, Rosaceae, Rutaceae, Fagaceae, Rubiaceae, Lamiaceae and Oleaceae (Figure 6). Many host plant species are very well studied (such as citrus and grapevine) by many research groups in different parts of the world. Among the listed host plants, there are many important crops, different tree species, shrubs, weeds and ornamentals. *Xylella* spp. are polyphagous, but many different host plant species can play different roles in the pathogen epidemiology, for example asymptomatic reservoir plants. *Xylella* spp. can be hosted by plants classified in the different botanical higher clades, such as Monocotyledons, Dicotyledons and also Gymnosperms.

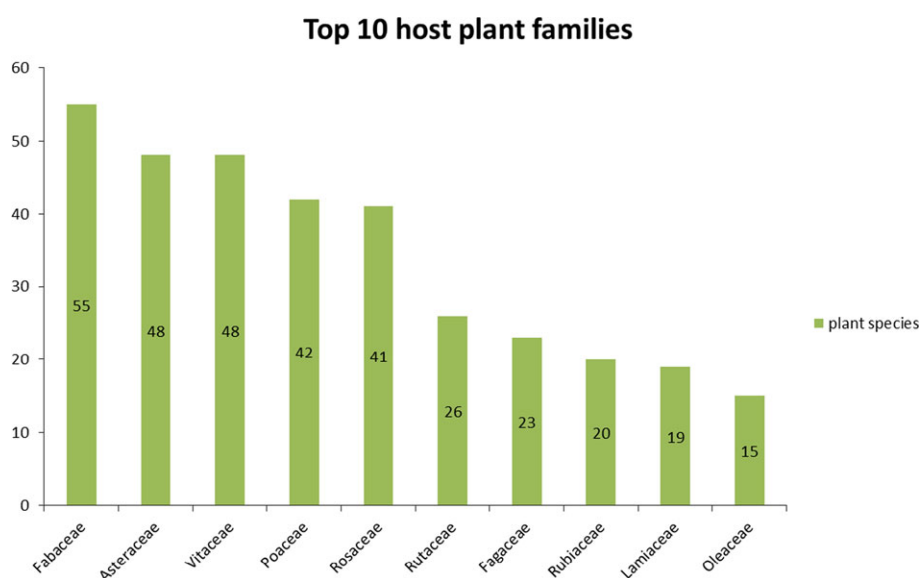


Figure 6: *Xylella* spp. host plant families – the most abundant in species

3.2.6. Tolerant or resistant host plants

Eighty-seven out of 853 publications contained information about the tolerance and resistance status of 64 plant species. As expected, the most studied genera belonged to economically important crops: *Vitis* and *Citrus* followed by *Prunus*. The fourth more studied genus, and with the most recent publications, was *Olea*. The full list of plant species together with the number of records of tolerant/resistant response for each plant species is listed in Table 12.

Table 12: Number of records in *Xylella* host plant database of tolerant/resistant response for each plant species

Plant species	Number of records
<i>Arabidopsis thaliana</i>	4
<i>Citrus celebica</i>	1
<i>Citrus clementina</i>	2
<i>Citrus jambhiri</i>	2
<i>Citrus junos</i>	1
<i>Citrus latifolia</i>	1
<i>Citrus limettioides</i>	1
<i>Citrus limon</i>	14
<i>Citrus medica</i>	1
<i>Citrus natsudaikai</i>	1
<i>Citrus paradisi</i>	4
<i>Citrus reticulata</i>	9
<i>Citrus reticulata</i> × <i>C. sinensis</i> × <i>C. paradisi</i>	1
<i>Citrus sinensis</i>	7
<i>Citrus</i> spp.	82
<i>Citrus tangerina</i>	32
<i>Citrus</i> × <i>nobilis</i>	11
<i>Citrus</i> × <i>tangelo</i>	13
<i>Coffea arabica</i>	4
<i>Coffea</i> spp.	1
<i>Fortunella margarita</i>	1
<i>Olea europaea</i>	13
<i>Platanus</i> spp.	2
<i>Poncirus trifoliata</i>	3
<i>Prunus angustifolia</i>	1
<i>Prunus armeniaca</i>	3
<i>Prunus avium</i>	4
<i>Prunus cerasus</i>	2
<i>Prunus domestica</i>	4
<i>Prunus dulcis</i>	8
<i>Prunus persica</i>	8
<i>Prunus salicina</i>	10
<i>Prunus</i> spp.	13
<i>Prunus</i> × <i>amygdalo-persica</i>	8
<i>Quercus ilex</i>	4
<i>Vaccinium corymbosum</i>	5
<i>Vitis aestivalis</i>	2
<i>Vitis arizonica</i>	5
<i>Vitis arizonica</i> hybrid	6
<i>Vitis arizonica</i> × <i>V. rupestris</i>	6
<i>Vitis arizonica</i> × <i>V. vinifera</i>	1
<i>Vitis arizonica/candicans</i>	3
<i>Vitis arizonica/candicans</i> × <i>V. rupestris</i>	2
<i>Vitis arizonica/girdiana</i>	1
<i>Vitis berlandieri</i> × <i>riparia</i> hybrids	6
<i>Vitis berlandieri</i> × <i>V. rupestris</i>	4
<i>Vitis candicans</i>	2
<i>Vitis cinerea</i> × <i>V. berlandieri</i>	2

Plant species	Number of records
<i>Vitis girdiana</i>	2
<i>Vitis munsoniana</i>	3
<i>Vitis popenoei</i>	1
<i>Vitis rotundifolia</i>	58
<i>Vitis rotundifolia</i> × <i>V. rupestris</i>	1
<i>Vitis simpsonii</i>	1
<i>Vitis</i> spp.	76
<i>Vitis tiliaefolia</i>	1
<i>Vitis vinifera</i>	25
<i>Vitis</i> × <i>champinii</i>	1
<i>Vitis aestivalis</i> var. <i>smalliana</i>	5
<i>Vitis aestivalis</i> var. <i>smalliana</i> × <i>V. simpsonii</i>	4
<i>Vitis aestivalis</i> var. <i>smalliana</i> × <i>V. vinifera</i>	1
<i>Vitis nesbittiana</i>	1
<i>Vitis rufotomentosa</i>	1
<i>Vitis shuttleworthii</i>	5
Total	507

For each record, the host status as reported in the publication has been inserted in the database. Moreover, categories have been created to group and analyse the outcome of the tolerant/resistance response. Those categories reflect the response (one or more than one) for which the authors of the studies considered the plant species as tolerant or resistant. The most described outcomes of the tolerant/resistant behaviour are the lack or reduction of symptoms expression, the lower amount of bacterial population, the lack of infection and the lack of systemic movement of bacteria (Table 13).

The lack or reduction of symptoms is the most considered outcome of the tolerant/resistant status, with 166 records equally distributed between natural (81) and artificial (85) way of infection. The lack of infection, both under natural inoculum pressure and artificial conditions, demonstrated the tolerant/resistant behaviour of the plant in 12 publications and 118 single records.

The lack of systemic movement was retrieved in 71 records through artificial inoculation, so in these plant species the infection occurred but the bacteria remain localised in proximity to the point of inoculum.

The occurrence of the bacterial population was tested 70 times in 23 different publications and the lower rate compared with other plant species or varieties let the authors of the studies consider these plants as tolerant/resistant.

In 89 records, the plant was considered tolerant/resistant but no details were described. In 51 of those records, the kind of infection was also not specified.

Table 13: Number of records and publications for each tolerant/resistance response category

Category	Number of records			Number of publications
	Artificial infection	Natural infection	Not specified	
Lack or reduction of symptoms	74	75		10
Lower bacterial population	47	6		19
Lack of systemic movement	71			7
Lack of infection or Negative reading	41	77		12
Lack or reduction of symptoms – Lower bacterial population	11	2		5
Lack or reduction of symptoms – Lower disease incidence		2		1
Lower bacterial population – Lower disease incidence		2		2

Category	Number of records			Number of publications
	Artificial infection	Natural infection	Not specified	
Lack or reduction of symptoms – Lower bacterial population – Lower disease incidence		2		2
Lower disease incidence		3		1
Not persistent infection	5			2
Reported as tolerant/resistant – no details	16	22	51	42

Table 14 proposes a list of plant species with negative result(s) in artificial infection, and never detected positive under natural conditions. Nevertheless, it should be stated that such a list was drafted by compiling the results of different studies performed under different conditions of inoculum, strains, incubation period, etc. Therefore, one should keep in mind that there is so many unknown (bacterial diversity, insect vectors, environmental conditions) that such experiments are fraught with difficulty and uncertainty, and should be considered with caution (EFSA, 2015).

Table 14: List of plant species with negative results in artificial infection and never detected positive under natural conditions

Plant family	Plant species	Number of records
Aizoaceae	<i>Tetragonia tetragonioides</i>	1
Amaranthaceae	<i>Beta vulgaris</i>	1
Anacardiaceae	<i>Pistacia lentiscus</i>	1
Anacardiaceae	<i>Rhus laurina</i>	1
Anacardiaceae	<i>Rhus ovata</i>	1
Asteraceae	<i>Acmella ciliata</i>	2
Asteraceae	<i>Artemisia californica</i>	1
Asteraceae	<i>Eclipta prostrata</i>	1
Asteraceae	<i>Matricaria discoidea</i>	1
Asteraceae	<i>Solidago microglossa</i>	1
Brassicaceae	<i>Brassica rapa</i>	1
Calycanthaceae	<i>Calycanthus occidentalis</i>	2
Commelinaceae	<i>Commelina virginica</i>	1
Convolvulaceae	<i>Jacquemontia grandifolia</i>	1
Cyperaceae	<i>Cyperus acuminatus</i>	1
Ericaceae	<i>Vaccinium ashei</i>	3
Fabaceae	<i>Acacia cowleana</i>	2
Hydrangeaceae	<i>Philadelphus californicus</i>	1
Juglandaceae	<i>Juglans californica</i>	1
Lamiaceae	<i>Prostanthera ovalifolia</i>	2
Myrtaceae	<i>Callistemon viminalis</i>	2
Myrtaceae	<i>Eucalyptus erythrocorys</i>	2
Myrtaceae	<i>Melaleuca lateritia</i>	2
Nyctaginaceae	<i>Bougainvillea</i> sp.	1
Phrymaceae	<i>Mimulus aurantiacus</i>	1
Pinaceae	<i>Pseudotsuga menziesii</i>	1
Poaceae	<i>Distichlis spicata</i>	1
Poaceae	<i>Poa pratensis</i>	1
Poaceae	<i>Polypogon monspeliensis</i>	1
Polygonaceae	<i>Eriogonum fasciculatum</i>	1
Proteaceae	<i>Banksia serrata</i>	2

Plant family	Plant species	Number of records
Rhamnaceae	<i>Frangula californica</i>	1
Rosaceae	<i>Cotoneaster franchetii</i>	1
Rosaceae	<i>Heteromeles arbutifolia</i>	2
Rosaceae	<i>Malus sylvestris</i>	1
Rosaceae	<i>Prunus davidiana</i>	3
Rosaceae	<i>Prunus tomentosa</i>	2
Rosaceae	<i>Prunus virginiana</i> var. <i>demissa</i>	1
Rosaceae	<i>Pyracantha angustifolia</i>	1
Rutaceae	<i>Citrus limettioides</i>	1
Rutaceae	<i>Citrus maxima</i>	1
Rutaceae	<i>Correa glabra</i>	2
Salicaceae	<i>Populus</i> sp.	1
Salicaceae	<i>Salix sessilifolia</i>	1
Verbenaceae	<i>Aloysia virgata</i>	2
Vitaceae	<i>Vitis popenoei</i>	1

4. Conclusions

Following the request of the European Commission, EFSA was asked to update and regularly maintain a *Xylella* spp. host plant database. In July 2018, the 'Updated *Xylella fastidiosa* pest categorisation' was published, which was an update of part of the EFSA PLH Panel, 2015 scientific opinion. Some of the information from the *Xylella* spp. host plant database was used in this categorisation.

The *Xylella* host plant database was enriched with recent world-wide scientific literature, grey literature, EUROPHYT notifications, internet sources and communications from different scientific groups.

An ELS was performed in 2017 starting from 3,614 publications with no time and language limits. In total, 853 publications were selected for data extraction and information on botanical identification of the plant, kind of infection, geographical data, detection methods, host status (resistance/tolerance) were retrieved from the publications. A new detailed distribution map has been drawn and findings of unconfirmed records distinguished. The nomenclature of the host plants was linked to the automatic EPPO codes, to facilitate further updates or changes. All data have been stored in Data Warehouse, which allows the storage and harmonisation of data.

The data of natural and artificial studies were distinguished and all numeric data recalled. A total of 122 species with evidence of artificial infection and 234 from natural infections were recorded.

In this scientific report, a comprehensive list of host plant species of *X. fastidiosa* and *X. taiwanensis* was created taking into account different detection methods and new genetic characterisations (multilocus sequence typing). The total number of plants reported infected by *X. fastidiosa* regardless of the detection method was 563 species, 264 genera and 82 families. When considering only records determined with at least two detection methods (excluding only symptoms, microscopy and unspecified detection method) or by sequencing or culturing, 312 host plant species remained from 152 genera and 61 botanical families.

Host status has been considered in the current database. Special categories with extensive comments have been added. In total, 87 publications were identified having information on resistance, tolerance response of the plants.

This update of the database of host plants of *Xylella* spp. reported world-wide provides a key tool for risk management, risk assessment and research on this polyphagous bacterial plant pathogen.

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Abbreviations

DCF	Data Collection Framework
EFSA PLH Panel	EFSA Panel on Plant Health
ELISA	enzyme-linked immunosorbent assay
ELS	extensive literature search
EPPO	European and Mediterranean Plant Protection Organization
ETL	Extract Transform Load
ISPP-CTPPB	International Society of Plant Pathology Committee on the Taxonomy of Plant Pathogenic Bacteria
MLST	multilocus sequence type
PCR	polymerase chain reaction
S-DWH	EFSA Scientific Data Warehouse
ST	sequence type
USDA	United States Department of Agriculture

Appendix A – *Xylella fastidiosa* subspecies in experimentally infected plants

<i>Xylella</i> subspecies	<i>fastidiosa</i>					<i>multiplex</i>					<i>pauca</i>				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
<i>Acer rubrum</i>						1	1	1	1	1					
<i>Amaranthus blitoides</i>	1	1	1	1	1										
<i>Ambrosia acanthicarpa</i>	2	2	2	2	2										
<i>Ambrosia artemisiifolia</i>	1	1	1	1	1	1	1	1	1	1					
<i>Carya illinoensis</i>						4	4	12	12	12					
<i>Catharanthus roseus</i>	2	2	2	2	2						3	3	6	6	6
<i>Chenopodium quinoa</i>	2	2	2	2	2										
<i>Citrus sinensis</i>											2	2	3	3	3
<i>Citrus</i> sp.											0	0	20	20	20
<i>Conium maculatum</i>	2	2	2	2	2										
<i>Convolvulus arvensis</i>	1	1	1	1	1										
<i>Cyperus esculentus</i>	1	1	1	1	1										
<i>Datura wrightii</i>	1	1	1	1	1										
<i>Dendranthema × grandiflorum</i>	0	0	1	1	1										
<i>Echinochloa crus-galli</i>	1	1	1	1	1										
<i>Erigeron canadensis</i>	1	1	1	1	1										
<i>Eriochloa gracilis</i>	1	1	1	1	1										
<i>Erodium moschatum</i>	2	2	2	2	2										
<i>Eucalyptus camaldulensis</i>	2	2	2	2	2										
<i>Eucalyptus globulus</i>	1	1	1	1	1										
<i>Helianthus annuus</i>	3	3	3	3	3										
<i>Ipomoea purpurea</i>	2	2	2	2	2										
<i>Lactuca serriola</i>	3	3	3	3	3										
<i>Liquidambar styraciflua</i>						1	1	1	1	1					
<i>Malva parviflora</i>	2	2	2	2	2										
<i>Medicago sativa</i>	18	18	18	18	18	15	15	15	15	15					
<i>Nerium oleander</i>											4	4	8	8	8
<i>Nicotiana clevelandii</i>											1	1	1	1	1
<i>Nicotiana glauca</i>	2	2	2	2	2										

Xylella subspecies	fastidiosa					multiplex					pauca				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
<i>Nicotiana tabacum</i>	0	0	10	10	12	0	0	3	3	4	1	1	1	1	1
<i>Olea europaea</i>	0	0	1	1	1	0	0	4	4	4	11	11	29	29	30
<i>Platanus occidentalis</i>						3	3	4	4	4					
<i>Polygala myrtifolia</i>						1	1	2	2	2	3	3	5	5	5
<i>Portulaca oleracea</i>	1	1	1	1	1										
<i>Prunus avium</i>											0	0	4	4	4
<i>Prunus cerasifera</i>						2	2	2	2	2					
<i>Prunus domestica</i>											0	0	1	1	1
<i>Prunus dulcis</i>	23	23	23	23	26	12	12	12	12	16	0	0	5	5	5
<i>Prunus persica</i>											0	0	1	1	1
<i>Prunus persica</i> × <i>P. webbii</i>	0	0	1	1	1	0	0	1	1	1					
<i>Prunus salicina</i>											0	0	1	1	1
<i>Prunus</i> sp.	3	3	4	4	4	3	3	4	4	5					
<i>Prunus webbii</i>	0	0	1	1	1	0	0	1	1	1					
<i>Prunus</i> × <i>amygdalo-persica</i>											0	0	6	6	6
<i>Quercus ilex</i>											0	0	1	1	1
<i>Quercus pubescens</i>											0	0	1	1	1
<i>Rubus ursinus</i>	2	2	2	2	2	1	1	1	1	1					
<i>Rumex crispus</i>	1	1	1	1	1										
<i>Simmondsia chinensis</i>	2	2	2	2	2										
<i>Solanum lycopersicum</i>	1	1	1	1	1										
<i>Solanum melongena</i>	1	1	1	1	1										
<i>Sonchus oleraceus</i>	1	1	1	1	1										
<i>Sorghum halepense</i>	1	1	1	1	1										
<i>Vaccinium corymbosum</i>	0	0	4	4	6	0	0	3	3	4					
<i>Vaccinium</i> sp.	0	0	0	0	4	0	0	0	0	4					
<i>Vicia faba</i>	1	1	1	1	1										
<i>Vicia sativa</i>	1	1	1	1	1										
<i>Vitis vinifera</i>	28	28	32	33	35	2	2	2	2	2	0	0	2	2	2
<i>Xanthium strumarium</i>	3	3	3	3	3										

<i>Xylella</i> subspecies	<i>fastidiosa</i>					<i>multiplex</i>					<i>pauca</i>				
Plant species in different classifications(A-E)	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Grand Total (Sum of records)	120	120	143	144	157	46	46	69	69	80	25	25	95	95	96
Plant species	35	35	41	41	42	12	12	17	17	18	7	7	17	17	17

Appendix B – *Xylella fastidiosa* subspecies in naturally infected plants

<i>Xylella</i> subspecies	<i>fastidiosa</i>					<i>multiplex</i>					<i>pauca</i>				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
<i>Acacia dealbata</i>						1	1	2	2	2					
<i>Acacia saligna</i>						0	0	1	1	1	1	1	1	1	2
<i>Acacia</i> sp.						1	1	1	1	1	1	1	1	1	1
<i>Acer griseum</i>						1	1	1	1	1					
<i>Acer platanoides</i>						0	0	2	2	2					
<i>Acer pseudoplatanus</i>						2	2	3	3	3					
<i>Acer rubrum</i>						1	1	2	2	2					
<i>Acer</i> sp.	1	1	1	1	1										
<i>Alnus rhombifolia</i>						2	2	2	2	2					
<i>Ambrosia psilostachya</i>						2	2	2	2	2					
<i>Ambrosia trifida</i>						9	9	9	9	9					
<i>Ambrosia trifida</i> var. <i>texana</i>						2	2	2	2	2					
<i>Ampelopsis cordata</i>						2	2	2	2	2					
<i>Anthyllis hermanniae</i>						1	1	1	1	1					
<i>Artemisia arborescens</i>						2	2	3	3	3					
<i>Asparagus acutifolius</i>						2	2	3	3	3	1	1	1	1	1
<i>Baccharis halimifolia</i>						1	1	1	1	1					
<i>Calicotome spinosa</i>	1	1	1	1	1										
<i>Calicotome villosa</i>						1	1	1	1	1					
<i>Carya illinoensis</i>						11	11	12	12	12					
<i>Carya</i> sp.						4	4	4	4	4					
<i>Catharanthus roseus</i>											2	2	2	2	2
<i>Celtis occidentalis</i>						1	1	1	1	1					
<i>Cercis canadensis</i>						3	3	3	3	3					
<i>Cercis occidentalis</i>	3	3	3	3	3	3	3	3	3	3					
<i>Cercis siliquastrum</i>						1	1	1	1	1					
<i>Chenopodium album</i>											2	2	2	2	2
<i>Chionanthus</i> sp.						1	1	1	1	1					

Xylella subspecies	fastidiosa					multiplex					pauca				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
<i>Cistus creticus</i>						1	1	1	1	1	1	1	1	1	1
<i>Cistus monspeliensis</i>	1	1	1	1	1	2	2	4	4	4					
<i>Cistus salviifolius</i>						2	2	3	3	3					
<i>Cistus</i> sp.						1	1	1	1	1					
<i>Citrus sinensis</i>	2	2	2	2	2						54	54	60	60	60
<i>Citrus</i> sp.											36	36	36	36	36
<i>Coffea arabica</i>	17	17	17	17	17						74	74	74	74	74
<i>Coffea</i> sp.											25	25	25	25	25
<i>Coronilla valentina</i>						2	2	3	3	3					
<i>Coronilla valentina</i> subsp. <i>glauca</i>						0	0	1	1	1					
<i>Cytisus scoparius</i>						1	1	1	1	1					
<i>Cytisus</i> sp.						1	1	2	2	2					
<i>Cytisus villosus</i>						1	1	1	1	1					
<i>Dodonaea viscosa</i>											1	1	1	1	1
<i>Encelia farinosa</i>						4	4	5	5	5					
<i>Eremophila maculata</i>											1	1	1	1	1
<i>Erigeron bonariensis</i>											2	2	2	2	2
<i>Erigeron sumatrensis</i>											1	1	1	1	1
<i>Erysimum hybrids</i>	1	1	1	1	1										
<i>Euphorbia terracina</i>											1	1	1	1	1
<i>Euryops chrysanthemoides</i>						1	1	2	2	2					
<i>Fallopia japonica</i>						1	1	1	1	1					
<i>Ficus carica</i>						2	2	2	2	2					
<i>Fraxinus americana</i>						1	1	1	1	1					
<i>Fraxinus angustifolia</i>						1	1	1	1	1					
<i>Fraxinus</i> sp.						1	1	1	1	1					
<i>Genista corsica</i>						1	1	1	1	1					
<i>Genista ephedroides</i>						2	2	3	3	3					
<i>Genista lucida</i>	1	1	1	1	1										
<i>Genista</i> sp.						1	1	1	1	1					

Xylella subspecies	fastidiosa					multiplex					pauca				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
<i>Genista</i> × <i>spachiana</i>						1	1	2	2	2					
<i>Ginkgo biloba</i>						3	3	3	3	3					
<i>Gleditsia triacanthos</i>						1	1	1	1	1					
<i>Grevillea juniperina</i>											1	1	1	1	1
<i>Hebe</i> sp.						2	2	3	3	3	1	1	1	1	1
<i>Helianthus annuus</i>						1	1	1	1	1					
<i>Helianthus</i> sp.						3	3	3	3	3					
<i>Helichrysum italicum</i>						2	2	2	2	2					
<i>Heliotropium europaeum</i>											2	2	2	2	2
<i>Hibiscus rosa-sinensis</i>											1	1	1	1	1
<i>Iva annua</i>						2	2	2	2	2					
<i>Juglans regia</i>	1	1	1	1	1										
<i>Koelreuteria bipinnata</i>						1	1	1	1	1					
<i>Lagerstroemia indica</i>						2	2	2	2	2					
<i>Lagerstroemia</i> sp.						1	1	1	1	1					
<i>Laurus nobilis</i>											1	1	1	1	1
<i>Lavandula angustifolia</i>						2	2	3	3	3	1	1	1	1	1
<i>Lavandula dentata</i>						3	3	4	4	4	1	1	1	1	1
<i>Lavandula</i> sp.						3	3	4	4	4					
<i>Lavandula stoechas</i>						2	2	3	3	3	1	1	1	1	1
<i>Lavandula</i> × <i>heterophylla</i>						1	1	2	2	2					
<i>Lavandula</i> × <i>intermedia</i>						2	2	3	3	3					
<i>Liquidambar styraciflua</i>						12	12	12	12	12					
<i>Liriodendron tulipifera</i>						0	0	1	1	1					
<i>Lupinus aridorum</i>	1	1	1	1	1										
<i>Lupinus villosus</i>						1	1	1	1	1					
<i>Magnolia grandiflora</i>	1	1	1	1	1										
<i>Medicago sativa</i>	4	4	4	4	4	1	1	2	2	2					
<i>Metrosideros excelsa</i>						1	1	2	2	2					
<i>Metrosideros</i> sp.	1	1	1	1	1										

Xylella subspecies	fastidiosa					multiplex					pauca				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
<i>Myoporum insulare</i>											1	1	1	1	1
<i>Myrtus communis</i>						2	2	3	3	3	1	1	1	1	1
<i>Nerium oleander</i>	1	1	1	1	1						9	9	12	12	13
<i>Olea europaea</i>						9	9	10	10	10	93	93	151	151	160
<i>Olea europaea</i> subsp. <i>sylvestris</i>						2	2	2	2	2	1	1	1	1	1
<i>Olea</i> sp.						1	1	1	1	1					
<i>Pelargonium fragrans</i>											1	1	1	1	1
<i>Pelargonium graveolens</i>						3	3	4	4	4					
<i>Pelargonium</i> sp.						5	5	6	6	6					
Periwinkle (common name)						1	1	1	1	1	1	1	1	1	1
<i>Phagnalon saxatile</i>						1	1	1	1	1					
<i>Phillyrea latifolia</i>											1	1	1	1	1
<i>Platanus occidentalis</i>						9	9	11	11	11					
<i>Pluchea odorata</i>	1	1	1	1	1										
<i>Polygala myrtifolia</i>	2	2	2	2	2	55	55	60	60	60	5	5	9	9	10
<i>Polygala</i> sp.						0	0	1	1	1					
<i>Polygala</i> × <i>dalmaisiana</i>						0	0	1	1	1					
<i>Polygala</i> × <i>grandiflora nana</i>						1	1	1	1	1					
<i>Prunus armeniaca</i>						1	1	1	1	1					
<i>Prunus avium</i>	6	6	6	6	6	0	0	1	1	1	4	4	8	8	9
<i>Prunus cerasifera</i>						19	19	21	21	21					
<i>Prunus cerasus</i>						0	0	1	1	1					
<i>Prunus domestica</i>						11	11	11	11	11	1	1	1	1	1
<i>Prunus dulcis</i>	20	20	20	20	20	21	21	21	21	22	6	6	6	6	7
<i>Prunus persica</i>	1	1	1	1	1	4	4	4	4	4	0	0	1	1	1
<i>Prunus</i> sp.						23	23	23	23	23					
<i>Quercus coccinea</i>						3	3	4	4	4					
<i>Quercus falcata</i>						1	1	1	1	1					
<i>Quercus ilex</i>											0	0	1	1	1
<i>Quercus laevis</i>						2	2	2	2	2					

Xylella subspecies	fastidiosa					multiplex					pauca				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
<i>Quercus macrocarpa</i>						1	1	2	2	2					
<i>Quercus nigra</i>						1	1	1	1	1					
<i>Quercus palustris</i>						14	14	16	16	16					
<i>Quercus phellos</i>						2	2	3	3	3					
<i>Quercus robur</i>						1	1	1	1	1					
<i>Quercus rubra</i>						8	8	10	10	10					
<i>Quercus shumardii</i>						1	1	1	1	1					
<i>Quercus sp.</i>						6	6	6	6	6					
<i>Quercus suber</i>						2	2	3	3	3					
<i>Ratibida columnifera</i>						3	3	3	3	3					
<i>Rhamnus alaternus</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Rosa canina</i>						1	1	1	1	1					
<i>Rosa sp.</i>						1	1	1	1	1					
<i>Rosmarinus officinalis</i>	1	1	1	1	1	4	4	5	5	5	2	2	2	2	2
<i>Rubus sp.</i>						2	2	2	2	2					
<i>Salvia mellifera</i>						3	3	4	4	4					
<i>Sambucus canadensis</i>	2	2	2	2	2										
<i>Sambucus sp.</i>	0	0	0	0	1	1	1	1	1	1					
<i>Sapindus saponaria</i>						2	2	2	2	2					
<i>Solidago virgaurea</i>						1	1	1	1	1					
<i>Spartium junceum</i>	2	2	2	2	2	5	5	7	7	7	1	1	1	1	2
<i>Spartium sp.</i>						1	1	1	1	1					
<i>Streptocarpus hybrids</i>	1	1	1	1	1										
<i>Ulmus americana</i>						4	4	6	6	6					
<i>Ulmus crassifolia</i>						2	2	2	2	2					
<i>Vaccinium corymbosum</i>						0	0	0	0	3					
<i>Vaccinium sp.</i>						8	8	8	8	8					
<i>Vinca minor</i>											1	1	1	1	1
<i>Vinca sp.</i>						1	1	1	1	1					
<i>Vitis aestivalis</i>	2	2	2	2	2										

<i>Xylella</i> subspecies	<i>fastidiosa</i>					<i>multiplex</i>					<i>pauca</i>				
Plant species in different classifications (A–E)	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
<i>Vitis aestivalis</i> hybrid	1	1	1	1	1										
<i>Vitis candicans</i>	1	1	1	1	1										
<i>Vitis cinerea</i> var. <i>helleri</i> × <i>V. vulpina</i>	1	1	1	1	1										
<i>Vitis girdiana</i>	1	1	2	2	2										
<i>Vitis rotundifolia</i>	3	3	3	3	3										
<i>Vitis</i> sp.	44	44	44	44	45										
<i>Vitis vinifera</i>	31	31	31	31	39										
<i>Weslingia fruticosa</i>						1	1	1	1	1	4	4	4	4	5
<i>Weslingia glabra</i>											1	1	1	1	1
<i>Xanthium strumarium</i>						1	1	2	2	2					
Grand Total(Sum of records)	157	157	158	158	168	379	379	440	440	444	346	346	423	423	439
Plant species	32	32	32	32	33	108	108	116	116	117	41	41	43	43	43

Appendix C – Xylella sequence types (STs)

List of records of plant species infected by different *Xylella* sequence types (STs) in artificial, natural or not specified kind of infection. The records of plant species naturally found infected are divided per country.

<i>X. fastidiosa</i> subspecies ST Plant species	Natural infection											Artificial infection	Not specified	Grand Total
	Argentina	Brazil	Costa Rica	Ecuador	France	Italy	Mexico	Spain	USA	unknown	Total	Total	Total	
<i>fastidiosa</i>			22				2	11	93		128	89		217
ST1							2	11	81		94	89		183
<i>Acer</i> sp.									1		1			1
<i>Amaranthus blitoides</i>												1		1
<i>Ambrosia acanthicarpa</i>												2		2
<i>Calicotome spinosa</i>								1			1			1
<i>Catharanthus roseus</i>												2		2
<i>Cercis occidentalis</i>									1		1			1
<i>Chenopodium quinoa</i>												2		2
<i>Cistus monspeliensis</i>								1			1			1
<i>Citrus sinensis</i>									1		1			1
<i>Conium maculatum</i>												2		2
<i>Convolvulus arvensis</i>												1		1
<i>Cyperus esculentus</i>												1		1
<i>Datura wrightii</i>												1		1
<i>Echinochloa crus-galli</i>												1		1
<i>Erigeron canadensis</i>												1		1
<i>Eriochloa gracilis</i>												1		1
<i>Erodium moschatum</i>												2		2
<i>Eucalyptus camaldulensis</i>												2		2
<i>Eucalyptus globulus</i>												1		1
<i>Genista lucida</i>								1			1			1
<i>Helianthus annuus</i>												3		3

<i>X. fastidiosa</i> subspecies ST Plant species	Natural infection											Artificial infection	Not specified	Grand Total
	Argentina	Brazil	Costa Rica	Ecuador	France	Italy	Mexico	Spain	USA	unknown	Total	Total	Total	
<i>Ipomoea purpurea</i>												2		2
<i>Juglans regia</i>								1			1			1
<i>Lactuca serriola</i>												3		3
<i>Malva parviflora</i>												2		2
<i>Medicago sativa</i>										3	3	6		9
<i>Metrosideros</i> sp.										1	1			1
<i>Nicotiana glauca</i>												2		2
<i>Olea europaea</i>												1		1
<i>Pluchea odorata</i>										1	1			1
<i>Polygala myrtifolia</i>								2			2			2
<i>Portulaca oleracea</i>												1		1
<i>Prunus avium</i>								2	2		4			4
<i>Prunus dulcis</i>								1	17		18	18		36
<i>Rhamnus alaternus</i>								1			1			1
<i>Rubus ursinus</i>												2		2
<i>Rumex crispus</i>												1		1
<i>Sambucus canadensis</i>										2	2			2
<i>Simmondsia chinensis</i>												2		2
<i>Solanum lycopersicum</i>												1		1
<i>Solanum melongena</i>												1		1
<i>Sonchus oleraceus</i>												1		1
<i>Sorghum halepense</i>												1		1
<i>Spartium junceum</i>										1	1			1
<i>Vicia faba</i>												1		1
<i>Vicia sativa</i>												1		1
<i>Vitis aestivalis</i>										2	2			2

<i>X. fastidiosa</i> subspecies ST Plant species	Natural infection											Artificial infection	Not specified	Grand Total
	Argentina	Brazil	Costa Rica	Ecuador	France	Italy	Mexico	Spain	USA	unknown	Total	Total	Total	
<i>Vitis girdiana</i>									1		1			1
<i>Vitis</i> sp.							1		29		30			30
<i>Vitis vinifera</i>							1	1	19		21	17		38
<i>Xanthium strumarium</i>												3		3
ST17			1								1			1
<i>Coffea arabica</i>			1								1			1
ST18			1								1			1
<i>Vitis</i> sp.			1								1			1
ST19			1								1			1
<i>Coffea arabica</i>			1								1			1
ST2									8		8			8
<i>Vitis rotundifolia</i>									3		3			3
<i>Vitis</i> sp.									5		5			5
ST20			1								1			1
<i>Coffea arabica</i>			1								1			1
ST21			1								1			1
<i>Coffea arabica</i>			1								1			1
ST3									1		1			1
<i>Lupinus aridorum</i>									1		1			1
ST33			1								1			1
<i>Coffea arabica</i>			1								1			1
ST4									3		3			3
<i>Vitis</i> sp.									3		3			3
ST47			2								2			2
<i>Coffea arabica</i>			1								1			1
<i>Vitis</i> sp.			1								1			1
ST52			1								1			1
<i>Coffea arabica</i>			1								1			1

<i>X. fastidiosa</i> subspecies ST Plant species	Natural infection											Artificial infection	Not specified	Grand Total
	Argentina	Brazil	Costa Rica	Ecuador	France	Italy	Mexico	Spain	USA	unknown	Total	Total	Total	
ST54			1								1			1
<i>Coffea arabica</i>			1								1			1
ST55			1								1			1
<i>Coffea arabica</i>			1								1			1
ST56			1								1			1
<i>Coffea arabica</i>			1								1			1
ST57			1								1			1
<i>Coffea arabica</i>			1								1			1
ST59			1								1			1
<i>Vitis vinifera</i>			1								1			1
ST60			1								1			1
<i>Vitis vinifera</i>			1								1			1
ST61			3								3			3
<i>Citrus sinensis</i>			1								1			1
<i>Coffea arabica</i>			2								2			2
ST72			1								1			1
<i>Coffea arabica</i>			1								1			1
ST76			2								2			2
<i>Coffea arabica</i>			2								2			2
ST77			1								1			1
<i>Coffea arabica</i>			1								1			1
<i>fastidiosa/sandyi</i>			3				1				4			4
ST72			2								2			2
<i>Coffea arabica</i>			2								2			2
ST75							1				1			1
<i>Coffea canephora</i>							1				1			1
ST76			1								1			1
<i>Coffea arabica</i>			1								1			1

<i>X. fastidiosa</i> subspecies ST Plant species	Natural infection											Artificial infection	Not specified	Grand Total
	Argentina	Brazil	Costa Rica	Ecuador	France	Italy	Mexico	Spain	USA	unknown	Total	Total	Total	
<u>morus</u>									22		22			22
ST29									7		7			7
<i>Morus alba</i>									3		3			3
<i>Morus rubra</i>									4		4			4
ST30									5		5			5
<i>Morus alba</i>									4		4			4
<i>Nandina domestica</i>									1		1			1
ST31									6		6			6
<i>Morus</i> sp.									6		6			6
ST62									4		4			4
<i>Morus alba</i>									4		4			4
<u>multiplex</u>		3			77			21	159		260	19	12	291
ST10									7		7			7
<i>Prunus domestica</i>									1		1			1
<i>Prunus persica</i>									3		3			3
<i>Prunus</i> sp.									3		3			3
ST15									3		3			3
<i>Prunus cerasifera</i>									3		3			3
ST22									3		3		1	4
<i>Ambrosia psilostachya</i>									1		1			1
<i>Ambrosia trifida</i>									2		2		1	3
ST23									10		10			10
<i>Acer rubrum</i>									1		1			1
<i>Ambrosia trifida</i>									2		2			2
<i>Helianthus</i> sp.									2		2			2
<i>Iva annua</i>									1		1			1
<i>Quercus rubra</i>									1		1			1
<i>Ratibida columnifera</i>									2		2			2

<i>X. fastidiosa</i> subspecies ST Plant species	Natural infection											Artificial infection	Not specified	Grand Total
	Argentina	Brazil	Costa Rica	Ecuador	France	Italy	Mexico	Spain	USA	unknown	Total	Total	Total	
<i>Solidago virgaurea</i>									1		1			1
ST24									5		5			5
<i>Cercis occidentalis</i>									1		1			1
<i>Liquidambar styraciflua</i>									3		3			3
<i>Ulmus crassifolia</i>									1		1			1
ST25									4		4			4
<i>Encelia farinosa</i>									4		4			4
ST26		1							12		13			13
<i>Alnus rhombifolia</i>									1		1			1
<i>Prunus cerasifera</i>									2		2			2
<i>Prunus domestica</i>		1							1		2			2
<i>Prunus</i> sp.									8		8			8
ST27									6		6		2	8
<i>Ginkgo biloba</i>									1		1			1
<i>Lagerstroemia</i> sp.									1		1			1
<i>Prunus cerasifera</i>													1	1
<i>Prunus dulcis</i>									2		2		1	3
<i>Prunus</i> sp.									2		2			2
ST28									4		4		1	5
<i>Ambrosia trifida</i>									2		2		1	3
<i>Helianthus</i> sp.									1		1			1
<i>Iva annua</i>									1		1			1
ST32									2		2		1	3
<i>Rubus fruticosus</i>													1	1
<i>Rubus</i> sp.									2		2			2
ST34									1		1			1
<i>Prunus cerasifera</i>									1		1			1

X. fastidiosa subspecies ST Plant species	Natural infection											Artificial infection	Not specified	Grand Total
	Argentina	Brazil	Costa Rica	Ecuador	France	Italy	Mexico	Spain	USA	unknown	Total	Total	Total	
ST35									1		1			1
<i>Xanthium strumarium</i>									1		1			1
ST36									1		1			1
<i>Prunus</i> sp.									1		1			1
ST37									1		1			1
<i>Lupinus villosus</i>									1		1			1
ST38									1		1			1
<i>Platanus occidentalis</i>									1		1			1
ST39									6		6			6
<i>Koelreuteria bipinnata</i>									1		1			1
<i>Liquidambar styraciflua</i>									4		4			4
<i>Prunus</i> sp.									1		1			1
ST40									4		4		1	5
<i>Prunus cerasifera</i>									3		3		1	4
<i>Sambucus</i> sp.									1		1			1
ST41									3		3			3
<i>Prunus</i> sp.									1		1			1
<i>Ulmus americana</i>									2		2			2
ST42									6		6		3	9
<i>Ambrosia trifida</i>									2		2		1	3
<i>Sapindus saponaria</i>									1		1			1
<i>Vaccinium corymbosum</i>													1	1
<i>Vaccinium corymbosum</i> × <i>V. angustifolium</i> hybrid											1	1		
<i>Vaccinium</i> sp.									3		3			3

<i>X. fastidiosa</i> subspecies ST Plant species	Natural infection											Artificial infection	Not specified	Grand Total
	Argentina	Brazil	Costa Rica	Ecuador	France	Italy	Mexico	Spain	USA	unknown	Total	Total	Total	
ST43									4		4		2	6
<i>Vaccinium corymbosum</i>													1	1
<i>Vaccinium corymbosum</i> × <i>V. angustifolium</i> hybrid											1	1		
<i>Vaccinium</i> sp.									4		4			4
ST44									2		2			2
<i>Quercus palustris</i>									1		1			1
<i>Quercus rubra</i>									1		1			1
ST45									6		6			6
<i>Acer griseum</i>									1		1			1
<i>Ampelopsis cordata</i>									1		1			1
<i>Cercis canadensis</i>									3		3			3
<i>Gleditsia triacanthos</i>									1		1			1
ST46									3		3			3
<i>Celtis occidentalis</i>									1		1			1
<i>Chionanthus</i> sp.									1		1			1
<i>Prunus armeniaca</i>									1		1			1
ST48									1		1			1
<i>Sapindus saponaria</i>									1		1			1
ST49									1		1			1
<i>Prunus</i> sp.									1		1			1
ST50									2		2			2
<i>Fraxinus americana</i>									1		1			1
<i>Fraxinus</i> sp.									1		1			1
ST51									2		2			2
Periwinkle (common name)									1		1			1
<i>Vinca</i> sp.									1		1			1

<i>X. fastidiosa</i> subspecies ST Plant species	Natural infection										Artificial infection	Not specified	Grand Total	
	Argentina	Brazil	Costa Rica	Ecuador	France	Italy	Mexico	Spain	USA	unknown	Total	Total		Total
ST58									1		1		1	2
<i>Ambrosia trifida</i>									1		1		1	2
ST6					2			2	10		14	11		25
<i>Medicago sativa</i>												3		3
<i>Olea europaea</i>								1			1	1		2
<i>Polygala myrtifolia</i>												1		1
<i>Prunus dulcis</i>								1	10		11	4		15
<i>Rubus ursinus</i>												1		1
<i>Spartium junceum</i>					2						2			2
<i>Vitis vinifera</i>												1		1
ST6 and ST7					1						1			1
<i>Cistus monspeliensis</i>					1						1			1
ST6 and/or ST7					72						72			72
<i>Acacia dealbata</i>					1						1			1
<i>Acer pseudoplatanus</i>					2						2			2
<i>Anthyllis hermanniae</i>					1						1			1
<i>Artemisia arborescens</i>					2						2			2
<i>Asparagus acutifolius</i>					2						2			2
<i>Calicotome villosa</i>					1						1			1
<i>Cercis siliquastrum</i>					1						1			1
<i>Cistus creticus</i>					1						1			1
<i>Cistus monspeliensis</i>					2						2			2
<i>Cistus salviifolius</i>					2						2			2
<i>Coronilla valentina</i>					2						2			2
<i>Cytisus scoparius</i>					1						1			1
<i>Cytisus sp.</i>					2						2			2
<i>Cytisus villosus</i>					1						1			1

<i>X. fastidiosa</i> subspecies ST Plant species	Natural infection											Artificial infection	Not specified	Grand Total
	Argentina	Brazil	Costa Rica	Ecuador	France	Italy	Mexico	Spain	USA	unknown	Total	Total	Total	
<i>Euryops chrysanthemoides</i>					1						1			1
<i>Genista corsica</i>					1						1			1
<i>Genista ephedroides</i>					2						2			2
<i>Genista</i> × <i>spachiana</i>					2						2			2
<i>Hebe</i> sp.					2						2			2
<i>Helichrysum italicum</i>					2						2			2
<i>Lavandula angustifolia</i>					2						2			2
<i>Lavandula dentata</i>					2						2			2
<i>Lavandula</i> sp.					3						3			3
<i>Lavandula stoechas</i>					2						2			2
<i>Lavandula</i> × <i>heterophylla</i>					2						2			2
<i>Lavandula</i> × <i>intermedia</i>					3						3			3
<i>Medicago sativa</i>					1						1			1
<i>Metrosideros excelsa</i>					2						2			2
<i>Myrtus communis</i>					2						2			2
<i>Pelargonium graveolens</i>					2						2			2
<i>Pelargonium</i> sp.					2						2			2
<i>Phagnalon saxatile</i>					1						1			1
<i>Polygala myrtifolia</i>					4						4			4
<i>Polygala</i> sp.					1						1			1
<i>Prunus cerasifera</i>					2						2			2
<i>Prunus dulcis</i>					1						1			1
<i>Quercus suber</i>					2						2			2
<i>Rosa canina</i>					1						1			1

<i>X. fastidiosa</i> subspecies ST Plant species	Natural infection											Artificial infection	Not specified	Grand Total
	Argentina	Brazil	Costa Rica	Ecuador	France	Italy	Mexico	Spain	USA	unknown	Total	Total	Total	
<i>Rosmarinus officinalis</i>					2						2			2
<i>Spartium junceum</i>					3						3			3
<i>Westringia fruticosa</i>					1						1			1
ST63		1									1			1
<i>Prunus domestica</i>		1									1			1
ST67		1									1			1
<i>Prunus domestica</i>		1									1			1
ST7					1			2	10		13	8		21
<i>Medicago sativa</i>												1		1
<i>Olea europaea</i>									1		1	3		4
<i>Olea sp.</i>									1		1			1
<i>Polygala myrtifolia</i>					1			1			2	1		3
<i>Prunus dulcis</i>								1	4		5	3		8
<i>Prunus sp.</i>										1	1			1
<i>Salvia mellifera</i>									3		3			3
ST79					1						1			1
<i>Polygala myrtifolia</i>					1						1			1
ST8										9	9			9
<i>Alnus rhombifolia</i>										1	1			1
<i>Carya illinoensis</i>										1	1			1
<i>Platanus occidentalis</i>										5	5			5
<i>Quercus palustris</i>										1	1			1
<i>Ulmus americana</i>										1	1			1
ST81								17			17			17
<i>Acacia sp.</i>								1			1			1
<i>Ficus carica</i>								2			2			2
<i>Fraxinus angustifolia</i>								1			1			1
<i>Lavandula dentata</i>								1			1			1

<i>X. fastidiosa</i> subspecies ST Plant species	Natural infection											Artificial infection	Not specified	Grand Total
	Argentina	Brazil	Costa Rica	Ecuador	France	Italy	Mexico	Spain	USA	unknown	Total	Total	Total	
<i>Olea europaea</i>								2			2			2
<i>Olea europaea</i> subsp. <i>sylvestris</i>								2			2			2
<i>Polygala myrtifolia</i>								2			2			2
<i>Prunus domestica</i>								1			1			1
<i>Prunus dulcis</i>								2			2			2
<i>Rhamnus alaternus</i>								1			1			1
<i>Rosmarinus officinalis</i>								2			2			2
ST9									28		28			28
<i>Quercus coccinea</i>									2		2			2
<i>Quercus falcata</i>									1		1			1
<i>Quercus laevis</i>									2		2			2
<i>Quercus nigra</i>									1		1			1
<i>Quercus palustris</i>									11		11			11
<i>Quercus phellos</i>									1		1			1
<i>Quercus robur</i>									1		1			1
<i>Quercus rubra</i>									5		5			5
<i>Quercus shumardii</i>									1		1			1
<i>Quercus</i> sp.									3		3			3
<i>pauca</i>	3	94	8	2	3	167		7		1	285	40		325
ST11		48									48			48
<i>Citrus sinensis</i>		18									18			18
<i>Citrus</i> sp.		29									29			29
<i>Coffea</i> sp.		1									1			1
ST12		3									3			3
<i>Citrus sinensis</i>		2									2			2
<i>Citrus</i> sp.		1									1			1
ST13		7									7			7

<i>X. fastidiosa</i> subspecies ST Plant species	Natural infection											Artificial infection	Not specified	Grand Total
	Argentina	Brazil	Costa Rica	Ecuador	France	Italy	Mexico	Spain	USA	unknown	Total	Total	Total	
<i>Citrus sinensis</i>		1									1			1
<i>Citrus</i> sp.		6									6			6
ST14		7									7			7
<i>Coffea arabica</i>		1									1			1
<i>Coffea</i> sp.		6									6			6
ST16		22									22	1		23
<i>Coffea arabica</i>		1									1			1
<i>Coffea</i> sp.		17									17			17
<i>Olea europaea</i>		4									4	1		5
ST53		1	7		3	167					178	39		217
<i>Acacia saligna</i>						1					1			1
<i>Asparagus acutifolius</i>						1					1			1
<i>Catharanthus roseus</i>						2					2	4		6
<i>Chenopodium album</i>						2					2			2
<i>Cistus creticus</i>						1					1			1
<i>Citrus sinensis</i>												1		1
<i>Coffea arabica</i>			2								2			2
<i>Coffea</i> sp.		1									1			1
<i>Dodonaea viscosa</i>						1					1			1
<i>Eremophila maculata</i>						1					1			1
<i>Erigeron bonariensis</i>						2					2			2
<i>Erigeron sumatrensis</i>						1					1			1
<i>Euphorbia terracina</i>						1					1			1
<i>Grevillea juniperina</i>						1					1			1
<i>Hebe</i> sp.						1					1			1
<i>Heliotropium europaeum</i>						2					2			2
<i>Laurus nobilis</i>						1					1			1
<i>Lavandula angustifolia</i>						1					1			1

<i>X. fastidiosa</i> subspecies ST Plant species	Natural infection											Artificial infection	Not specified	Grand Total
	Argentina	Brazil	Costa Rica	Ecuador	France	Italy	Mexico	Spain	USA	unknown	Total	Total	Total	
<i>Lavandula stoechas</i>						1					1			1
<i>Myoporum insulare</i>						1					1			1
<i>Myrtus communis</i>						1					1			1
<i>Nerium oleander</i>			5			6					11	5		16
<i>Olea europaea</i>						113					113	18		131
<i>Pelargonium fragrans</i>						1					1			1
Periwinkle (common name)						1					1			1
<i>Phillyrea latifolia</i>						1					1			1
<i>Polygala myrtifolia</i>					1	5					6	3		9
<i>Prunus avium</i>						6					6	2		8
<i>Prunus dulcis</i>						4					4	4		8
<i>Prunus persica</i>					1						1			1
<i>Prunus × amygdalo- persica</i>												1		1
<i>Quercus ilex</i>					1						1			1
<i>Quercus pubescens</i>												1		1
<i>Rhamnus alaternus</i>						1					1			1
<i>Rosmarinus officinalis</i>						1					1			1
<i>Spartium junceum</i>						1					1			1
<i>Vinca minor</i>						1					1			1
<i>Westringia fruticosa</i>						3					3			3
<i>Westringia glabra</i>						1					1			1
ST64		1									1			1
<i>Citrus sinensis</i>		1									1			1
ST65		1									1			1
<i>Citrus sinensis</i>		1									1			1
ST66		1									1			1
<i>Coffea arabica</i>		1									1			1

<i>X. fastidiosa</i> subspecies ST Plant species	Natural infection											Artificial infection	Not specified	Grand Total
	Argentina	Brazil	Costa Rica	Ecuador	France	Italy	Mexico	Spain	USA	unknown	Total	Total	Total	
ST68		1									1			1
<i>Coffea arabica</i>		1									1			1
ST69	2										2			2
<i>Citrus sinensis</i>	2										2			2
ST70		1									1			1
<i>Hibiscus rosa-sinensis</i>		1									1			1
ST71		1									1			1
<i>Prunus domestica</i>		1									1			1
ST73										1	1			1
<i>Coffea arabica</i>										1	1			1
ST73 and ST53			1								1			1
<i>Coffea arabica</i>			1								1			1
ST74				2							2			2
<i>Coffea arabica</i>				2							2			2
ST78	1										1			1
<i>Prunus dulcis</i>	1										1			1
ST80								7			7			7
<i>Acacia</i> sp.								1			1			1
<i>Lavandula dentata</i>								1			1			1
<i>Olea europaea</i>								1			1			1
<i>Olea europaea</i> subsp. <i>sylvestris</i>								1			1			1
<i>Polygala myrtifolia</i>								1			1			1
<i>Prunus dulcis</i>								1			1			1
<i>Rosmarinus officinalis</i>								1			1			1
<i>sandyi</i>		2			1					23	26	4		30
ST5										23	23	4		27
<i>Hemerocallis</i> sp.										1	1			1

<i>X. fastidiosa</i> subspecies ST Plant species	Natural infection											Artificial infection	Not specified	Grand Total
	Argentina	Brazil	Costa Rica	Ecuador	France	Italy	Mexico	Spain	USA	unknown	Total	Total	Total	
<i>Jacaranda mimosifolia</i>									1		1			1
<i>Magnolia grandiflora</i>									1		1			1
<i>Nerium oleander</i>									20		20	1		21
<i>Prunus dulcis</i>												1		1
<i>Vinca major</i>												2		2
ST72		1									1			1
<i>Coffea</i> sp.		1									1			1
ST76		1			1						2			2
<i>Coffea</i> sp.		1									1			1
<i>Polygala myrtifolia</i>					1						1			1
Grand Total	3	99	33	2	81	167	3	39	297	1	725	152	12	889

Appendix D – List of contradictive findings

Plant family	Plant species	Detection methods	POS/NEG	Reference
Asteraceae	<i>Baccharis pilularis</i>	ELISA	POS	Costa et al. (2004)
		PCR-based methods	NEG	
Rutaceae	<i>Citrus limon</i>	ELISA	POS	
		PCR-based methods	NEG	
Rutaceae	<i>Citrus</i> sp.	ELISA	POS	
		PCR-based methods	NEG	
Asteraceae	<i>Encelia farinosa</i>	ELISA	POS	
		PCR-based methods	NEG	
Araliaceae	<i>Hedera helix</i>	ELISA	POS	
		PCR-based methods	NEG	
Rosaceae	<i>Heteromeles arbutifolia</i>	ELISA	POS	
		PCR-based methods	NEG	
Juglandaceae	<i>Juglans californica</i>	ELISA	POS	
		PCR-based methods	NEG	
Apocynaceae	<i>Nerium oleander</i>	ELISA	POS	
		PCR-based methods	NEG	
Oleaceae	<i>Olea europaea</i>	ELISA	POS	
		PCR-based methods	NEG	
Anacardiaceae	<i>Pistacia vera</i>	ELISA	POS	
		PCR-based methods	NEG	
Platanaceae	<i>Platanus racemosa</i>	ELISA	POS	
		PCR-based methods	NEG	
Rosaceae	<i>Prunus americana</i>	ELISA	POS	
		PCR-based methods	NEG	
Rosaceae	<i>Prunus</i> sp.	ELISA	POS	
		PCR-based methods	NEG	
Fagaceae	<i>Quercus agrifolia</i>	ELISA	POS	
		PCR-based methods	NEG	
Salicaceae	<i>Salix</i> sp.	ELISA	POS	
		PCR-based methods	NEG	

Plant family	Plant species	Detection methods	POS/NEG	Reference	
Adoxaceae	<i>Sambucus</i> sp.	ELISA	POS		
		PCR-based methods	NEG		
Anacardiaceae	<i>Schinus molle</i>	ELISA	POS		
		PCR-based methods	NEG		
Solanaceae	<i>Solanum elaeagnifolium</i>	ELISA	POS		
		PCR-based methods	NEG		
Rutaceae	<i>Citrus sinensis</i>	Immunological detection method	POS		Damsteegt et al. (2006)
		PCR-based methods	NEG		
Rutaceae	<i>Citrus clementina</i>	ELISA	NEG		Gonzalez et al. (2002)
		PCR-based methods	POS		
Rutaceae	<i>Citrus clementina</i> × <i>C. sinensis</i>	ELISA	NEG		
		PCR-based methods	POS		
Rutaceae	<i>Citrus clementina</i> × <i>C. sinensis</i>	ELISA	POS		
		PCR-based methods	NEG		
Rutaceae	<i>Citrus reticulata</i>	ELISA	NEG		
		PCR-based methods	POS		
Rutaceae	<i>Citrus</i> × <i>tangelo</i>	ELISA	NEG		
		PCR-based methods	POS		
Fagaceae	<i>Quercus palustris</i>	ELISA	NEG	Harris et al. (2013)	
		PCR-based methods	POS		
Fagaceae	<i>Quercus rubra</i>	ELISA	NEG		
		PCR-based methods	POS		
Ginkgoaceae	<i>Ginkgo biloba</i>	ELISA	POS	Harris et al. (2014)	
		PCR-based methods	NEG		
Magnoliaceae	<i>Liriodendron tulipifera</i>	ELISA	POS		
		PCR-based methods	NEG		
Apocynaceae	<i>Nerium oleander</i>	ELISA	POS	Hernandez-Martinez et al. (2006)	
		PCR-based methods	NEG		
Vitaceae	<i>Vitis vinifera</i>	ELISA	POS		
		PCR-based methods	NEG		
Rosaceae	<i>Prunus persica</i>	ELISA	NEG	Hopkins and Adlerz (1988)	
		Immunological detection method	POS		

Plant family	Plant species	Detection methods	POS/NEG	Reference
Anacardiaceae	<i>Rhus</i> sp.	ELISA	POS	
		Immunological detection method	NEG	
Asteraceae	<i>Solidago fistulosa</i>	ELISA	POS	
		Immunological detection method	NEG	
Rutaceae	<i>Citrus × tangelo</i>	Immunological detection method	NEG	
		PCR-based methods	POS	
Malvaceae	<i>Hibiscus syriacus</i>	ELISA	POS	
		PCR-based methods	NEG	
Vitaceae	<i>Vitis vinifera</i>	ELISA	POS	
		PCR-based methods	NEG	
Vitaceae	<i>Vitis</i> sp.	ELISA	NEG	
		PCR-based methods	POS	
Rutaceae	<i>Citrus sinensis</i>	ELISA	POS	
		PCR-based methods	NEG	
Rutaceae	<i>Citrus sinensis</i>	ELISA	NEG	
		PCR-based methods	POS	
Oleaceae	<i>Olea</i> sp.	ELISA	NEG	
		PCR-based methods	POS	
Verbenaceae	<i>Phyla nodiflora</i>	ELISA	POS	
		Immunological detection method	NEG	
		PCR-based methods	POS	
Rosaceae	<i>Rubus trivialis</i>	ELISA	POS	
		Immunological detection method	NEG	
		PCR-based methods	POS	
Bromeliaceae	<i>Tillandsia usneoides</i>	ELISA	POS	
		Immunological detection method	NEG	
		PCR-based methods	NEG	
Apocynaceae	<i>Vinca minor</i>	ELISA	POS	
		Immunological detection method	NEG	
		PCR-based methods	NEG	
Vitaceae	<i>Vitis candicans</i>	ELISA	POS	
		Immunological detection method	NEG	
		PCR-based methods	POS	

Appendix E – References used for data extraction

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