Assessing the risk posed to plant health by Xylella fastidiosa in the European Union

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The plant pathogenic bacterium *Xylella fastidiosa* Wells et al., 1987 was detected in olive trees in Lecce province in Apulia, Italy, in October 2013, being this its first outbreak under field conditions in the European Union. Following a request by the European Commission, in November 2013 the European Food Safety Authority (EFSA) published a Statement reviewing the host plants range and the vectors of this pathogen, its pathways for entry and spread, as well as the options available to reduce the risk it poses (EFSA, 2013).

This was followed in January 2015 by a comprehensive assessment of the risks to plant health of *X. fastidiosa* for the EU and by a systematic identification and evaluation of risk reduction options (EFSA PLH Panel, 2015). In spring 2015, EFSA has published a searchable electronic list of host plants of *X. fastidiosa* (EFSA, 2015a) and has also further discussed studies on the quick olive decline syndrome (EFSA, 2015b). This paper presents a summary of the main findings of these assessments.

**The pathogen *Xylella fastidiosa***

*X. fastidiosa* is a gammaproteobacterium in the family Xanthomonadaceae causing many important plant diseases such as Pierce’s disease of grapevine, phony peach disease, plum leaf scald as well as almond, elm, oak, American sycamore, mulberry and maple leaf scorch, and citrus variegated chlorosis disease. The genus *Xylella* consists of only one species, *X. fastidiosa*. The current distributions of *X. fastidiosa* and its main subspecies are presented in Figure 1, which shows that *X. fastidiosa* has been reported over a large range of climatic environments.

**Figure 1**

*World map of annual minimum temperatures from WorldClim database (http://www.worldclim.org) and Xylella fastidiosa subspecies distribution.*

Temperature classes were chosen based on annual minimum temperatures of northern records of *X. fastidiosa*.

Reports of *X. fastidiosa* from an EFSA literature search database: (lit) indicates reports where the subspecies was assigned in the original paper; (pot) indicates reports for which a potential subspecies was assigned by the Panel.
However, there is a lack of data regarding its overwintering capacity and the range of temperatures within which the different subspecies of the bacteria can thrive. *X. fastidiosa* colonises the xylem vessel network of plants, where it can move up- and downstream, restricting water movement in the xylem. High frequencies of blocked xylem vessels are associated with development of disease symptoms based on plant physiological responses to water stress (Figure 2).

![Figure 2](image)

*Xylella fastidiosa* symptoms on various host plant species.  
(A) Olive trees  (B) Oleander  (C) Almond leaf scorch disease  (D) Cherry  (E) *Polygala myrtifolia*  (F) *Acacia saligna*

Source: Photographs by courtesy of Donata Boscia, CNR—Institute for Sustainable Plant Protection.

A large host range

The host plant range of *X. fastidiosa* is very large. Based on currently available data, the host range comprises plants in 68 families, 187 genera and more than 300 plant species (Fig. 3).
Six of the families are monocotyledons, while 59 are dicotyledons and three are gymnosperms. Despite this reported wide host range, it is important to highlight that not all of these plants express symptoms and are susceptible to disease. For some species certain varieties have been reported showing symptoms whereas others remain generally asymptomatic. In addition, not all host plant species are associated with each *X. fastidiosa* subspecies. There are some indications of host specificity; however its mechanism is not yet fully understood.

**A large number of vectors**

*X. fastidiosa* is exclusively transmitted by xylem sap-feeding insects of the order Hemiptera, sub-order Auchenorrhyncha (Redak et al., 2004), which are able with their sucking mouthparts to reach the xylem of their host plants. These insects are generally not direct pests unless they are present at very high population levels. Within the Cicadomorpha the three superfamilies, Cercopoidea, Cicadoidea and Membracoidea, include xylem fluid-feeding groups but, whereas all Cercopoidea (known as spittlebugs or froghoppers) and Cicadoidea (cicadas) are regarded as xylem fluid feeders, the superfamily Membracoidea includes a single xylem fluid-feeding subfamily, the Cicadellinae (known as sharpshooters).

Only these three groups of ‘specialists’ in xylem fluid feeding have been shown to be vectors of *X. fastidiosa*. Spittlebugs, cicadas and sharpshooters are heterometabolous insects that develop through egg, five nymphal stages and adult winged stage. Nymphs of cicadas and of spittlebugs of the family Cercopidae are subterranean root feeders, whereas nymphs of spittlebugs of the family Aphrophoridae and of sharpshooters develop on the parts of host plants above the ground. All adults feed and live on the aerial parts of host plants (Ossiannilsson, 1981; Tremblay, 1995; Redak et al., 2004).

With the exception of *Philaenus spumarius* (Aphrophoridae), an Old World species introduced in North America and identified as a vector of *X. fastidiosa* in California (Purcell, 1980) and in Apulia (Saponari et al., 2014), all the American vector species are absent from Europe according to the Fauna Europaea database (de Jong, 2013). Sharpshooters (Cicadellidae, subfamily Cicadellinae) are by far the most important vectors of *X. fastidiosa* in the Americas (table 1), but only a few species are present in Europe (Wilson et al., 2009). One species, *Cicadella viridis*, is widespread in Europe, but is common only in humid areas.
### Table 1

**Vectors of *X. fastidiosa* in the Americas: main insect groups and most important vector species**

<table>
<thead>
<tr>
<th>Insect group</th>
<th>Most important species</th>
<th>Distribution</th>
<th>Role as vector</th>
<th>Role as vector: criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sharpshooters</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Cicadellidae, Cicadellinae): 38 spp.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bucephalonia xanthophis (Berg)</td>
<td>Neotropical: Argentina, Bolivia, Brazil, Paraguay</td>
<td>High in citrus</td>
<td>Common, abundant on ornamental plants, citrus and nursery stocks</td>
<td></td>
</tr>
<tr>
<td>Dilobopterus costalimai Young</td>
<td>Neotropical: Brazil</td>
<td>High in citrus</td>
<td>Common, abundant on ornamental plants and citrus</td>
<td></td>
</tr>
<tr>
<td>Graphocephala atropunctata (Signoret)</td>
<td>USA and Central America</td>
<td>High in grapevine</td>
<td>Common in diverse ecosystems, on grape and ornamental plants</td>
<td></td>
</tr>
<tr>
<td>Homalodisca vitripennis (Germar)</td>
<td>USA (southern states), Mexico (northern part), French Polynesia, Easter Island</td>
<td>High in grapevine</td>
<td>Common and abundant in diverse ecosystems, on grape, ornamentals, citrus and nursery stock</td>
<td></td>
</tr>
<tr>
<td><strong>Spittlebugs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Cercopoidea): six species</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Philaenus spumarius L.</td>
<td>USA Including Hawaii, Mexico, Tahiti</td>
<td>Low</td>
<td>Not associated with disease epidemics</td>
<td></td>
</tr>
<tr>
<td><strong>Cicadas</strong> (Cicadoidea): two species</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diceroprocta apache Davis</td>
<td>Mexico, Arizona, Utah, Nevada, California</td>
<td>Doubtful</td>
<td>Missing information on transmission capacity</td>
<td></td>
</tr>
<tr>
<td>Dorisiana viridis (Olivier)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In contrast, a relatively high number of spittlebug species (Cercopoidea: Aphrophoridae and Cercopidae), which are less important vectors in America, occur in Europe and some, such as *Philaenus spumarius*, are very common, but are generally associated with herbaceous plants. According to Frazier (1944) and Purcell (1989), all the xylem fluid feeders should be considered to be potential vectors. A list of potential vectors of *X. fastidiosa* in Europe, gathering all the sharpshooters and spittlebugs was drawn from the Fauna Europaea database. From this list, the species with the highest potential for *X. fastidiosa* spread were identified, based on three criteria: polyphagy, abundance and frequency in different environments (Table 2, Figure 4).

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**Figure 4**

Reported presence in Europe of the most important potential vector species of *X. fastidiosa*
Table 2

Current and potential vector species of *X. fastidiosa* in Europe: main insect groups and most important potential vector species

<table>
<thead>
<tr>
<th>Insect group</th>
<th>Most common species</th>
<th>Distribution</th>
<th>Potential role as vector</th>
<th>Potential role as vector: criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharpshooters (Cicadellidae, Cicadellinae): seven species</td>
<td>Cicadella viridis (Linnaeus 1758)</td>
<td>All Europe</td>
<td>Moderate to high</td>
<td>Very common, wide host range but hygrophilous</td>
</tr>
<tr>
<td>Spittlebugs (Cercopoidea): 34 species</td>
<td>Aphrophora alni (Fallen 1805)</td>
<td>All Europe</td>
<td>Moderate to high</td>
<td>Common, wide host range</td>
</tr>
<tr>
<td></td>
<td>Aphrophora salicina (Goeze 1778)</td>
<td>All Europe</td>
<td>Moderate</td>
<td>Common, oligophagous</td>
</tr>
<tr>
<td></td>
<td>Philaenus spumarius (L.)</td>
<td>All Europe</td>
<td>High</td>
<td>Very common and abundant in diverse ecosystems Identified as a vector in Apulia (Saponari et al., 2014)</td>
</tr>
<tr>
<td></td>
<td>Cercopsis vulnerata Rossi 1807</td>
<td>Not present in northern Europe</td>
<td>Moderate</td>
<td>Many host plants but mainly associated with herbaceous plants</td>
</tr>
<tr>
<td>Cicadas (Cicadoidea): 54 species</td>
<td>Cicada orni Linnaeus</td>
<td>Not present in northern Europe</td>
<td>Doubtful</td>
<td>Missing information on transmission capacity</td>
</tr>
<tr>
<td></td>
<td>Cicadatra atra (Olivier)</td>
<td>Balkans, Italy and France</td>
<td>Doubtful</td>
<td>Missing information on transmission capacity</td>
</tr>
<tr>
<td></td>
<td>Lyristes plebejus (Scopoli)</td>
<td>Not present in northern Europe</td>
<td>Doubtful</td>
<td>Missing information on transmission capacity</td>
</tr>
<tr>
<td></td>
<td>Cicadivetta tibialis (Panzer)</td>
<td>Not present in northern Europe</td>
<td>Doubtful</td>
<td>Missing information on transmission capacity</td>
</tr>
<tr>
<td></td>
<td>Tibicina haematodes (Scopoli)</td>
<td>Not present in northern Europe</td>
<td>Doubtful</td>
<td>Missing information on transmission capacity</td>
</tr>
</tbody>
</table>

As stated earlier, cicadas are xylem fluid feeders and are also expected to be potential vectors, although there are only two reports on their role in *X. fastidiosa* transmission (Paiaõ et al., 2002; Krell et al., 2007). Owing to the large populations of cicadas, particularly in southern EU regions, in addition to the wide host range of plant species utilised by these insects, cicadas could potentially play an important role as vectors of *X. fastidiosa*, however uncertainty is high due to the lack of studies.
Conclusions of the EFSA risk assessment

The EFSA Plant Health Panel has concluded that plants for planting and infectious vectors in plant consignments were the most important pathways for the introduction of *X. fastidiosa* into new areas. The entry of *X. fastidiosa* with plants for planting was rated as very likely mainly because of the very large number of host plant species, the very high trade volumes and the possibility of asymptomatic infection. The likelihood of entry of *X. fastidiosa* with infectious insect vectors in plant consignments was considered as moderately likely.

The assessment identified some uncertainties particularly due to the lack of precise knowledge on distribution, prevalence and symptoms expression of *X. fastidiosa* in the cultivated crops in the countries of origin. Following an entry of *X. fastidiosa*, the probability of establishment was rated as very likely, based on the very high probability that the pathogen would find a suitable host owing to the very large range of host plants and potential host plants, and to the wide distribution and polyphagy of known and potential vectors. Other elements taken into account were the high probability of finding a climatically suitable environment with few adverse abiotic factors and the lack of effective natural enemies, cropping practices or control measures.

Similarly the probability of spread from established infestations of *X. fastidiosa* was rated as very likely because of the large number of confirmed or potential host plants and the abundance and widespread distribution of known or potential vectors. Spread over short to long distances may occur by human assistance, via trade of infected plants for planting or by passive transport of infectious insects in vehicles. However, infectious vectors may also spread locally by flying or being passively transported longer distances by wind. The uncertainties related to the spread include the contributions of human- and wind mediated spread mechanisms, the lack of data on how far the insect vectors can fly, and on how farming practices could impact potential insect vectors and limit the spread of the disease. The overall potential consequences of *X. fastidiosa* in the European territory were rated as major considering the severe losses on cultivated tree crops, such as on citrus in South America and on grapes in North America.

With regard to risk reduction options, the Panel concluded that, because of the broad host range of the pathogen and its vectors, the key priority should be to prevent introduction. Strategies for preventing the introduction from areas where the pathogen is present and for the containment of outbreaks should focus on the two main pathways of plants for planting and of infectious insects and should be based on an integrated system approach, combining, when applicable, the most effective options (e.g. pest-free areas, surveillance, certification, screen house production, control of vectors and testing for plant propagation material, preparation, treatment and inspection of consignments for the pathway of the infectious vectors).

The Panel recommended the continuation and intensification of research activities on the host range, epidemiology and control of the Apulian outbreak of *X. fastidiosa*. Based on the knowledge acquired by this research, uncertainties could be substantially reduced and a more thorough assessment of the risk and of the mitigation measures could be conducted for the Apulian strain of *X. fastidiosa*.

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