Food and Agriculture Organization of the United Nations

International Plant Protection Convention

African Union

USDA

Survey Guidance for *Xylella fastidiosa*

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Scientific Name

Xylella fastidiosa (Wells et al.)

Common Names

Pierce's disease of grapevines
Citrus variegated chlorosis
Coffee leaf scorch
Olive leaf scorch and quick decline
Almond leaf scorch
Bacterial leaf scorch of shade trees
Bacterial leaf scorch of blueberry
Phony peach disease
Plum leaf scald
Alfalfa dwarf

Figure 1. Symptoms of *Xylella fastidiosa* on *Vitis* leaf
(Image courtesy of Theodore D. Leininger, USDA Forest Service, Bugwood.org)

Type of Pest

Bacterium

Taxonomic Position

Xanthomonadales: Xanthomonadaceae

Known Hosts

Xylella fastidiosa is the causal agent of many economically important plant diseases of agronomic and horticultural crops such as *Olea* (olive), *Coffea* (coffee), *Vitis* (grapes), *Prunus* (stone fruits like almond, peach or plum), *Citrus* (citrus), *Ulmus* (elm), *Quercus* (oak), *Vaccinium* (blueberry), *Medicago sativa* (alfalfa), various flowers, and other fruit tree hosts. This pathogen has a wide, expanding host range and comprehensive lists of susceptible hosts are available (see *Identification and Diagnostic Resources* for comprehensive host lists).

Survey Protocol

Survey Site Selection

Surveys should occur wherever hosts of concern are present.

Time of Year to Survey

Sampling should be performed during the period of active growth of the plants.

Visual Survey

Symptoms

Although host plants infected with *X. fastidiosa* may not show symptoms, some display leaf scorching, defoliation, chlorosis or bronzing along the leaf margin, and dwarfing. The bronzing may intensify before browning and drying. Symptoms are usually more

pronounced in stressed plants (e.g., by temperature or drought) and can vary between plant species and environmental conditions.

Examples of characteristic symptoms on key hosts include:

- **Pierce's disease of grapevines (*Vitis*):** Chlorotic spots form on leaves, especially along the margins, with a sudden drying of leaf edges often surrounded by a yellow or red halo (**Figs. 1, 2A**). In late summer and autumn, the necrotic leaf edges coalesce to form concentric rings that extend from the outer edge towards the center. Subsequently, the leaf turns dry on the edges, but the leaf remains firm and may shrivel and drop while the petiole remains attached to the branch (as so-called "match sticks," **Fig. 2B**). The latter is a characteristic symptom of Pierce's disease late in the season. Fruit clusters shrivel or turn into raisins; branches and twigs usually start wilting from the tip; and infected stems mature irregularly, showing patches of green tissue called "green islands." Buds on infected plants sprout later than those on healthy plants, and the new shoots grow slowly and are stunted. Severely affected plants may die within one or two years, although in several species and cultivars they may continue to live considerably longer. Symptoms are rarely seen in one-year-old plants.

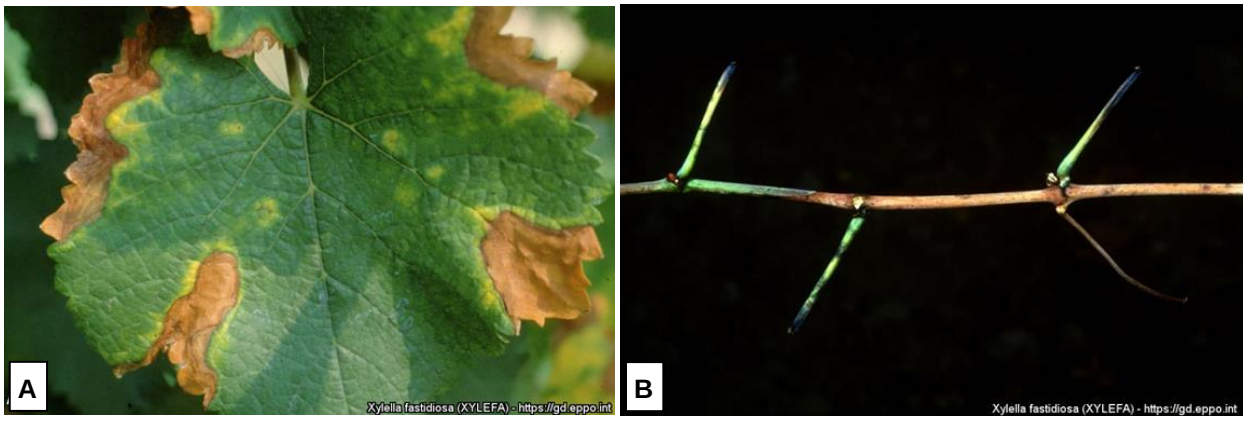

Figure 2. Symptoms of *X. fastidiosa* on grapevine: (A) Leaf showing marginal necrosis surrounded by chlorotic halo; (B) Persistent petioles ("match sticks") (Images courtesy of M. Scortichini, Instituto Sperimentale per la Frutticoltura, Rome, gd.eppo.int; J. Clark & A.H. Purcell, University of California, Berkeley, gd.eppo.int)

- **Citrus variegated chlorosis (on *Citrus*):** Mottled variegations appear on leaves, with small chlorotic spots on the upper surface that correspond to small gummy brown spots on the underside of the leaf (**Fig. 3A**). Symptoms are most obvious on 3- to 6-year old trees, especially on cultivars of *C. sinensis*. The pattern of chlorosis between leaf veins is asymmetrical on opposite sides of the leaf. Symptoms may only appear on portions of newly infected trees, whereas the entire canopy may be symptomatic in older infections. Stunting occurs along with a thin canopy due to defoliation and dieback of twigs and branches (**Fig. 3B**). Flowering is abnormal. Fruits ripen early without filling and are much smaller and very firm (**Fig. 3C**).

Figure 3. Symptoms of citrus variegated chlorosis caused by *X. fastidiosa*: (A) Typical spots on sweet orange leaves; (B) Twig dieback and reduction of production; (C) Fruit ripens early with reduced dimensions (Images courtesy of Gabriel et al. 2020; M. Scortichini, Instituto Sperimentale per la Frutticoltura, Rome, gd.eppo.int)

- **Coffee leaf scorch (on *Coffea)*:** Symptoms appear on young flushes of field plants as large, scorched zones on edges and ends of recently matured leaves (**Fig. 4**). Other symptoms include premature leaf drop, shoot stunting, small and chlorotic apical leaves, followed by shoot dieback and overall plant stunting. Fruit size and yield are reduced. Side branches have no leaves or fruit except for a tuft of leaves at the branch tip.

Figure 4. Symptoms of coffee leaf scorch caused by *X. fastidiosa* (Image courtesy of Maria Bergsma-Vlami, NPPO, NL, gd.eppo.int)

- **Olive leaf scorch and quick decline (on *Olea*):** Symptoms include leaf scorching (**Fig. 5A**) and randomly distributed desiccation of twigs and small branches (**Fig. 5B**), mainly in the upper part of the canopy in early stages of infection. Leaf tips and margins turn dark yellow to brown, eventually leading to desiccation. Symptoms become increasingly severe over time and give a blighted appearance to the entire crown. Desiccated leaves and mummified fruits remain attached to shoots (**Fig. 5C**). Wood in cross-section shows irregular discoloration.

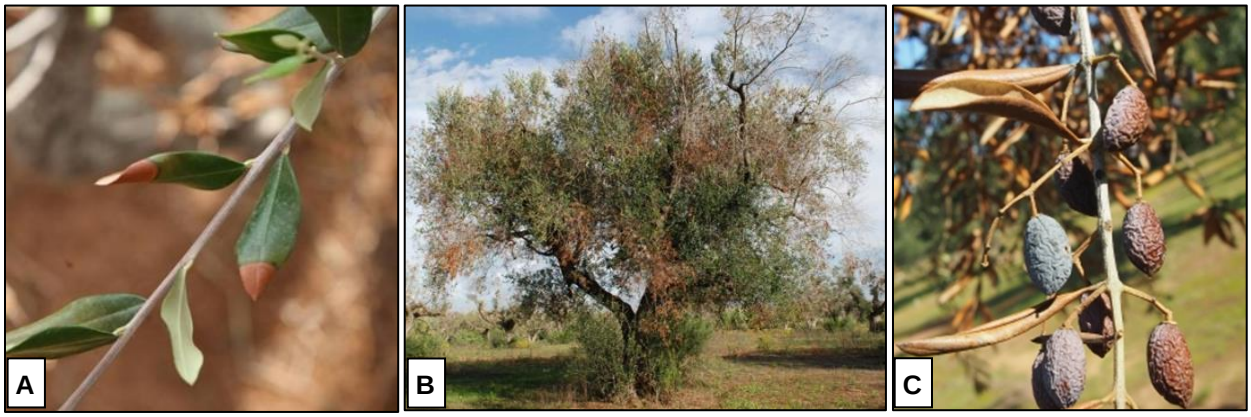

Figure 5. Symptoms of olive leaf scorch and quick decline caused by *X. fastidiosa*: (A) Leaf scorching; (B) desiccation of branches; (C) mummified fruits (Images courtesy of Donato Boscia, CNR - Institute for Sustainable Plant Protection, UOS, Bari, IT; Franco Nigro Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti, Università degli Studi di Bari, IT; Antonio Guario, Plant Protection Service, Regione Puglia, IT; gd.eppo.int; FAO-UN, flickr; Camille Picard, DGAL-SDQPV, FR; gd.eppo.int)

- **Almond leaf scorch (on *Prunus dulcis*):** The most characteristic symptoms in almond trees infected with *X. fastidiosa* are leaf scorching followed by decreased productivity and general decline. Leaf scorching occurs along the edges of leaves and may be surrounded by a narrow band of yellow (**Fig. 6**). As the disease progresses, twigs may die back starting at the tip and nut production is severely reduced.

Figure 6. Symptoms of almond (*P. dulcis*) leaf scorch caused by *X. fastidiosa*
(Image courtesy of Donato Boscia, CNR, Institute for Sustainable Plant Protection, UOS, Bari, IT, gd.eppo.int)

- **Bacterial leaf scorch of shade trees:** Symptoms are similar on different shade tree hosts (e.g., *Acer, Platanus, Quercus, Ulmus*). Scorching at leaf margins may be surrounded by a yellow or red halo (**Fig. 7**). Symptoms generally progress from older to younger leaves as diseased branches die and the tree declines.

Figure 7. Symptoms of bacterial leaf scorch caused by *X. fastidiosa* on maple (*Acer* sp.) (Image courtesy of John Hartman, University of Kentucky, Bugwood.org)

- **Bacterial leaf scorch of blueberry (*Vaccinium*) :** Scorching at leaf edges may be bordered by a darker band (**Fig. 8A**). Over time, symptoms may become uniformly distributed throughout the foliage. New shoots may be thin with fewer flower buds. Leaves drop and twigs and stems develop a “skeletal” yellow appearance (**Fig. 8B**).

Figure 8. Bacterial leaf scorch of blueberry caused by *X. fastidiosa*: (A) Leaf scorch; (B) Twigs and stems with "skeletal" yellow appearance (Images courtesy of Phillip M. Brannen, University of Georgia, US, gd.eppo.int)

- **Phony peach disease and plum leaf scald (*Prunus* spp.):** Young shoots are stunted with greener, denser foliage compared to healthy trees (**Fig. 9**). Side branches grow horizontally or droop, so the tree appears uniform, compact, and rounded. Leaves and flowers appear early and remain on the tree longer, and fruit production is reduced in quantity and size.

Figure 9. Symptoms of phony peach disease caused by *X. fastidiosa* (Image courtesy of M. Scortichini, Instituto Sperimentale per la Frutticoltura, Rome, IT, gd.eppo.int)

- **Alfalfa dwarf (on *Medicago sativa*):** The main symptom on alfalfa is stunted regrowth after cutting (**Fig. 10**). Leaflets are smaller and often slightly darker in color, but **not** distorted, cupped, mottled, or yellow. Internal lignified tissue is yellowish with fine dark streaks of dead tissue.

Figure 10. Symptoms of alfalfa dwarf caused by *X. fastidiosa* on *M. sativa* (Image courtesy of Céline Vidal, gd.eppo.int**)**

- **Other hosts:** Most symptomatic plants display typical leaf scorching (**Fig. 11**).

Figure 11. Leaf scorch symptoms caused by *X. fastidiosa* on examples of other hosts: (A) Milkwort (*Polygala* sp.); (B) Oleander (*Nerium* sp.) (Images courtesy of Céline Vidal, gd.eppo.int; Donato Boscia, CNR, Institute for Sustainable Plant Protection, UOS, Bari, IT, gd.eppo.int)

Insect Vectors

Xylella fastidiosa is spread by insect vectors that feed on the xylem of plants. Many known vectors belong to the Families Aphrophoridae, Cercopidae, and Cicadellidae; however, any xylem-feeding insect has the potential to transmit the disease when feeding on infected plants then subsequently feeding on healthy plants (**Fig. 12**).

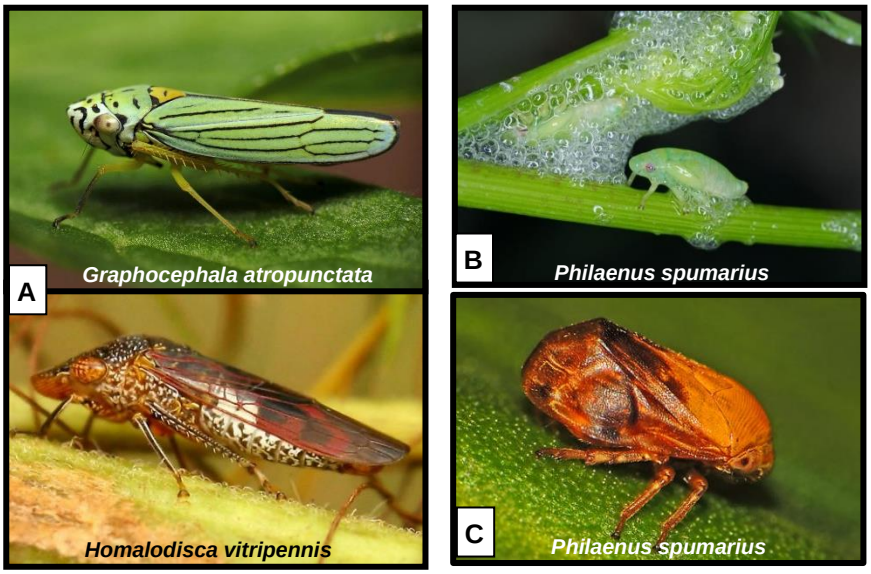

Figure 122. Examples of insects that vector *X. fastidiosa.* Many vectors are from the following Families: (A) Cicadellidae, (B) Aphrophoridae, or (C) Cercopidae (Images courtesy of Tomasz Klejdysz,shutterstock.com; CABI; Trevor Edmonson, University of Minnesota, https://www.countyofnapa.org/; Lisa Powers, 2015, https://bugguide.net/node/view/1494408)

Sample Collection

Samples of branches or canes with attached leaves that include mature leaves generally provide the most reliable results. Young growing shoots should be avoided. For small plants, the entire plant can be sent to the laboratory.

The petiole and midrib of leaves are the best sources for diagnosis, however other sources of living tissue can include small twigs and roots of *Prunus*, stems and roots of *Vaccinium,* and *Citrus* fruit petioles.

The sample should consist of branches or cuttings representative of the symptoms seen on the plant or plants—preferably from a single plant, although a pooled sample may also be collected. See **Table 1** for guidelines on sample type and size.

Table 1. Number of leaves (including their petioles) to be used and approximate weight of the laboratory sample.

Type of sample	Host plants and type of tissue	Minimum number of leaves per laboratory sample	Approximate weight of laboratory sample
Sample from individual plant with leaves	Petioles or midribs, or both, of leaves of large size (e.g., *Coffea* spp., *Ficus* spp., *Vitis* spp., *Nerium* spp.)	5	0.5-1 g
	Petioles or midribs, or both, of leaves of small size (e.g., *Polygala myrtifolia*; *Olea* spp.)	25	0.5-1 g
	Plant species without petioles or with small petiole and midrib	25	0.5-1 g
Dormant plant or cuttings	Xylem tissue	not applicable	0.5-1 g
Composite sample from several coffee plants from a single lot with leaves	Samples of asymptomatic plants (e.g., collected from imported consignments or nursery monitoring)	100-200	10-50 g

See *Guidance from International Plant Protection Convention* for more information:
https://www.ippc.int/static/media/files/publication/en/2018/09/DP_25_2018_Xylellafastidiosa_2018-09-21.pdf

IMPORTANT:

After collection, keep samples cool (e.g., 4-15 °C) to avoid deterioration. Send samples to the laboratory as soon as possible.

Pest Identification and Diagnostics

Laboratory diagnosis is best achieved with serological methods such as double antibody sandwich enzyme-linked immunosorbent assay (DAS-ELISA) or molecular methods such as conventional polymerase chain reaction (PCR), real-time PCR, or loop-mediated isothermal amplification (LAMP). Isolation methods are not recommended for detection due to difficulty isolating *X. fastidiosa* from plant tissue.

Pest Description

Xylella fastidiosa is a xylem-limited bacterium with fastidious growth requirements (i.e., it is difficult to isolate and culture outside of a host plant). It is inoculated into the water-transporting (xylem elements) of its host plants by xylem sap-feeding insects.

Identification and Diagnostic Resources

International Plant Protection Convention (IPPC):
Diagnostic Protocol 25: *Xylella fastidiosa*
https://www.fao.org/3/cb4697en/cb4697en.pdf

European and Mediterranean Plant Protection Organization (EPPO):
Diagnostics PM 7/24 (4) *Xylella fastidiosa*
https://onlinelibrary.wiley.com/doi/epdf/10.1111/epp.12575

European and Mediterranean Plant Protection Organization (EPPO):
Xylella fastidiosa Photos
https://gd.eppo.int/taxon/XYLEFA/photos

European Food Safety Authority (EFSA):
Update of the *Xylella* spp. host plant database – systematic literature search (up to 31 December 2022)
https://doi.org/10.2903/j.efsa.2023.8061

Easily Mistaken Species and Conditions

Symptoms can be confused with those of other diseases (e.g., several fungal diseases, depending on the host) or physiological causes (environmental stresses, water deficiency, salt, air pollutants, nutritional problems, etc.).

Reference

Much of the content of these guidelines were taken directly from the IPPC Diagnostic Protocol for *X. fastidiosa*:
IPPC. 2018. Diagnostic Protocol 25: *Xylella fastidiosa*. Food and Agriculture Organization of the United Nations, International Plant Protection Convention (IPPC), Rome. https://www.fao.org/3/cb4697en/cb4697en.pdf 36 pp.

The United States Department of Agriculture developed this datasheet in support of the Africa Phytosanitary Program (2023).

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