

# EPPO Datasheet: *Erwinia amylovora*

Last updated: 2020-04-22

## IDENTITY

**Preferred name:** *Erwinia amylovora*

**Authority:** (Burrill) Winslow, Broadhurst, Buchanan, Krumwiede, Rogers & Smith

**Taxonomic position:** Bacteria: Proteobacteria:

Gammaproteobacteria: Enterobacterales: Erwiniaceae

**Other scientific names:** *Bacillus amylovorus* (Burrill) Trevisan, *Bacterium amylovorum* (Burrill) Chester, *Erwinia amylovora* f. sp. *rubi* Starr, Cardona & Folsom, *Micrococcus amylovorus* Burrill

**Common names:** fire blight (US), fireblight (GB), twig blight of apple

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**EPPO Categorization:** A2 list

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**EU Categorization:** PZ Quarantine pest ((EU) 2019/2072 Annex III), RNQP ((EU) 2019/2072 Annex IV)

**EPPO Code:** ERWIAM



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## HOSTS

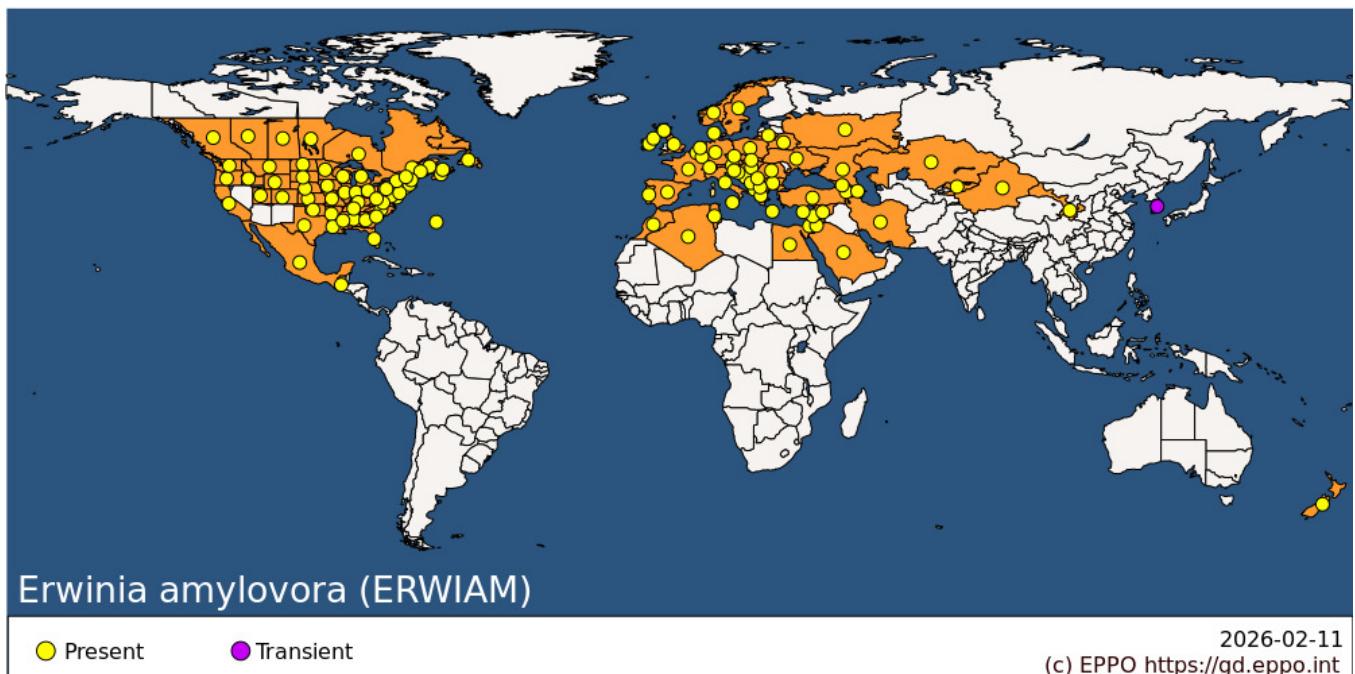
Fireblight, caused by *Erwinia amylovora*, specifically affects plants within the Rosaceae family, and more particularly those in the subfamily Maloideae which includes economically important pome fruit trees, such as apple (*Malus domestica*) and pear (*Pyrus communis*). The latter two being among the most consumed fruits in the world. A few hosts belonging to the subfamilies Rosoideae and Amygdaloideae can also be affected (Momol and Aldwinckle, 2000). Genera in the subfamily Spiraeoideae have been reported as hosts on the basis of artificial inoculation (van der Zwet and Keil, 1979), or occasionally being found infected (e.g. *Spiraea prunifolia*; Bastas and Sahin, 2014). Most strains of *E. amylovora* isolated from one host are also pathogenic on other hosts (Mohan and Thomson, 1996; Vanneste *et al.*, 2002). However, *Rubus* strains which have been isolated in North America are host specific; they are pathogenic on brambles but not on apple and pear (Starr *et al.*, 1951; Braun and Hildebrand, 2005). Strains of *E. amylovora* isolated from *Rubus* species in the United States are different from strains detected in other hosts (Starr *et al.*, 1951; Powney *et al.*, 2011). *E. amylovora* has occasionally been isolated from *Rosa canina* and *R. rugosa* (Bastas *et al.*, 2013; Vanneste *et al.*, 2002), but has not been reported causing fireblight in commercially cultivated roses.

Most of the plants specified in the list below are widely distributed in the EPPO region either as cultivated or as native wild plants. Wild *Pyrus* species (*P. amygdaliformis*, *P. syriaca*) play an important role as sources of inoculum in Southern Europe and in the Mediterranean area, because of their abundance in these areas. *Crataegus* (*C. laevigata*, *C. monogyna*) and ornamentals (*Pyracantha*, *Cotoneaster*, *Sorbus*) are important sources of inoculum for apple and pear trees in Europe.

**Host list:** *Amelanchier alnifolia*, *Amelanchier canadensis*, *Amelanchier laevis*, *Aronia melanocarpa*, *Chaenomeles japonica*, *Chaenomeles*, *Cotoneaster bullatus*, *Cotoneaster buxifolius*, *Cotoneaster dammeri*, *Cotoneaster horizontalis*, *Cotoneaster lacteus*, *Cotoneaster lucidus*, *Cotoneaster microphyllus*, *Cotoneaster moupinensis*, *Cotoneaster niger*, *Cotoneaster salicifolius*, *Cotoneaster x crispii*, *Cotoneaster x watereri*, *Cotoneaster*, *Crataegus laevigata*, *Crataegus monogyna*, *Crataegus pinnatifida*, *Crataegus x prunifolia*, *Crataegus*, *Cydonia oblonga*, *Eriobotrya japonica*, *Fragaria x ananassa*, *Malus baccata*, *Malus coronaria*, *Malus domestica*, *Malus floribunda*, *Malus*, *Mespilus germanica*, *Photinia davidiana*, *Prunus armeniaca*, *Prunus cerasifera*, *Prunus domestica*, *Prunus salicina*, *Pseudocydonia sinensis*, *Pyracantha coccinea*, *Pyracantha crenatoserrata*, *Pyracantha*, *Pyrus betulifolia*, *Pyrus bourgaeana*, *Pyrus communis*, *Pyrus elaeagnifolia*, *Pyrus pyraster*, *Pyrus pyrifolia*, *Pyrus spinosa*, *Pyrus ussuriensis*, *Pyrus x sinkiangensis*, *Pyrus*, *Rosa canina*, *Rosa rugosa*, *Rosa*, *Rubus fruticosus*, *Rubus idaeus*, *Sorbus alnifolia*

## GEOGRAPHICAL DISTRIBUTION

Fireblight was first described in the USA in 1780 (Denning, 1794) and has then spread throughout the North American continent, New Zealand (since 1920), and Europe where the disease was first reported in England in 1957. Since then, it rapidly spread through Western Europe and the Middle East (Van der Zwet, 2002, 2006). On the African continent, fireblight was declared to be present for the first time in 1964 in Egypt. Currently, this disease has reached many parts of the world. However major pome production areas such as Asia, in particular China, and South America have not yet been infected.



**EPPO Region:** Albania, Algeria, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czechia, Denmark, France (mainland), Georgia, Germany, Greece (mainland, Kriti), Hungary, Ireland, Israel, Italy (mainland, Sicilia), Jordan, Kazakhstan, Kyrgyzstan, Lithuania, Luxembourg, Montenegro, Morocco, Netherlands, North Macedonia, Norway, Poland, Portugal (mainland), Romania, Russian Federation (Central Russia, Southern Russia), Serbia, Slovakia, Slovenia, Spain (mainland), Sweden, Switzerland, Tunisia, Türkiye, Ukraine, United Kingdom (England, Northern Ireland, Scotland)

**Africa:** Algeria, Egypt, Morocco, Tunisia

**Asia:** China (Gansu, Xinjiang), Iran, Islamic Republic of, Israel, Jordan, Kazakhstan, Korea, Republic of, Kyrgyzstan, Lebanon, Saudi Arabia, Syrian Arab Republic

**North America:** Canada (Alberta, British Columbia, Manitoba, New Brunswick, Newfoundland, Nova Scotia, Ontario, Prince Edward Island, Québec, Saskatchewan), Mexico, United States of America (Alabama, Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin, Wyoming)

**Central America and Caribbean:** Bermuda, Guatemala

**Oceania:** New Zealand

## BIOLOGY

The fireblight pathogen overwinters exclusively in infected host plants. The bacterium spreads from active lesions via pollinating insects during the flowering period, birds, rain splashing, wind and contaminated pruning tools. It enters the host through natural openings (nectaries, stomata, hydaphodes) or accidental ones (wounds) during

flowering or shoot growth. The disease cycle has been fully illustrated by Beer, 1979; Paulin, 1996; Agrios, 2005; Khan *et al.*, 2012.

## DETECTION AND IDENTIFICATION

### Symptoms

All the above-ground parts of hosts can be infected by the pathogen. The most common and characteristic symptoms are:

- (a) Wilt and death of flower clusters. Some or all the blossoms of a cluster wilt and die. The dead blossoms become dry and dark-brown to black in colour. They usually remain attached to the plant.
- (b) Withering and death of shoots and twigs. Infected young succulent shoots and twigs wither, turn brown and in most cases the tip of the shoot bends in a characteristic way forming the symptom known as 'shepherd's crook'.
- (c) Leaf blight: infected leaves show either necrotic patches which start from the margin of the leaf blade or blackening of the petiole and leaf midrib depending on how the infection took place.
- (d) Fruit blight: infected fruits also turn brown to black, shrivel and, like the blossoms, remain attached to the spur, taking on a mummified appearance.
- (e) Limb and trunk blight: from the infected blossoms, shoots or fruits, the disease spreads through the spurs to larger twigs and branches causing cankers and then may continue into the scaffold limbs and the trunk. Cankers cause quick death of branches or the whole tree by girdling. The cankers are recognized, externally, because their surface is slightly sunken, varying in size and surrounded by irregular cracks in the bark. Internally the tissues of the cankered area show a slightly orangey red or brown discolouration which diffuses into the healthy tissues; they are often water-soaked in appearance.

In warm, wet conditions, a whitish mucoid bacterial ooze may exude from infected shoots, petioles, cankered bark and infected fruit and blossoms. The ooze from infected apple shoots may have a golden colour (for more details see Agrios, 2005; Janse, 2005).

### Morphology

*E. amylovora* cells are Gram-negative. Colonies are domed, circular, mucoid on sucrose nutrient agar (mucoid on KB medium (Paulin and Samson, 1973); smooth large, pulvinate, light blue opalescent with craters on CCT medium (Ishimaru and Klos, 1984). The cell size is about 0.3  $\mu\text{m}$  x 1–3  $\mu\text{m}$ , they occur singly, in pairs and sometimes in short chains, and are motile by two to seven peritrichous flagella per cell (Paulin, 2000).

### Detection and inspection methods

To detect the disease, it is necessary to make inspections during the growing season, when the symptoms are visible. The time of inspection depends on the kind of host to be inspected and on the geographical location. It is preferable to inspect from after flowering until late summer, when the symptoms are more obvious. During the winter, on dormant plants, disease detection is quite difficult because cankers are not always visible. Latent infection has been reported in woody tissues and is considered significant in disease development (Van der Zwet and Van Buskirk, 1984; EPPO, 2013).

Since the symptoms of fireblight may be confused with those caused by other diseases and there is a possibility of latent infection, detection should be confirmed by isolation and laboratory tests (Lelliott, 1968). For reliable and rapid identification of the pathogen, immunofluorescence (Paulin, 1981), dot-ELISA (Zutra *et al.*, 1986), nested PCR (Llop *et al.*, 2000), real-time PCR (Hinze *et al.*, 2016), LAMP (Bühlmann *et al.*, 2012; Moradi *et al.*, 2012). For more details see EPPO Standard PM 7/20. Support for the identification can be achieved by DNA barcoding and sequencing using the recA gene (Laala *et al.*, 2012).

## PATHWAYS FOR MOVEMENT

Natural dispersal by insects or rain only disseminates *E. amylovora* locally. The fireblight pathogen is mainly transmitted over long distances by host plants which are latently infected or have undetectable cankers. *E. amylovora* can be endophytic in internal tissues of multiplication material, thus resulting in movement of the pathogen to bacterium free areas (McManus and Jones, 1995). Another important source of inoculum are ornamental hosts grown near the orchards (Thomson, 2000). Bacterial ooze on fruit containers was thought to be the means of the first introduction into Europe but the risk of transmission on fruit is considered insignificant in current trade practice (Robert and Sawyer, 2008). The way the disease has spread in the Mediterranean countries does not exclude the possibility that aerosols have played a significant role in the spread of the pathogen over long distances (Psallidas, 1990). Moreover, *E. amylovora* is spread through the use of non-disinfected pruning tools (Teviotdale *et al.*, 1991).

## PEST SIGNIFICANCE

### Economic impact

The fireblight pathogen causes considerable damage to susceptible hosts. It is not only destructive to the current year's crop but also extremely dangerous to the plants themselves. After favourable weather conditions during blooming, yield is considerably reduced and, in some cases to zero. The next year's productivity is also significantly affected because of the destruction of fruiting spurs. In susceptible hosts the infection spreads so rapidly through the tree that, once infected, trees cannot be saved, even by drastic and immediate surgery, and die within a short time after the first visual signs of infection. In some states of the USA and other countries, the cultivation of particularly susceptible varieties of pear has been largely abandoned because of the disease. Fireblight is a sporadic disease that can cause significant damage because it is necrogenic and progresses very rapidly. The economic impact is difficult to quantify because it depends on the intensity of the epidemic and a fireblight attack can have repercussions over several years. In the USA, crop losses and control costs have been estimated to be more than 100 million USD per year (Norelli *et al.*, 2003). In Switzerland, where the disease was first observed in 1989, the financial burden of control measures (from quarantine to diagnostics), together with compensation payments for destroyed plants, were estimated to be about 35 million EUR over a 14-year period, from 1989 to 2003 (Duffy *et al.*, 2005).

### Control

Control of the disease is mainly based on prophylactic measures, which include elimination of inoculum reservoirs, particularly crop debris, weeds, and the use of certified seedlings as pathogen-free planting material. Crop surveillance and monitoring are necessary, as well as certification programs, to ensure the sanitary quality of the plants. Warning systems based mainly on climatic data have been developed for successful and economic control of the disease (Thomson *et al.*, 1982, Billing, 1984, 1990; Lightner and Steiner, 1990).

Current control methods are diverse, but each is of limited effectiveness. Any control method against this disease must be accompanied by measures aiming at reducing the bacterial inoculum, such as manual removal of infected shoots or even uprooting of trees. Chemical control can be applied as a precautionary measure, but it is not considered environmentally-friendly; for this reason, many studies are focussing on the identification of potential biological control agents, such as antagonistic microorganisms (Mikici?ski *et al.*, 2016; Ait Bahadou *et al.*, 2018). Other more recent approaches aim to modify the susceptibility of plants to the pathogen, for example by elicitation of the plant's natural defences (Wöhner *et al.*, 2017).

### Phytosanitary risk

Fireblight is a major threat for the EPPO region, and *E. amylovora* has been included on the EPPO A2 list since 1975. It is also considered as a quarantine pest by COSAVE and IAPSC, and by numerous uninfested countries around the world (e.g. Australia, Japan). It presents a risk to the pear and apple industries, as well as to the nursery trade, since many ornamental species are susceptible hosts. The presence of fireblight in a country is a major constraint for export trade in plants for planting of fireblight hosts. For the Mediterranean region the risks are more serious because of the favourable climatic conditions for disease development and the existence of self-rooted wild

hosts. The damage that the disease has inflicted in the Mediterranean countries where it has occurred are very severe. Most of the susceptible pear cultivars (Passe Crassane, General Leclerc, Santa Maria, Williams and some local cultivars) have suffered severe losses and are tending to disappear (Psallidas, 1990). The damage the disease may inflict to Mediterranean ecosystems is difficult to predict.

## PHYTOSANITARY MEASURES

*E. amylovora* is a regulated pest in most countries of the EPPO region. All countries, even those where the disease exists, have imposed restrictions on the introduction of susceptible host plants. All plant organs except seeds are considered as potential sources for disseminating the pathogen, but it is widely accepted that fruits present an insignificant risk in practice. There is no adequate chemical or other treatment for the elimination of the pathogen from plant material without destroying the plant tissues.

Van der Zwet *et al.* (1990) reported that apple fruits collected from apparently healthy trees or harvested a minimum of 100 cm from visible blight symptoms are free from *E. amylovora*, and thus incapable of disseminating the disease to areas or countries without fireblight. A subsequent study using a predictive model under different scenarios, also concluded that the risk of spreading *E. amylovora* to disease-free areas via commercial apple fruit was insignificant (Roberts and Swayer, 2008).

Because of the great importance of the disease, eradication is generally attempted in newly infested areas. However, once the disease has become established in orchards or on wild hosts, eradication measures have proved to be very costly and, in most areas, ineffective. In a few cases, isolated imported nursery plants have been found to be infected and have been destroyed soon enough to prevent establishment.

The most effective method for preventing or postponing the spread of *E. amylovora* into uninfested areas is to impose strict phytosanitary measures on imported host plant material and to maintain vigilance in orchards and nurseries. Countries at high risk may prohibit importation of host plants for planting. However, an exception can be made for importation during the winter months, in which case consignments should come from an area where *E. amylovora* does not occur, or from an area found free from the pest during the last growing season and where an official control campaign has minimized spread. To reduce the risk of spread in international trade, other countries (even those where *E. amylovora* occurs) are recommended to require area freedom or growing-season inspection.

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## ACKNOWLEDGEMENTS

This datasheet was extensively revised in 2020 by Samia Laala, teacher and researcher at ENSA (École Nationale Supérieure Agronomique d'Alger). Her valuable contribution is gratefully acknowledged.

### How to cite this datasheet?

EPPO (2026) *Erwinia amylovora*. EPPO datasheets on pests recommended for regulation. Available online.  
<https://gd.eppo.int>

### Datasheet history

This datasheet was first published in the EPPO Bulletin in 1983 and revised in the two editions of 'Quarantine Pests for Europe' in 1992 and 1997, as well as in 2020. It is now maintained in an electronic format in the EPPO Global Database. The sections on 'Identity', 'Hosts', and 'Geographical distribution' are automatically updated from the database. For other sections, the date of last revision is indicated on the right.

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Co-funded by the  
European Union