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Data Sheets on Quarantine Pests

Erwinia amylovora

IDENTITY

Name: *Erwinia amylovora* (Burrill) Winslow *et al.*
Synonyms: *Micrococcus amylovorus* Burrill
Bacillus amylovorus (Burrill) Trevisan
Bacterium amylovorus (Burrill) Chester
Erwinia amylovora (Burrill) Winslow *et al.* f.sp. *rubi* Starr *et al.*
Taxonomic position: Bacteria: Gracilicutes
Common names: Fireblight (English)
Feu bactérien (French)
Feuerbrand (German)
Bacterievuur (Dutch)
Colpo di fuoco (Italian)
Ildsot (Danish)
Kerakhon (Hebrew)
Lefha nareya (Egyptian)
Paerebraun (Norwegian)
Pala (Czech)
Fuego bacteriano (Spanish)
Tizón de fuego (Mexican)
Ates yanikligi (Turkish)
Vaktiriako kapsimo (Greek)
Zaraga ogniova (Polish)
Bayer computer code: ERWIAM
EPPO A2 list: No. 52
EU Annex designation: II/A2

HOSTS

The principal and most susceptible hosts are in the sub-family Pomoideae of the family Rosaceae. The following plants are considered as important hosts, from both economic and epidemiological points of view: *Amelanchier alnifolia*, *A. canadensis*, apples, *Chaenomeles* spp., *Cotoneaster* spp., *Crataegus* spp., *Cydonia* spp., loquats, medlars, pears, *Pyracantha* spp., *Pyrus amygdaliformis*, *Sorbus* spp., *Stranvaesia davidiana*. Of these, the most susceptible are: *Crataegus* (most species), *Cydonia* (most species), *Cotoneaster bullatus*, *C. dammeri* (except cv. Eichholz No. 1), *C. lacteus*, *C. lucidus*, *C. microphyllus*, *C. moupinensis*, *C. salicifolius*, *C. watereri*, pear cultivars Alexandrine Douillard, Durondeau and Passe Crassane, apple cultivars Idared, Red Jade, Van Eseltine, *Pyracantha fortuneana* cv. Orange Glow, *Sorbus aria* and *Stranvaesia davidiana*. The following are not, however, considered as hosts: *Crataegus arnoldiana*, *C. phaenopyrum*, *C. viridis*, *Sorbus intermedia*.

E. amylovora isolated from diseased *Rubus* (in the USA) appears distinct on the basis of cross-infection studies and has been named f.sp. *rubi* (Ries & Otterbacher, 1977); very little has been published on this pathogen which has not been reported anywhere else in the world and is consequently of slightly dubious status. *Rosa* spp. have also been reported as hosts in relatively recent literature, but again very little information is available. Records on other rosaceous hosts are old, mostly based on artificial inoculations and extremely dubious. See also Van der Zwet & Keil (1979) and Bradbury (1986) for fuller lists of genuine and doubtful hosts.

All the above plants specified as important hosts are widely distributed in the EPPO region either as cultivated or as native wild plants. *Crateagus* and *Pyrus amygdaliformis* play an important role as sources of inoculum in northern Europe and the Mediterranean, respectively, because of their abundance in these areas. *Crateagus* is widely used as a wayside and hedging plant, while *P. amygdaliformis* is a common wild plant of the Mediterranean landscape.

GEOGRAPHICAL DISTRIBUTION

E. amylovora is native to North America and was introduced into northern Europe in the 1950s to 1960s. It has slowly spread southwards, but fairly large areas in France and Germany still remain free from the disease. Since the early 1980s, fireblight has been spreading in the eastern Mediterranean area, apparently separately. There thus remained a zone across Europe, from Portugal across to Romania and Russia, including the large pear production areas in Italy and Spain, where fireblight did not occur. In 1995-96, this gap has begun to close, with outbreaks found in previously uninfested areas (Hungary, Romania, northern Italy and northern Spain. Eradication efforts continue in these areas.

EPPO region: Austria (EPPO Reporting Service 94/172), Belgium, Bosnia and Herzegovina (RS 96/145), Bulgaria (Bobev, 1990, personal communication), Croatia (EPPO Reporting Service, 96/004), Cyprus (EPPO Reporting Service 457), Czech Republic (Kudela, 1988), Denmark, Egypt (new outbreaks from 1983 - considered established EPPO Reporting Service 520/07), France (except south-east) (Larue & Vincent, 1990), Germany, Greece (Psallidas, 1990), Hungary (isolated outbreaks in apple orchard in 1995, under eradication; RS 96/106), Ireland (EPPO Reporting Service 472), Israel (EPPO Reporting Service 459, Shabi *et al*., 1990), Italy (Emilia Romagna - EPPO Reporting Service 95/114), Lebanon (potential EPPO country) (EPPO Reporting Service 498), Luxembourg, Macedonia (RS 96/145), Netherlands, Norway (EPPO Reporting Service 471; Sletten, 1990), Poland, Romania (EPPO Reporting Service 93/170), Slovakia, Spain (isolated outbreak in Países Basco in 1995, under eradication; EPPO RS 96/107), Sweden (EPPO Reporting Service 477), Switzerland (several cantons in the east, EPPO Reporting Service 96/144), Turkey (EPPO Reporting Service 520/08 and 529/10; Oktem & Benlioglu, 1988), UK (Absent from Northern Ireland; EPPO Reporting Service 93/069), Ukraine (IMI, 1993; declared erroneous by Ukrainian authorities), Yugoslavia (Serbia - north, west, south, Kosovo, Slavonia; EPPO Reporting Service 96/145).

Asia: Armenia (EPPO Reporting Service 506/08), China (unconfirmed), Cyprus, Israel, Japan (unconfirmed; 'bacterial short blight' of Asian pear, occurring in Hokkaido, is considered by some authors to be caused by an organism indistinguishable from *E. amylovora*; EPPO Reporting Service 96/108), Jordan (EPPO Reporting Service 527/10), Lebanon, Korea Republic (unconfirmed), Saudi Arabia (unconfirmed), Turkey, Viet Nam (unconfirmed), India (Papdiwal & Deshpande, 1978; on roses and therefore dubious).

Africa: Egypt.

North America: Bermuda (EPPO Reporting Service 524/09), Canada (all provinces and territories), Mexico, USA (widespread: Alabama, California, Colorado, Connecticut, Georgia, Illinois, Maine, Maryland, Michigan, New York, North Carolina, Ohio, Oregon, Pennsylvania, Texas, Utah, Virginia, Washington, West Virginia, Wisconsin).

Central America and Caribbean: Guatemala (EPPO Reporting Service 529/10), Haiti (a previously cited record is erroneous).
South America: Colombia (unconfirmed). The record in Chile cited in the first edition of the EPPO data sheet (OEPP/EPPO, 1983) is an error.
Oceania: New Zealand.
EU: Present.
Distribution map: See IMI (1993, No. 2), International Working Group on Fireblight Research - Newsletters 1988, 1989, 1990.

BIOLOGY

The fireblight pathogen overwinters exclusively in infected host plants. Hold-over cankers are the most important source of primary inoculum for blossom infection in the spring. Bacteria enter the plant through blossoms, natural openings (stomata, lenticels, hydathodes) or wounds, carried by insects or by wind-driven rain. The disease cycle has been fully illustrated by Beer (1979).

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 the way 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 foxy red or brown discoloration 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.

Morphology

E. amylovora has cells 1.1-1.6 x 0.6-0.9 µm in size, Gram-negative short rods, with rounded ends, motile by many peritrichous flagellae. For more details, see Van der Zwet & Keil (1979).

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 & Van Buskirk, 1984).

Since the symptoms of fireblight may be confused with those caused by other diseases and there is a possibility of latent infection, detection of the disease 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) and DNA-hybridization (Steinbrenner *et al*., 1990) methods are the most promising among those that have been proposed. An EPPO quarantine procedure is now available (OEPP/EPPO, 1992).

MEANS OF MOVEMENT AND DISPERSAL

Natural dispersal by insects or rain only disseminates *E. amylovora* locally, though migrating birds have been considered to carry infectious bacteria over longer distances. The fireblight pathogen can mainly be transmitted over long distances by host plants which are latently infected or have undetectable cankers. Bacterial ooze on fruit containers was supposed to be the means of the first introduction into Europe but the risk of transmission on fruit is considered insignificant in current trade practice. 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).

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 nullified. 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 in a short time after the first visual sign of infection. In some states of the USA, pear cultivation has been largely abandoned because of the disease. Accurate estimates of the annual losses for a given locality or region are difficult to obtain (Van der Zwet & Keil, 1979).

Control

For the control of the disease, an integrated programme of chemical control combined with sanitation, pruning, eradication, tree nutrition and use of resistant or tolerant cultivars is recommended. In North America streptomycin sprays during blossoming give adequate control. 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 & Steiner, 1990). In northern Europe, where streptomycin is not allowed for agricultural use, other chemicals have been tested, such as flumequine, kasugamycin, fosetyl-Al, with some degree of success. Oxonilic acid (Hikiki *et al*., 1989) seems a promising chemical for the control of fireblight (Jones & Byrde, 1987; Dimova-Aziz, 1990).

Phytosanitary risk

Fireblight is a major threat for the EPPO region, and *E. amylovora* is one of the most important pests on the EPPO A2 list (OEPP/EPPO, 1983). 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 will inflict on Mediterranean ecosystems is unpredictable.

PHYTOSANITARY MEASURES

E. amylovora is a quarantine pest and its introduction is prohibited by almost all countries. All countries, even those where the disease exists, have imposed restrictions and ask for phytosanitary certificates for 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.

Roberts & Reymond (1989) reported that citrate buffer, benzalkonium chloride and sodium hypochlorite gave significant reductions in surviving *E. amylovora* cells on apple fruits, while 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.

Eradication measures have proved ineffective to prevent the spread of the disease in a given area, once it has become established in orchards or on wild hosts. They are costly and have been rapidly abandoned wherever they were tried. In a few cases, isolated imported nursery plants have been found to be infected and have been destroyed soon enough to prevent establishment. Because of the great importance of the disease, eradication is generally attempted in newly infested areas, despite past experience.

The only sure 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. EPPO (OEPP/EPPO, 1990) recommends countries at high risk to 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 by the EPPO Quarantine Procedure (OEPP/EPPO, 1992) 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.

BIBLIOGRAPHY

Beer, S.V. (1979) Fireblight inoculum: sources and dissemination. *Bulletin OEPP/EPPO Bulletin* **9** (1), 13-25.

Billing, E. (1984) Principles and applications of fireblight risk assessment. *Acta Horticulturae* No. 151, pp. 15-24.

Billing, E. (1990) Fireblight concepts and a revised approach to risk assessment. *Acta Horticulturae* No. 273, pp. 163-170.

Bradbury, J.F. (1986) *Guide to plant pathogenic bacteria*, 332 pp. CAB International, Wallingford, UK.

Dimova-Aziz, M. (1990) Chemical control of fireblight blossom infection under field conditions in Cyprus. *Acta Horticulturae* No. 273, pp. 377-382.

Grim, R.; Vogelsänger, J. (1989) First record of fireblight in Switzerland. *Schweizerische Zeitschrift für Obst und Weinbau* **125**, 514-516.

Hikiki, Y.; Noda, Ch.; Shimizu, K. (1989) Oxonilic acid. *Japan Pesticide Information* **55**, 21-23.

IMI (1993) *Distribution Maps of Plant Diseases* No. 2 (edition 7). CAB International, Wallingford, UK.

Jones, D.R.; Byrde, R.J.W. (1987) Chemical control of fireblight on cider apple. *Acta Horticulturae* No. 217, pp. 235-238.

Kudela, V. (1988) [*Erwinia amylovora*, causal agent of fireblight on rosaceous plants in Czechoslovakia]. *Sbornik UVTIZ, Ochrana Rostlin* **24**, 173-182.

Larue, P.; Vincent, M. (1990) History of fireblight in France 1972-1989 and administrative measures. *Acta Horticulturae* No. 273, 57-66.

Lelliott, R.A. (1968) The diagnosis of fireblight (*Erwinia amylovora*) and some diseases caused by *Pseudomonas syringae*. *EPPO Publications. Series A* No. 45, 27-34.

Lightner, G.W.; Steiner, P.W. (1990) Computerization of blossom blight prediction model. *Acta Horticulturae* No. 273, pp. 171-184.

OEPP/EPPO (1983) Data sheets on quarantine organisms No. 52, *Erwinia amylovora*. *Bulletin OEPP/EPPO Bulletin* **13** (1).

OEPP/EPPO (1990) Specific quarantine requirements. *EPPO Technical Documents* No. 1008.

OEPP/EPPO (1992) Quarantine procedures No. 40, *Erwinia amylovora* - sampling and test methods. *Bulletin OEPP/EPPO Bulletin* **22**, 225-232.

Oktem, Y.E.; Benlioglu, K. (1988) Studies on fireblight [*Erwinia amylovora* (Burr.) Winsl. *et al*.] of pome fruits. *Journal of Turkish Phytopathology* **17**, 106.

Papdiwal, P.B.; Deshpande, K.B. (1978) New records of bacterial diseases from India. *Proceedings of the National Academy of Sciences, India, B* **48**, 1-4.

Paulin, J.P. (1981) Overwintering of *Erwinia amylovora*: sources of inoculum in spring. *Acta Horticulturae* No. 117, pp. 49-54.

Psallidas, P.G. (1990) Fireblight of pomaceous trees in Greece - Evolution of the disease and characteristics of the pathogen *Erwinia amylovora*. *Acta Horticulturae* No. 273, pp. 25-32.

Ries, S.M.; Otterbacher, A.G. (1977) Occurrence of fire blight on thornless blackberry in Illinois. *Plant Disease Reporter* **61**, 232-235.

Roberts, R.G.; Reymond, S.T. (1989) Evaluation of post-harvest treatment for eradication of *Erwinia amylovora* from apple fruit. *Crop Protection* **4**, 283-288.

Shabi, E.; Zutra, D.; Herzog, Z. (1990) Five years of fireblight in Israel. *Acta Horticulturae* No. 273, p. 41.

Sletten, A. (1990) Fireblight in Norway. *Acta Horticulturae* No. 273, pp. 37-40.

Steinbrenner, B.; Belleman, P.; Zeller, W.; Geider, K. (1990) DNA-hybridization, a specific method for the diagnosis of fireblight. *Acta Horticulturae* No. 273, pp. 91-93.

Thomson, S.V.; Schroth, M.N.; Moller, W.J.; Reid, M.D. (1982) A forecasting model for fireblight of pear. *Plant Disease* **66**, 576-577.

Van der Zwet, T.; Keil, H.L. (1979) Fireblight: a bacterial disease of rosaceous plants. *USDA Agriculture Handbook* No. 510.

Van der Zwet, T.; Thomson, S.V.; Covey, R.P.; Bonn, W.G. (1990) Population of *Erwinia amylovora* on external and internal apple fruit tissues. *Plant Disease* **74**, 711-716.

Van der Zwet, T.; Van Buskirk, P.D. (1984) Detection of endophytic and epiphytic *Erwinia amylovora* in various pear and apple tissues. *Acta Horticulturae* No. 151, pp. 69-75.

Zutra, D.; Shabi, E.; Lazarovits, G. (1986) Fireblight on pear, a new disease in Israel. *Plant Disease* **70**, 1071-1073.