cdfa CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Profile for

Erwinia amylovora (Burrill 1882) Winslow et al. 1920

Fire blight

Previous Rating: C

Pest Rating: C

Domain: Bacteria, Phylum: Proteobacteria

Class: Gammaproteobacteria, Order: Enterobacteriales

Family: Erwiniacae

Comment Period: 7/17/2020 through 8/31/2020

Initiating Event:

On August 9, 2019, USDA-APHIS published a list of "Native and Naturalized Plant Pests Permitted by Regulation". Interstate movement of these plant pests is no longer federally regulated within the 48 contiguous United States. There are 49 plant pathogens (bacteria, fungi, viruses, and nematodes) on this list. California may choose to continue to regulate movement of some or all these pathogens into and within the state. In order to assess the needs and potential requirements to issue a state permit, a formal risk analysis for *Erwinia amylovora* is given herein and a permanent pest rating is proposed.

History & Status:

Background:

Erwinia amylovora was the first bacterium proven to be a pathogen of plants and is also one of the first plant pathogens to be associated with an insect vector. Today, fire blight is still an important disease of apples and pears worldwide. Fire blight was first described in New York in the 1780s after European settlers introduced apple and pear to North America. It is believed to be endemic to wild, rosaceous hosts (presumably *Crataegus*) in eastern North America, specifically the regions surrounding the Hudson valley, Southern Ontario, and Quebec. From this point of origin, fire blight has been spread throughout North America. In California, the disease was first reported in 1887 (Johnson, 2000). The

first detection outside the United States was in New Zealand in 1919. It was accidentally moved to the United Kingdom (1957) and Egypt (1973) with apples or pears. From those two outbreaks it spread and became established in most of Europe and around the Mediterranean Sea (van der Zwet and Keil, 1979). Large areas of the world are still free of fire blight (South America, most of Africa, and Asia), although susceptible European and American cultivars commonly grown in these areas are potentially susceptible hosts. Phytosanitary restrictions have been put in place by many countries hoping to remain disease free (USDA PCIT, 2020).

In California, pear and quince are extremely susceptible to fire blight. Apple, crabapple, and firethorns also are frequently damaged. Fire blight is less common on hawthorn, *Spiraea*, *Cotoneaster*, toyon, *Photinia*, serviceberry, loquat, or mountain ash (Teviotdale, 2011).

Hosts: *Amelanchier alnifolia* (Pacific serviceberry), *Amelanchier canadensis* (shadblow serviceberry), *Amelanchier laevis* (Allegheny serviceberry), *Aronia melanocarpa* (black chokeberry), *Chaenomeles* spp. (quince), *Chaenomeles japonica* (Japanese quince), *Cotoneaster* spp. (cotoneaster), *Cotoneaster bullatus* (hollyberry cotoneaster), *Cotoneaster buxifolius* (boxwood cotoneaster), *Cotoneaster dammeri* (bearberry cotoneaster), *Cotoneaster horizontalis* (rockspray cotoneaster), *Cotoneaster lacteus* (red clusterberry), *Cotoneaster lucidus* (hedge cotoneaster), *Cotoneaster microphyllus* (littleleaf cotoneaster), *Cotoneaster moupinensis* (moupin cotoneaster), *Cotoneaster niger* (black cotoneaster), *Cotoneaster salicifolius* (willow leaf cotoneaster), *Cotoneaster x crispii* (cotoneaster), *Cotoneaster x watereri* (waterer's cotoneaster), *Crataegus* spp. (hawthorn), *Crataegus laevigata* (smooth hawthorn), *Crataegus monogyna* (common hawthorn), *Crataegus x prunifolia* (broad-leaved cockspur), *Cydonia oblonga* (quince), *Eriobotrya japonica* (loquat), *Fragaria x ananassa* (strawberry), *Heteromeles arbutifolia* (toyon), *Malus* spp. (apple), *Malus baccata* (Siberian crabapple), *Malus coronaria* (wild crabapple), *Malus domestica* (apple), *Malus floribunda* (Japanese crabapple), *Malus ioensis* (prairie crabapple) *Mespilus germanica* (medlar), *Photinia davidiana* (Chinese photinia), *Prunus armeniaca* (apricot), *Prunus avium* (sweet cherry), *Prunus cerasifera* (myrobalan plum), *Prunus domestica* (European plum), *Prunus salicina* (Japanese plum), *Prunus subhirtella* (higan cherry), *Pseudocydonia sinensis* (Chinese quince), *Pyracantha* spp. (firethorn), *Pyracantha coccinea* (scarlet firethorn), *Pyracantha crenatoserrata* (broad-leaf firethorn), *Pyrus* spp. (pear), *Pyrus betulifolia* (birchleaf pear), *Pyrus bourgaeana* (Iberian pear), *Pyrus calleryana* (flowering pear), *Pyrus communis* (European pear), *Pyrus elaeagnifolia* (oleaster-leafed pear), *Pyrus kawakamii* (evergreen pear), *Pyrus pyraster* (European wild pear), *Pyrus pyrifolia* (Asian pear), *Pyrus spinosa* (almond-leaved pear), *Pyrus ussuriensis* (Ussurian pear), *Raphiolepsis indica* (Indian hawthorn), *Rosa* spp. (rose), *Rosa canina* (dog rose), *Rosa rugosa* (Japanese rose), *Rubus fruticosus* (European blackberry), *Rubus idaeus* (red raspberry), *Sorbus* spp. (mountain ash), *Sorbus aria* (whitebeam), *Sorbus aucuparia* (mountain ash), *Spiraea prunifolia* (bridal wreath spiraea).

***Symptoms*:** Fire blight can affect all aboveground tissues including blossoms, fruits, shoots, branches, and limbs, as well as scions and rootstocks. Some infected tissues turn black and appear as though they have been burned, thus the name “fire blight.” Infected new shoots can have a characteristic “shepherd’s crook” shape as the tissues are killed and turn black very quickly. Young trees are most seriously affected and can be killed.

Blossoms and young shoots show symptoms 1-2 weeks after petal fall. The floral receptacle, ovary, and peduncles become water soaked and dull, grayish-green in appearance. Later these tissues shrivel and turn brown to black. Similar symptoms can develop in the young fruitlets as the infection spreads internally. During periods of high humidity, small droplets of bacterial ooze, first appearing white then becoming amber colored with age, form on water soaked and discolored tissues (Agrios, 2005; Johnson, 2000). Bark on younger branches becomes darkened and water soaked. At advanced stages, cracks will develop in the bark, and the surface will be sunken slightly with amber-colored bacterial ooze mixed with plant sap. Wood under the bark will show streaked, brown to black discolorations (Teviotdale, 2011).

Penetration and invasion of young leaves are like those of flowers. Bacteria may enter through stomata and hydathodes, but more often through wounds made by insects. In contrast to other bacterial wilts, *E. amylovora* moves very rapidly, killing cells and causing blight and canker symptoms. Young, tender twigs may be infected through their lenticels, through wounds, and through flower and leaf infections. In the twigs, bacteria travel intercellularly or through the xylem. Nearby cortical or xylem parenchyma cells collapse and break down, forming large cavities. If bacteria reach the phloem, they are carried upward to the tip of the twig and to the leaves. Invasion of large twigs and branches is restricted primarily to the cortex.

Transmission: *Erwinia amylovora* overwinters in "holdover cankers," dark, sunken areas on infected branches that were formed during the previous summer. As temperatures warm in spring, bacteria multiply in the margins of the holdover cankers. Free bacterial cells are released onto the bark, sometimes as visible ooze. Insects, including flies are attracted to the ooze and, along with splashing rain, the bacteria are disseminated from the cankers to flowers. Bees can move bacterial inoculum between flowers (Johnson, 2000).

Weather conditions during spring and summer are the key to the occurrence and the severity of fire blight outbreaks. The population size of *E. amylovora* growing epiphytically on the stigmas of healthy flowers is related to daily temperature. Temperatures between 18-30°C with rain during the bloom time are highly conducive to flower infection. Frequent spring storms with wind-driven rain and warm temperatures during the period of new shoot growth and new development of fruits can lead to the rapid development of severe disease (Thomson et al., 1982).

Bacteria are spread by wind and wind-driven rain within and between trees as bacterial ooze, mixed polysaccharide threads produced by the trees, and rain generated aerosols (McManus and Jones, 1994). Rattails (secondary blossoms), which grow after the primary bloom in late spring and summer, are often heavily infected. Severe infections may also take place in summer on shoots, leaves, and fruits, following a hailstorm or any event which wounds the plant surfaces when the plants are wet. Infection of succulent tissues is rapid under warm, humid conditions. Under cool, dry conditions the host forms cork layers around the infected area and limits the expansion of the cankers. In susceptible varieties and during warm, humid weather, bacteria may progress from spurs or shoots into the second year, third year, and older growth, killing the bark along the way (Agrios, 2005).

Long distance spread of the pathogen to new regions and countries has occurred with the shipping of infected plant material. Latent infections may be present without any visible symptoms and disease can develop when the material is planted out in the field (CABI-CPC, 2020).

Damage Potential: Fire blight can be lethal to young fruit trees, especially to apple, pear, quince, and loquat. Epidemics are sporadic, but often devastating depending on the age and the susceptibility of the host species. In years without favorable conditions during bloom, the disease can of secondary or minor importance. Preventative bactericide treatments are often necessary to protect trees and heavy remedial pruning is needed to eliminate any holdover cankers or wood that could be systemically infected (Teviotdale, 2011).

Losses of 60-90% of flowers and buds in some years and large reduction of yields have been reported (Kalinichenko and Kalinichenko, 1983). Most severe epidemics are associated with heavy rainfall during bloom. In years where rainfall is combined with windstorms during bloom, disease was mainly flower blight and caused a loss of 10-75% flowers/tree (van der Zwet, 1986). Fire blight restricts pear production in the eastern United States (van der Zwet and Keil, 1979). In Europe, disease limits some pear varieties, several cider-varieties for apples, and the ornamental plantings of *Cotoneaster salicifolius* and *Pyracantha atalantioïdes* (Paulin, 1996). Rootstock blight can develop from the internal spread of bacteria from an infected scion. For apples, the popular dwarfing Malling rootstocks are highly susceptible to internal invasion and rootstock blight, and infections may result in 30-100% tree death (Norelli et al., 2003).

In California, fire blight is most severe on pears grown in the Sacramento valley and the North Coast. High levels of streptomycin resistance in pathogen populations was reported by Schroth et al. (1978) and continue to be an issue in effective disease control with antibiotics (Forster et al., 2015).

Worldwide Distribution: Albania, Algeria, Armenia, Austria, Belarus, Belgium, Bermuda, Bosnia and Herzegovina, Bulgaria, Canada, Croatia, Cyprus, Czech Republic, Denmark, Egypt, France, Georgia, Germany, Greece, Guatemala, Hungary, Iran, Ireland, Israel, Italy, Italy, Jordan, Kazakhstan, Kyrgyzstan, Latvia, Lebanon, Lithuania, Luxembourg, Mexico, Moldova, Montenegro, Morocco, Netherlands, New Zealand, North Macedonia, Norway, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Syria, Tunisia, Turkey, Ukraine, United Kingdom, and United States of America (EPPO, 2020).

Official Control: *Erwinia amylovora* is a regulated non-quarantine pest in Egypt; a quarantine pest in Belarus, Morocco, Norway, and Tunisia. It is on the A1 quarantine list in Argentina, Azerbaijan, Bahrain, Brazil, Chile, China, East Africa, Georgia, Moldova, Paraguay, Southern Africa, Uruguay, and Uzbekistan, and on the A2 auarantine list forJordan, Kazakhstan, Russia, Turkey, and Ukraine. It is on the USDA Harmful Organism list for Albania, Angola, Antarctica, Argentina, Azerbaijan, Benin, Bosnia and Herzegovina, Botswana, Brazil, Burkina Faso, Burundi, Cameroon, Canada, Central African Republic, Chad, Chile, China, Democratic Republic of the Congo, Costa Rica, Cote d'Ivoire, Dominica, El Salvador, Equatorial Guinea, Eurasian Customs Union, European Union, French Polynesia, Gabon, Gambia,

Georgia, Ghana, Grenada, Guatemala, Guinea, Guinea-Bissau, Holy See (Vatican City State), Honduras, India, Indonesia, Israel, Japan, Jordan, Republic of Korea, Lesotho, Liberia, Madagascar, Mali, Mauritania, Mauritius, Republic of Moldova, Monaco, Morocco, Mozambique, Namibia, New Caledonia, Niger, Nigeria, Norway, Oman, Paraguay, Peru, Republic of North Macedonia, Rwanda, Saint Lucia, San Marino, Senegal, Serbia, Sierra Leone, Somalia, South Africa, Taiwan, Tajikistan, Tanzania, United Republic of Thailand, The Kingdom of Eswatini, Timor-Leste, Togo, Tunisia, Turkey, Turkmenistan, Uganda, Ukraine, United Arab Emirates, Uruguay, Uzbekistan, and Zimbabwe (USDA-PCIT, 2020).

California Distribution: Contra Costa, Glenn, Mariposa, Placer, Plumas, Sacramento, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Shasta, Solano, Sonoma, Stanislaus, Tulare, Yolo counties (CDFA PDR Database)

California Interceptions: None

The risk *Erwinia amylovora* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:**
   Fire blight has been observed sporadically in all apple and pear growing areas of California, plus on ornamental hosts in Southern California, but epidemics are highly dependent on weather conditions during flowering and early shoot growth.

   Evaluate if the pest would have suitable hosts and climate to establish in California.
   Score: **3**
   - Low (1) Not likely to establish in California; or likely to establish in very limited areas.
   - Medium (2) may be able to establish in a larger but limited part of California.
   - High (3) likely to establish a widespread distribution in California.

2) **Known Pest Host Range:** The host range of *E. amylovora* is moderate with many perennial woody plants in the family Rosaceae. Most of the natural hosts are in the subfamily Maloideae (formerly Pomoideae)

   Evaluate the host range of the pest.
   Score: 2
   - Low (1) has a very limited host range.
   - Medium (2) has a moderate host range.
   - High (3) has a wide host range.

3) **Pest Reproductive Potential:** *Erwinia amylovora* reproduces at an exponential rate on highly susceptible hosts under favorable weather conditions. It spreads with wind, rain, and insects.

Honeybees can move the pathogen directly into the flowers to initiate the blossom blight phase of the disease. It is spread long distances by moving latently on infected nursery stock.

Evaluate the natural and artificial dispersal potential of the pest.

Score: 3

- Low (1) does not have high reproductive or dispersal potential.
- Medium (2) has either high reproductive or dispersal potential.
- **High (3) has both high reproduction and dispersal potential.**

4) **Economic Impact:** No commercial pear or apple varieties are immune to fire blight. Moderately resistant varieties are available and should be used in areas where fire blight is destructive. In many areas, fire blight forecasting models have been developed and are used with variable success. Most models use a combination of data on temperature, rainfall or humidity, and growth stage of the tree and advise growers on the timing of bactericidal treatments. Fire blight is also very damaging to ornamentals including street trees.

Evaluate the economic impact of the pest to California using the criteria below.

Economic Impact: A, B, C, D

A. **The pest could lower crop yield.**
B. **The pest could lower crop value (includes increasing crop production costs).**
C. **The pest could trigger the loss of markets (includes quarantines).**
D. **The pest could negatively change normal cultural practices.**
E. The pest can vector, or is vectored, by another pestiferous organism.
F. The organism is injurious or poisonous to agriculturally important animals.
G. The organism can interfere with the delivery or supply of water for agricultural uses.

Economic Impact Score: **3**

- Low (1) causes 0 or 1 of these impacts.
- Medium (2) causes 2 of these impacts.
- **High (3) causes 3 or more of these impacts.**

5) **Environmental Impact:** In many areas, satisfactory control of fire blight to protect fruit trees from lethal damage or heavy crop loss requires careful pesticide use. Dormant sprays with copper sulfate or with the Bordeaux mixture offer some protection. Bordeaux and streptomycin are the only effective blossom sprays, and are sometimes used to control twig blight, but neither gives good control. Streptomycin-resistant strains of the fire blight bacterium are observed in many areas (Forster et al., 2015). Susceptible plants, including ornamentals and some California native plants such as toyon and serviceberry should not be planted in climates highly favorable to fire blight or adjacent to fruit tree orchards.

Environmental Impact: A, D, E

A. **The pest could have a significant environmental impact such as lowering biodiversity, disrupting natural communities, or changing ecosystem processes**.
B. The pest could directly affect threatened or endangered species.
C. The pest could impact threatened or endangered species by disrupting critical habitats.
D. The pest could trigger additional official or private treatment programs.
E. The pest significantly impacts cultural practices, home/urban gardening or ornamental plantings.

Environmental Impact Score: 3
- Low (1) causes none of the above to occur.
- Medium (2) causes one of the above to occur.
- High (3) causes two or more of the above to occur.

Consequences of Introduction to California for *Erwinia amylovora:* High

Add up the total score and include it here. **14**
-Low = 5-8 points
-Medium = 9-12 points
-High = 13-15 points

6) **Post Entry Distribution and Survey Information**: Evaluate the known distribution in California. Only official records identified by a taxonomic expert and supported by voucher specimens deposited in natural history collections should be considered. Pest incursions that have been eradicated, are under eradication, or have been delimited with no further detections should not be included.

Evaluation is 'high'. Fire blight has been detected in multiple counties statewide, on fruit trees in commercial and residential orchards, and on ornamentals in nurseries and in landscapes.

Score: -3
-Not established (0) Pest never detected in California or known only from incursions.
-Low (-1) Pest has a localized distribution in California or is established in one suitable climate/host area (region).
-Medium (-2) Pest is widespread in California but not fully established in the endangered area, or pest established in two contiguous suitable climate/host areas.
-High (-3) Pest has fully established in the endangered area, or pest is reported in more than two contiguous or non-contiguous suitable climate/host areas.

7) **The final score is** the consequences of introduction score minus the post entry distribution and survey information score: (Score)

Final Score: *Score of Consequences of Introduction – Score of Post Entry Distribution and Survey Information* **= 11**

Uncertainty:

None.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for *Erwinia amylovora* is C.

References:

Agrios, G. N. 2005. Plant Pathology, 5th Edition. Elsevier Academic Press. 922 pg

CABI Crop Production Compendium 2020. *Erwinia amylovora*. https://www.cabi.org/cpc/datasheet/21908. Accessed 6/10/2020

EPPO Global Database. 2020. https://gd.eppo.int/taxon/ ERWIAM. Accessed 6/10/2020

Förster, H., McGhee, G. C., Sundin, G. W. and Adaskaveg, J. E., 2015. Characterization of streptomycin resistance in isolates of *Erwinia amylovora* in California. Phytopathology, 105(10), pp.1302-1310.

French, A. M. 1989. California plant disease host index. CA Division of Plant Industry. 2nd Ed. 394 pg

Johnson, K.B. 2000. Fire blight of apple and pear. The Plant Health Instructor. DOI: 10.1094/PHI-I-2000-0726-01. Updated 2015.

Kalinichenko GV; Kalinichenko RI, 1983. Characteristics of fruiting of pear under bacterial infection in the Crimea. Sel'skokhozyaistvennaya Biologiya, No.4:68-71

McManus, P. S. and Jones. A. L. 1994. Role of wind-driven rain, aerosols, and contaminated budwood in incidence and spatial pattern of fire blight in an apple nursery. Plant Disease, 78(11):1059-1066

Norelli, J. L., Holleran, H. T. Johnson, W. C., Robinson, T. L., and Aldwinckle, H.S. 2003. Resistance of Geneva and other apple rootstocks to *Erwinia amylovora*. Plant Disease, 87(1):26-32; 23 ref.

Paulin, J. P. 1996. Control of fireblight in European pome fruits. Outlook on Agriculture, 25(1):49-55.

Schroth, M. N., Thomson, S. V., and Moller, W. J. 1978. Streptomycin resistance in Erwinia amylovora. Phytopathology 69:565-568.

Teviotdale, B. L. 2011. PEST NOTES Publication 7414 Fire Blight. University of California Statewide Integrated Pest Management Program Agriculture and Natural Resources.

Thomson, S. V., Schroth, M. N., Moller, W. J., and Reil, W.O. 1982. A forecasting model for fire blight of pear. Plant Disease, 66(7):576-579

UC Pest Management Guidelines. Corn: Common Smut. http://ipm.ucanr.edu/PMG/r113100311.html. Accessed 1/30/2020

USDA Phytosanitary Certificate Issuance and Tracking System, Phytosanitary Export Database (PExD) Harmful Organisms Database Report. *Erwinia amylovora*. Accessed 6/10/2020

van der Zwet, T. 1979. Fire blight: A bacterial disease of rosaceous plants (No. 510). US Department of Agriculture.

van der Zwet, T. 1996. Present worldwide distribution of fire blight. Acta Horticulturae, 411:7-8.

Responsible Party:

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***Comment Period: 7/17/2020 through 8/31/2020**

***NOTE:**

You must be registered and logged in to post a comment. If you have registered and have not received the registration confirmation, please contact us at permits[@]cdfa.ca.gov.

Comment Format:

- Comments should refer to the appropriate California Pest Rating Proposal Form subsection(s) being commented on, as shown below.

  Example Comment:

  Consequences of Introduction: 1. Climate/Host Interaction: [Your comment that relates to "Climate/Host Interaction" here.]

- Posted comments will not be able to be viewed immediately.
- Comments may not be posted if they:

Contain inappropriate language which is not germane to the pest rating proposal;

Contains defamatory, false, inaccurate, abusive, obscene, pornographic, sexually oriented, threatening, racially offensive, discriminatory or illegal material;

Violates agency regulations prohibiting sexual harassment or other forms of discrimination;

Violates agency regulations prohibiting workplace violence, including threats.

- Comments may be edited prior to posting to ensure they are entirely germane.
- Posted comments shall be those which have been approved in content and posted to the website to be viewed, not just submitted.

Pest Rating: C