California Pest Rating Proposal for

Xylella fastidiosa subsp. *pauca* (Wells et al., 1987) Schaad et al. 2004

Current Pest Rating: none

Proposed Pest Rating: A

Domain: Bacteria; Kingdom: Eubacteria

Phylum: Proteobacteria; Class: Gammaproteobacteria

Order: Xanthomonadales; Family: Xanthomonadaceae

Comment Period: 6/1/2020 through 7/16/2020

Initiating Event:

In 2013, the bacterium *Xylella fastidiosa* (*Xf*) was confirmed to be in Salento, Italy's most southeastern region, where it was associated with the sudden death of thousands of centuries-old olive trees and the disease was given the name "olive quick decline syndrome." *Xf* was subsequently found in coffee and oleander in Costa Rica and olives in Brazil and Argentina. All of these strains have been characterized as *Xf* subsp. *pauca,* which also causes the serious diseases known as citrus variegated chlorosis and coffee leaf scorch in Central and South America but is not known to occur in the United States. The risk of *Xf* subsp. *pauca* to California is described herein and a permanent rating is proposed.

History & Status:

Background:

Xylella fastidiosa is a gram negative, xylem-limited, nutritionally fastidious, non-flagellated bacterium. It can infect a broad range of plants from diverse taxonomic groups including both monocots and dicots. The primary mode of pathogen spread between plants is by xylem sap-feeding insects. Many host plants can have symptomless infections, whereas others can be severely affected by the pathogen impeding the water transport function of the xylem, resulting in scorch, stunt, dieback, wilt symptoms, and death of the hosts. In the Americas, *X. fastidiosa* sensu lato occurs in southeastern Canada, the eastern United States, California, Mexico, Central America, and South America.

The discovery of olive quick decline syndrome in Italy was the first documented field outbreak of *Xf* in the European Union. *Xyllela fastidiosa* has been present in California for more than 100 years and is best known for causing Pierce's disease of grapes, a serious disease that can destroy entire vineyards.

Phylogenetic studies support the classification of *X. fastidiosa* into at least four subspecies in the Americas (Schaad et al., 2004). *Xf* subspecies vary in host specificity. *Xylella fastidiosa* subsp. *fastidiosa* causes Pierce's Disease of grapevines and alfalfa dwarf, *Xf* subsp. *sandyi* is associated with oleander leaf scorch, *Xf* subsp. *multiplex* is associated with leaf scorching of a number of trees, including almond, ornamental, and shade trees, and *Xf* subsp. *pauca* is the agent of citrus variegated chlorosis and coffee leaf scorch. A fifth subspecies, *Xf* subsp. *morus*, associated with mulberries in multiple states, including California (Hernandez-Martinez et al., 2006), has been proposed.

The distribution of individual *Xf* subspecies is limited, which suggests that allopatric speciation has been important in the evolution of this bacterium. However, human activity has played a role in increasing dispersal of *Xf* over continents (Almeida and Nunney, 2015). One important aspect of *Xf* transmission relevant to the emergence of new diseases is that these bacteria are not limited to a single species of insect vector (Almeida et al., 2005). The sharpshooters and spittlebugs that transmit *Xf* are distributed worldwide in tropical and temperate climates, and all species belonging to either group should be considered as potential vectors until proven otherwise.

Olives with symptoms suspected to be caused by *Xf* have been studied in California. Krugner et al. (2014) detected *Xf* subsp. *multiplex* in 17% of olive trees with leaf scorch and branch dieback. Isolates recovered from some of these symptomatic trees were successfully inoculated and vector-transmitted to olives, but under experimental conditions, infection phenotypes did not match the field symptoms, leading them to conclude that *Xf* was not the primary cause of the scorch symptoms. They did show that olives could be an alternate, but sub-optimal host for *Xf* while also harboring sharpshooter vectors.

Xylella fastidiosa subsp. *pauca* was consistently associated with declining olive trees in Italy (Saponari et al., 2014) and its virulence was confirmed with pathogenicity testing (Saponari et al., 2016). The genome of the *Xf* subsp. *pauca* strain in Italy was matched to an isolate (ST53) from Costa Rica where it is a pathogen of coffee and oleander (Giampetruzzi et al., 2015). Following the Italian reports, olive diseases caused by *Xf* subsp. *pauca* with similar symptoms have been reported from Argentina (Haelterman et al., 2015) and Brazil (Coletta-Filho et al., 2016). In both of these countries, symptomatic plants were infected by strains that show high genome similarity to *Xf* subsp. *pauca* but are genetically distinct from the Italian and Costa Rican isolate ST53, showing that pathogenicity on olive is more widespread within the subspecies *pauca*, and not restricted to a single strain.

Risks to the Mediterranean basin from *Xf* have been predicted and realized with the accidental introduction of *Xf* into Italy (*Xf* subsp. *pauca*) and into France (*Xf* subsp. *multiplex*) (Purcell, 1997; Bosso et al., 2016). Although not specifically expressed for olive because it was not a known host at the time, similar predictions of accidental *Xf* introduction were made by Hopkins and Purcell (1999) for California if *Xf* subsp. *pauca* were introduced, as citrus variegated chlorosis is a serious problem in citrus production in Central and South America, especially Brazil.

Hosts: Acacia saligna, Coffea spp., *Dodonaea viscosa purpurea, Grevillea juniperina, Laurus nobilis, Myoporum insulare, Myrtus communis, Nerium oleander* (Oleander), *Olea europa* (Olive), *Polygala myrtifolia* (mugwort), *Prunus* spp., *Rhamnus alaternus, Rosmarinus officinalis*, and *Westringia fruticosa* (Almeidia et al., 2008; Saponari et al., 2016; Martinelli et al., 2016).

Citrus: most of the citrus cultivars, species, and hybrids are hosts. Sweet oranges are the most susceptible, grapefruit, mandarins, mandarin hybrids, lemons, limes, kumquat, and trifoliate orange are moderately susceptible, and Rangpur lime, citron, and pummelo are less susceptible (UF, 2013).,

Symptoms: Olive quick decline syndrome: Early symptoms are scattered leaf scorching and twig death throughout the upper part of the canopy. Leaf scorching starts as a browning at the tip of the leaf, spreading towards the base until the whole leaf is brown. Leaves remain attached to the branches. Browning and branch death spreads throughout the canopy giving the tree a burned appearance. These leaf scorch and dieback symptoms can be easily confused with several other olive diseases or environmental disorders that interfere with movement of water in the trees. Trees will sucker from the base and grow as long as the roots are viable. The symptoms appear 18–24 months after infection and olive trees are dead in 2–5 years (Fierro et al., 2019).

Citrus variegated chlorosis: Foliar wilt and interveinal chlorosis on the upper surfaces of citrus leaves (similar to zinc deficiency) that correspond to necrotic, gum-like regions on the undersides of the leaves. Affected trees may exhibit reduced vigor and growth and show abnormal flowering and fruit set with dieback and hardening of fruits. Newly affected trees may only exhibit symptoms on one limb or branch, and then symptoms may spread to the entire canopy. Older trees may only show symptoms on the extremities of the branches. Severely diseased trees frequently show upper crown branches with defoliation at terminal twigs and small leaves and fruit along with defoliation (UF, 2013).

Transmission: X. fastidiosa is dispersed by insect vectors on a local scale. Vectors could also be carried internationally on plants or on fruits of grapevine, peach, citrus, or ornamentals. In California, the most important vector of *Xf* is an invasive leafhopper, the glassy winged sharpshooter, *Homalodisca vitripennis*. This sharpshooter has been expanding its distribution in California for two decades and has an extremely wide host range. Climate-matching models predict it could become established statewide (Hoddle, 2004) and it is under official control in uninfested counties and in nurseries in infested counties by CDFA's Pierce's Disease Program. In Brazil, *Xf* subsp. *pauca* is vectored by 11 insect species in ten different genera and the bacteria are also dispersed by infected propagation material such as nursery plants and budwood (Laranjeira et al., 2008).

Damage Potential: In Italy, *Xf* subsp. *pauca* has been able to infect a million olive trees in the last decade with spittlebugs as vectors (Fierro et al., 2019) and tens of thousands of valuable trees have been lost. Citrus variegated chlorosis doesn't kill its hosts but it infects an estimated 40% of citrus plants in Brazil and causes annual losses in excess of $100M US to the Brazilian citrus industry, with the biggest losses in sweet oranges. Disease control requires insecticide applications, tree removal, and pruning of symptomatic branches (Goncalvez et al., 2012).

Worldwide Distribution: Italy, Brazil, Ecuador, Argentina, Costa Rica, and Paraguay (CABI-CPC).

Official Control: *Xylella fastidiosa* strains that cause citrus variegated chlorosis (subsp. *pauca*) are on the USDA APHIS Ag Bioterrorism Agent and Toxin list. *Xylella fastidiosa* sensu lato is on the European Plant Protection Organization's A1 list of regulated quarantine agents. A Federal Quarantine order was issued in October 2009 to prevent the introduction of citrus variegated chlorosis into the United States specifically to prevent the importation of infected citrus seeds (citrus plants for planting are also prohibited). The following countries outside of the European Union also list *Xylella fastidiosa* on their harmful organism list: Albania, Angola, Argentina, Benin, Botswana, Brazil, Burkina Faso, Burundi, Cameroon, Canada, Central African Republic, Chad, Chile, China, Colombia, Congo, Cote d'Ivoire, Ecuador, Egypt, Equatorial Guinea, Eurasian Customs Union, French Polynesia, Gabon, Gambia, Georgia, Ghana, Guatemala, Guinea, Guinea-Bissau, Holy See (Vatican City State), Honduras, India, Israel, Jamaica, Japan, Jordan, Republic of Korea, Lebanon, Lesotho, Liberia, Mali, Mauritania, Mexico, Republic of Moldova, Monaco, Morocco, Mozambique, New Caledonia, New Zealand, Nicaragua, Niger, Oman, Panama, Peru, Rwanda, San Marino, Senegal, Serbia, Sierra Leone, Somalia, South Africa, Thailand, The Kingdom of Eswatini, Togo, Tunisia, Turkey, United Arab Emirates, Uruguay, Viet Nam, and Zimbabwe (USDA PCIT, 2020).

California Distribution: None

California Interceptions: None

The risk *Xylella fastidiosa* subsp. *pauca* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** *Xylella fastidiosa* subsp. *pauca* is likely to establish everywhere in the state where its hosts are grown. Highly efficient vectors like the glassy winged sharpshooter will likely amplify the speed of spread wherever they are established. Pierce's disease caused by *Xf* subsp. *fastidiosa* is widely established in California and is a limiting factor for vineyards in southern California.

   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 *Xf* subsp. *pauca* includes citrus, olives, coffee, stone fruit, and ornamentals. Researchers are continually adding new hosts (including those that are symptomless).

   Evaluate the host range of the pest.

   Score: 3

- 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:** *Xylella fastidiosa* multiplies in its host plants and inside its insect vectors. It does not disperse through the air or with pruning tools, but it can be spread with infected or infested host plants including nursery stock and budwood if vectors are present at the destination.

   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:** The *H. vitripennis–Xf* subsp. *pauca* vector-pathogen combination could potentially have a severe adverse effect on production of both olives and citrus if the pathogen is introduced into California. It is a quarantine pest for significant trading partners including the European Union and Australia.

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

   Economic Impact: A, B, C, E

   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:** The host range of *Xf* subsp. *pauca* is still expanding in Europe and in Central and South America. Similar to other subspecies of *Xf* already present in California, this subsp. will likely infect a variety of woody plants, including natives and ornamentals, causing leaf scorch, branch dieback, and mortality.

   Environmental Impact: A, 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 *Xf* subsp. *pauca:* High

Add up the total score and include it here. **15**
-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 'not established'. There have been no detections or interceptions of *Xf* subsp. *pauca* in California. Lab testing capable of diagnosis to subspecies is routinely done by CDFA's Plant Pest Diagnostics Center for phytosanitary certification for plants going to the EU.

Score: -0
-**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:

Final Score: *Score of Consequences of Introduction – Score of Post Entry Distribution and Survey Information* **= 15**

Uncertainty:

The host range and taxonomy of *Xf* subspecies are under continual revision and expansion. It is likely that the confirmed hosts of *Xf* subsp. *pauca* will continue to increase as the pathogen spreads in Europe.

Conclusion and Rating Justification:

Based on the evidence provided above **the proposed rating for *Xylella fastidiosa* subsp. *pauca* is A.**

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Responsible Party:

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***Comment Period:** 6/1/2020 through 7/16/2020

***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.

Proposed Pest Rating: A