California Pest Rating Proposal for

Pseudomonas savastanoi pv. *savastanoi* (ex Smith 1908) Gardan et al. 1992

Olive knot/Oleander knot

Current Pest Rating: C

Proposed Pest Rating: C

Kingdom: Bacteria, Phylum: Proteobacteria,
Class: Gammaproteobacteria, Order: Pseudomonadales,
Family: Pseudomonadaceae

Comment Period: 08/21/2023 through 10/05/2023

Initiating Event:

This pathogen has not been through the pest rating process. The risk to California from *Pseudomonas savastanoi* pv. *savastanoi* is described herein and a permanent rating is proposed.

History & Status:

Background:

California produces nearly 100% of all olives grown in the United States. Olive trees are grown on 36,000 acres with a value in 2022 of $158M (CDFA Ag Stats, 2021/22). California olive production is mostly in the San Joaquin and Sacramento valleys, although olives are grown throughout California. Tulare County is the leading producer, accounting for about a third of all acres. Tehama, Glenn, Butte, Yolo, and San Joaquin counties are also large producers of olives (Lazicki and Geisseler, 2016).

Pseudomonas savastanoi pv. *savastanoi* (Psv) causes knots, galls, and cankers on some members of the family Oleaceae, notably on olive (*Olea europa*) and oleander (*Nerium oleander*). Olive knot is a serious disease of olive trees in most olive-growing regions worldwide, particularly in Mediterranean countries. The pathogen appears to have been spread worldwide with the movement of olive trees (Bradbury, 1986). Olive knot is considered one of the most important diseases affecting olive trees in California. The incidence of olive knot is related to a striking reduction in fruit yield and with a substantial decrease in the sizes of olives (Schroth, 1973). Olives produced from diseased limbs can have “off” flavors which further damages their value (Schroth et al., 1968).

In 1886, Savastano, working in France, isolated a bacterium from olive knots, and following inoculation to healthy plants was able to reproduce the disease symptoms. In 1908, Smith gave it the name *Bacterium savastanoi,* named after the first detector. Later, in 1913, Stevens transferred this species to the genus *Pseudomonas* as *P. savastanoi*. In 1978, Young et al. proposed a new nomenclature and classification for plant-pathogenic bacteria, introducing the concept of pathovars. They considered all fluorescent oxidase-negative *Pseudomonas* species (except *P. viridiflava*) as members of a single species, *P. syringae*, with various pathovars. As a result, *P. savastanoi* became *P. syringae* pv. *savastanoi*. In 1992, Gardan et al., using both laboratory tests and DNA-DNA hybridization studies, proposed that the pathogen be reclassified as a species again, becoming *P. savastanoi* pv. *savastanoi*. Today there are three closely related pathovars of *P. savastanoi*: pathovar *fraxini* (Janse, 1982) Young et al. 1986., pathogen of *Fraxinus excelsior* and (by inoculation) on *Olea europea*, pathovar *nerii* (Janse, 1982) Young et al. 1986., a pathogen of *Nerium oleander* and various species of Oleaceae, and pathovar *savastanoi,* (ex Smith 1908) Gardan et al., 1992, pathogen of various species of Oleaceae and other hosts (Buonaurio et al., 2015). In 1999, Gardan et al. used DNA-DNA hybridization and ribotyping to define nine discrete genomospecies within the *P. syringae* complex. Psv was placed in genomospecies 2.

Psv has been a problem for olives in California for over 100 years, with reports of the disease dating back to the late 19th century (Fichtner, 2011). In 1935, E. E. Wilson, a Plant Pathologist from the University of California, Davis, published his investigations of the disease. It was described as “highly destructive”. None of the commercial olive varieties grown in California at that time appeared to be immune to olive knot. The Mission variety was ‘badly attacked’ following a heavy frost in December 1932, resulting in the splitting of the bark and defoliation during the rainy season. The Sevillano, Nevadillo Blanco, and Manzanillo varieties were also described by Wilson as highly susceptible. Some of these varieties are commonly grown today in California, including ‘Manzanillo’. Changes in production practices have adapted olive trees to high-density and super-high-density planting systems with automated hedging and mechanical harvesting. This management style can cause wounding which increases the risk of disease spread (Nguyen et al., 2018). Olive knot disease has reportedly become more common and serious in California in this century (Fichtner, 2011).

Gall or knot-forming *P. savastanoi* strains are different from almost all other bacterial plant pathogens. They produce substantial amounts of the plant hormones indol-3-acetic acid (IAA) and cytokinin. The effect of these is to induce unregulated cell multiplication in their hosts (Surico et al., 1985). This provokes an increase in plant cell size (hypertrophy) followed by an abnormal cell division (hyperplasia) (Quesada et al., 2012). Psv can also multiply in a saprophytic phase and live on the phylloplane of olive trees (Ercolani, 1978). Visual inspections will not detect latently infected trees, allowing for accidental shipment of diseased nursery stock.

Hosts: Cultivated and wild olive (*Olea europaea* subsp*. europaea, O. europaea* subsp. *oleaster*, *O. europaea* subsp. *sativa*), *Ligustrum* spp. such as Japanese privet (*L. japonica*) and privet (*L. vulgare*); *Jasminus* spp.; *Forsythia intermedia; Phillyrea* spp.; and oleander (*Nerium oleander*).

Symptoms: This disease is characterized by the formation of neoplastic tissue, known as knots or galls, primarily on young stems and branches. Galls are most commonly formed at leaf nodes, due to infection of leaf scars by the bacterium; however, they also can be formed at other points, such as leaves, roots, and fruit. Initially, the knots appear as small, pale-green excrescences (distinct outgrowths) that gradually enlarge and turn greenish-brown or brown. Internally, the knots consist of compact, spongy tissues filled with bacterial cells. As the knots age, they crack, necrotize, decay, and eventually die within 6-8 months. In severe cases, the affected branches can be girdled, dwarfed, defoliated, or killed. In rare instances, fruit infection can occur, causing deformation and brown spots on the mesocarp. The disease can impact the tree structure and is especially damaging to young trees (Teviotdale, 1994; Schroth et al., 1968, Schroth, 1973).

Transmission: The pathogen primarily infects through wounds on the plants, caused by factors like frost, hailstorms, wind-blown sand, pruning, and crop harvesting (Wilson, 1935). Psv is spread at short distances by splashing rain, windblown aerosols, insects, and on pruning tools and equipment. Psv can survive inside knots from one season to the next and if the humidity and Psv populations are high enough, bacteria will exudate from the plants, spreading with winter and spring rain events (Wilson, 1935: Fitchner, 2011). Long-distance spread can occur with the movement of contaminated nursery stock (Montilon et al., 2023). Psv can migrate within the plants and develop secondary tumors in oleanders (Wilson and Magie, 1964) and olives (Penyalver et al., 2006).

Damage Potential: The economic significance of olive knot is evident in its adverse effects on yield, fruit size, and quality. It is a serious issue in California for nurseries, and for both commercial table olive growers and those growing olives for oil production (Fichtner, 2011). Schroth et al. (1973) reported that olive plants with moderate infections of only 0.5-1 knots/ft of fruitwood had smaller fruits and 28% lower production than slightly infected plants with 0.1-0.3 knots/ft of fruitwood. The severe symptoms of olive knot not only impact the yield of fruit but also diminish the visual appeal of olive trees and other ornamental hosts, such as oleander and privet, used in landscapes. Bactericide treatments may be necessary to manage the disease in some areas and on susceptible cultivars (Nguyen et al., 2018).

Worldwide Distribution: The list of countries provided by CABI (2023) is based largely on the observation of knot diseases on Oleaceous hosts (Bradbury, 1986). However, an unknown proportion of records could be detections of the closely related pv. *nerii*, rather than pv. *savastanoi*, because at one time, they were not considered to be different pathogens. Africa: *Algeria, Egypt, Libya, Morocco, South Africa, Tanzania, Tunisia.* Asia: *Iran, Iraq, Israel, Japan, Jordan, Lebanon, Nepal, Syria, Turkey*. Europe: *Austria, Cyprus, France, Germany, Greece, Italy, Netherlands, Norway, Poland, Portugal, Slovenia, Spain, Sweden, Switzerland, United Kingdom*. North America: *Mexico, United States* (Alabama, Arizona, Arkansas, California, Texas). Oceania: *Australia, New Zealand.* South America: *Argentina, Brazil, Colombia, Peru, Uruguay* (CABI, 2023).

Official Control: *Pseudomonas savastanoi* pv *savastanoi* is on the USDA PCIT's harmful organism list for Australia, Chile, India, Jordan, Mexico, Panama, and Paraguay (USDA PCIT, 2023). It is on the EPPO's A1 list for Chile, and on the A2 list for Jordan. It is a quarantine pest in Mexico and a regulated non-

quarantine pest in Egypt, Switzerland, and the United Kingdom (EPPO, 2023). The European Plant Protection Organization has a certification scheme for olive trees and rootstocks https://doi.org/10.3390/plants12040699 which includes Psv. This standard directs that the certification scheme should start from clean source plants, called nuclear stocks, which are propagated through various phases to control the phytosanitary status and the trueness to the type of the plants produced, and guaranteeing the traceability of the entire supply chain (Montilon et al., 2023).

California Distribution: Alameda, Butte, Glenn, Monterey, Riverside, Sacramento, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Shasta, Sonoma on oleander, olive, and *Mandevilla* spp. (CDFA PDR database accessed 8/2/23).

California Interceptions: none

The risk *Pseudomonas savastanoi* pv. *savastanoi* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** There are records of Psv from Southern California and the Central Coast, disease severity is much greater in the northern parts of the state. This is where higher rainfall promotes disease development.

   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 is limited to some members of Apocynaceae and Oleaceae

   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:** Bacteria multiply very rapidly under favorable environmental conditions. Psv can survive as an epiphyte and as an endophyte. It is dispersed easily with water.

   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:** This pathogen damages trees, reducing fruit yield and quality. It is a quarantine pest in some places.

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

Economic Impact: A, B, C

A. The pest could lower crop yield.
B. The pest could lower crop value (including increasing crop production costs).
C. The pest could trigger the loss of markets (including 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:** This pathogen has ornamental hosts (i.e. oleander) that are widely planted in California.

Evaluate the environmental impact of the pest on California using the criteria below

Environmental Impact: 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: 2
- 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 *Pseudomonas savastanoi* pv. *savastanoi:* High

Add up the total score and include it here. **13**
-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'.

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 the 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* ***= 10***

Uncertainty:

None

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for ***Pseudomonas savastanoi*** **pv. *savastanoi* is C.**

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Responsible Party:

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***Comment Period: 08/21/2023 through 10/05/2023**

***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: C
