CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Pseudomonas corrugata Roberts & Scarlett (1981), emend. Sutra et al. 1997

pith necrosis of tomato

Current Pest Rating: C

Proposed Pest Rating: C

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

Comment Period: 04/12/2022 through 05/27/2022

Initiating Event:

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

History & Status:

Background:

A disease of mature tomato plants was described as widespread in greenhouses in England in the 1970s. Symptoms included brown discoloration and/or necrosis and collapse of the pith, with vascular browning, external dark brown to black stem lesions, bacterial flux from stem wounds, and adventitious root formation. Severe losses were seen only occasionally. It was shown to be caused by a new species of bacteria and named *Pseudomonas corrugata* (Scarlett et al., 1978).

Pith necrosis of tomato caused by *P. corrugata* was first observed in California in 1976 in San Diego County in fields along the Mexican border. Symptoms of infection were stunting, stem lesions, and necrosis of the pith. Crop losses were estimated to be as high as 10% (Lai et al., 1983). It was reported subsequently in Florida (Jones et al., 1983) and in Baja California Sur, Mexico (Rodriquez-Alvarado et al., 2007).

Pseudomonas corrugata has been successfully tested as a biological control agent in different pathosystems. Its efficacy as a biological control agent seems linked to its elevated rhizosphere colonizing competence. It has in vitro antimicrobial activity against a long list of microorganisms (Gram-negative and Gram-positive bacteria, Chromista, yeast, and fungi). It is able to compete by producing substances possessing antimicrobial activity and probably also by competing for iron through siderophore corrugation. Potentially it could be used in other fields, such as the production of commercial biomolecules with a wide range of application including bioremediation (Catara, 2007).

Hosts: Pseudomonas corrugata is a ubiquitous bacterium and has been isolated from a wide variety of sources. The main host that can develop serious disease is tomato (*Solanum lycopersicum*). Peppers (*Capsicum annuum*), *Chrysanthemum* spp. and *Geranium* spp. are also hosts that develop disease symptoms. *Pseudomonas corrugata* has been isolated from the rhizosphere and various plant parts on crops such as alfalfa, beans, broccoli, canola, cucumber, grapevine, potatoes rice, strawberry, and wheat, where it can grow without causing apparent symptoms in all of these.

Symptoms: This is a disease that affects mature tomato plants. Infections are evident when the first trusses ripen on the tomato plants. Initially, only slight wilting in the hottest part of the day with chlorosis at the apex. Dark, water-soaked areas may be present on the epidermis and may extend along the entire stem. Under ideal conditions, it can infect up to 100% of a susceptible crop leading to severe economic losses. (CABI, 2022).

Occasionally, traces of bacterial ooze can be observed on wounds including leaf scars. The stems can develop long, conspicuous adventitious roots even 1–2 m above the soil. The most characteristic symptom of the disease is stem pith necrosis. The pith may appear as: necrotic, dry and slightly disaggregated in the core; hydropic, white or dark hard core and necrotic in the areas near the xylem; disaggregated due to the formation of ladder-like cavities. In advanced stages, the xylem becomes necrotic. The disease starts from the base of the stem and works up to the leaf stems and bunches. Necrosis can also affect the taproot and, occasionally, the rootlets (Davis et al., 2013; Jones et al., 2016).

Symptoms on pepper and chrysanthemum are similar to those observed on tomato. Injections of a bacterial suspension of some isolates of *P. corrugata* have caused pith necrosis in eggplant, bean, celery, cucumber, melon, pea, tobacco, and zucchini (Catara et al., 2002).

Transmission: The bacteria overwinter in plant debris in the soil, in dried diseased leaves, and on seed. Bacteria are carried to the leaves by rain splashing, by wind, or they may be accidentally spread during handling of the plants. This is especially a problem for greenhouse grown tomatoes and peppers that are handled frequently during training, staking, tying, pollinating, and harvesting. High humidity or a film of moisture must be present for infections to occur and for the development of epidemics. Bacteria enter the leaf through stomata, hydathodes, and wounds (Jones et al., 2016). *Pseudomonas corrugata* is soilborne and can be found in flowers, fruits, and seeds of tomatoes (Cirvilleri et al., 2008).

Damage Potential: Bacterial pith necrosis is considered an important problem in tomatoes and peppers worldwide. Usually, it is referred to as a mild and opportunistic pathogen with 1-10% of plants

affected, although individual plantings or greenhouses may suffer higher losses (Catara et al., 2002; Lai et al., 1983). Co-infection with multiple *Pseudomonas* spp., all proven to cause similar symptoms on tomato, complicates the ability to estimate damage potential for each species individually (Trantas et al., 2015; Xu et al., 2013).

Worldwide Distribution: Africa: *Egypt, South Africa, Tanzania*. Asia: *India, Israel, Japan, Philippines, Saudi Arabia, Syria, Turkey*. Europe: *Albania, Belarus, Czechia, Denmark, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, North Macedonia, Norway, Poland, Portugal, Russia, Serbia and Montenegro, Spain, Sweden, Switzerland, United Kingdom*. North America*: Canada, Mexico, United States* (California, Florida, Louisiana, Massachusetts, North Carolina, Ohio, Washington). Oceania: *Australia, New Zealand*. South America: *Argentina, Brazil* (CABI-ISC, 2022)

Official Control: None

California Distribution: In California, tomato and pepper pith necrosis is seen primarily in greenhouses but can occur in fresh market tomato fields in the southern part of the state, and occasionally, but rarely, in Central Valley tomatoes (Davis et al., 2013). There are additional records on lettuce and geranium (CDFA PDR database).

California Interceptions: None

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

Consequences of Introduction:

1) **Climate/Host Interaction:** this pathogen is likely to be found wherever its hosts are grown. For tomatoes it has been found most often in southern San Diego County fields, and statewide in tomato greenhouses.

   Evaluate if the pest would have suitable hosts and climate to establish in California.

   Score: **2**

   - 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:** There are several hosts where it is a naturally infecting pathogen: tomatoes, peppers, chrysanthemums and geraniums. It has been isolated as an endophyte from many more.

   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: Bacterial pathogens multiply exponentially under favorable conditions. However, they require moisture on the leaf or stem surface to infect, which limits their potential in dry climates.

Evaluate the natural and artificial dispersal potential of the pest.

Score: 2

- 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: Modest losses are reported in tomatoes and peppers in most situations. However, in a highly favorable environment, losses can be considerable.

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

Economic Impact: 2

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: **2**

- 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: No impacts have been reported as to date it has only affected agronomic crops.

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

Environmental Impact:

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: 1
- 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 corrugata:* Medium

Add up the total score and include it here. **9**
-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 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* ***= 6***

Uncertainty:

Pseudomonas mediterranea is a closely related species that also causes pith necrosis on several hosts including cannabis and tomato. It was separated from *P. corrugata* by Catata et al. in 2002. Previous records of *P. corrugata* might now be classified as *P. mediterranea* and they may co-occur. *Pseudomonas mediterranea* is a B-rated pathogen known to be in California (https://blogs.cdfa.ca.gov/Section3162/wp-content/uploads/2020/08/P-mediterranea_PRP_ADA.pdf)

Conclusion and Rating Justification:

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

References:

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

CABI Crop Production Compendium 2022. Pseudomonas corrugata https://www.cabi.org/cpc/datasheet/44945 Accessed 3/2/22

Catara, V., 2007. *Pseudomonas corrugata*: plant pathogen and/or biological resource? Molecular plant pathology, 8(3), pp.233-244.

Catara, V., Sutra, L., Morineau, A., Achouak, W., Christen, R. and Gardan, L., 2002. Phenotypic and genomic evidence for the revision of *Pseudomonas corrugata* and proposal of *Pseudomonas mediterranea* sp. nov. International Journal of Systematic and Evolutionary Microbiology, 52(5), pp.1749-1758.

Cirvilleri G., Bella P., La Rosa R., Catara V. 2008 Internalization and Survival of *Pseudomonas corrugata* from Flowers to Fruits and Seeds of Tomato Plants. In: Fatmi M. et al. (eds) Pseudomonas syringae Pathovars and Related Pathogens – Identification, Epidemiology and Genomics. Springer, Dordrecht.

Davis, R. M., Miyao, G., Subbarao, K. V., Stapleton, J. J., Aegerter, B. J. 2013. UC IPM Pest Management Guidelines: Tomato. Tomato Pith Necrosis. UC ANR Publication 3470.

Jones, J.B., Jones, J.P., Stall, R.E. and Miller, J.W., 1983. Occurrence of stem necrosis on field-grown tomatoes incited by *Pseudomonas corrugata* in Florida. Plant disease, 67(4), pp.425-426.

Jones, J. B., Zitter, T. A., Momol, T. M and Miller, S.A. 2016. Compendium of tomato diseases and pests, second edition. APS press

Lai, M. I., Opgenorth, D. C., White, J. B. 1983.Occurrence of *Pseudomonas corrugata* on tomato in California. Plant disease. Jan 1;67(1):110-2.

Rodriguez-Alvarado, G., Holguín-Peña, J., Ochoa-Alvarez, N., Fernandez-Pavia, S.P. and Geraldo-Verdugo, J.A., 2002. *Pseudomonas corrugata* Causing Pith Necrosis on Tomato Plants in Baja California Sur, México. Plant Disease, 86(5), pp.563-563.

Scarlett, C.M., Fletcher, J.T., Roberts, P. and Lelliott, R.A., 1978. Tomato pith necrosis caused by *Pseudomonas corrugata* n. sp. Annals of applied Biology, 88(1), pp.105-114.

Trantas, E.A., Sarris, P.F., Pentari, M.G., Mpalantinaki, E.E., Ververidis, F.N. and Goumas, D.E., 2015. Diversity among *Pseudomonas corrugata* and *Pseudomonas mediterranea* isolated from tomato and pepper showing symptoms of pith necrosis in Greece. Plant Pathology, 64(2), pp.307-318.

Xu, X., Baysal-Gurel, F. and Miller, S.A., 2013. First report of tomato pith necrosis caused by *Pseudomonas mediterranea* in the United States and *P. corrugata* in Ohio. Plant disease, 97(7), pp.988.

Responsible Party:

Heather J. Scheck, Primary Plant Pathologist/Nematologist, CDFA/PHPPS ECOPERS, 1220 N St Rm 221, Sacramento, CA 95814 Phone: (916) 654-1017, permits[@]cdfa.ca.gov.

***Comment Period: 04/12/2022 through 05/27/2022**

***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