

California Pest Rating Proposal for *Pectobacterium aroidearum* Nabhan et al. 2013

Current Pest Rating: Z

Proposed Pest Rating: C

Domain: Bacteria, Phylum: Proteobacteria,
Class: Gammaproteobacteria, Order: Enterobacteriales,
Family: Pectobacteriaceae

Comment Period: 02/21/2023 through 04/07/2023

Initiating Event:

In October 2021, San Luis Obispo County Agricultural inspectors collected a sample of *Sansevieria trifasciata* that was part of an incoming shipment from Florida. The sample went to CDFA's Plant Pest Diagnostics Lab at Meadowview where CDFA plant pathologist Sebastian Albu diagnosed the soft rotting symptoms on the cuttings as caused by *Pectobacterium aroidearum*. The pathogen was isolated in culture and the diagnosis was confirmed by PCR, DNA sequencing, and phylogenetic analysis. He assigned it a temporary Z-rating. Subsequently, San Luis Obispo, along with San Diego and Sonoma counties, have submitted additional symptomatic samples positive for *P. aroidearum* from *Dracaena marginata*, *Dieffenbachia* sp., *Dracaena* sp., *Cordyline terminalis*, *Spathiphyllum* sp. and *Epipremnum aureum*, from various shippers in Florida and Costa Rica. This pathogen has not been through the current pest rating process. The risk to California from *Pectobacterium aroidearum* is described herein and a permanent rating is proposed.

History & Status:

Background: *Pectobacterium* is a genus of gram-negative, facultative anaerobic, nonsporulating, rod-shaped flagellated bacteria that belong to the family, Pectobacteriaceae. This family consists largely of plant pathogens, including *Brenneria* and *Dickeya*. Many *Pectobacterium* spp. were formerly characterized as "pectinolytic *Erwinia* spp." Soft rot pectobacteria are devastating plant pathogens with a global distribution and a broad host range, considered to be one of the top ten most important agricultural phytopathogens (Mansfield et al., 2012). They are known for causing various plant diseases such as soft rot, blackleg, and tuber and crown rot. They can cause significant damage to crops and have the ability to produce plant cell-wall-degrading enzymes. *Pectobacterium* species are found in soil

and water and are adapted to a wide range of temperatures. They generally have broad host ranges, causing soft rots on important crop plants, both in the field and after harvest.

The classification of the genus *Pectobacterium* has been subjected to wide revision over the last decade, and it is likely that some strains were incorrectly assigned to *P. carotovorum* (Zhang et al., 2016). For instance, *P. carotovorum* subsp. *carotovorum* served as a catchall for pectobacteria isolates differing from the specific descriptions of the other taxa. There are now 18 species in the genus (Khadka et al., 2022). In 2013, work by Nabhan et al., showed that several pectolytic bacterial strains, mainly isolated from monocotyledonous plants and previously identified as *P. carotovorum*, could be reclassified as *P. aroidearum*. Along with variation in DNA-DNA hybridization, these strains also showed some unique chemotaxonomic features and quantitative differences in polar lipids, lipoquinones and fatty acids. The taxonomic status of these unique strains based on their 16S rRNA gene sequence, chemotaxonomic, and physiological analyses was corroborated by their distinct clustering in multi-locus sequence analysis. The name *P. aroidearum* was proposed and adopted for these strains. The specific epithet, *aroidearum* is derived from the subfamily Aroideae (arum family) of Araceae, a family of monocotyledonous flowering plants, which includes *Zantedeschia aethiopica* (calla lily), the host on which the type-strain of *P. aroidearum* was isolated.

Hosts: *Amorphophallus konjac* (konjac), *Brassica pekinensis* (Napa cabbage), *Capsicum annuum* (pepper), *Colocasia esculenta* (taro), *Cordyline terminalis* (ti), *Cucurbita pepo* (winter squash, pumpkin), *Daucus carota* (carrot), *Dieffenbachia* sp., *Dracaena marginata* (dragon tree), *Dracaena* sp., *Epipremnum aureum* (pothos), *Lactuca sativa* (lettuce), *Prunus persica* (peach), *Solanum tuberosum* (potato), *Spathiphyllum* sp., *Syngonium podophyllum* (arrowhead plant), *Zantedeschia aethiopica* (calla lily) (Barroso, et al., 2019; CDFA PDR database, 2023; Chen et al., 2020; Liang et al., 2022; Moraes et al., 2017; Moraes et al., 2020; Moretti et al., 2015; Tang et al., 2021; Wei et al., 2020; Xie et al., 2018; Xu et al., 2020; Zhou et al., 2022).

Symptoms: *Pectobacterium* spp. and other soft rotting bacteria produce various enzymes that degrade plant cell wall components. Among these, pectinases are believed to be the most important factor for pathogenesis. They macerate tissue by degrading the pectic substances in the middle lamella and are indirectly responsible for cell death. The invaded tissues become soft and are transformed into a slimy mass consisting of bacteria swimming in the liquefied plant cell contents. The epidermis of most plants is not directly attacked by the bacteria. However, if cracks are present, the slimy mass can extrude through them into the soil or in storage. If the slime comes into contact with other fleshy organs, they can be infected (Agrios, 2005). The symptoms of *P. aroidearum* infection specifically can include wilting, yellowing, and softening of plant tissue, as well as the production of foul-smelling liquids (Nabhan et al., 2013). This can occur in living plants and as a post-harvest disease of plants or plant parts in storage.

Transmission: *Pectobacterium* spp. appear to mainly be soil-borne pathogens. They survive between crops either by infecting alternative weed host plants, especially in tropical regions, or in association with plant residues. They have been isolated from water and can infect plants via contaminated irrigation water. Dispersal within and between crops can also occur with contaminated wind-driven

water splashing and aerosols. The pathogen survives in infected fleshy organs in storage and in the field, in debris, and on roots, stems and leaves. Some tubers, rhizomes, and bulbs become infected through wounds or lenticels after they are formed in the soil and the disease may first appear on daughter plants grown from previously infected propagules. Soft-rot bacteria can move with different stages of several insects. The bodies of maggots can become contaminated with bacteria when they crawl around on rotting seed pieces and move to clean pieces. Flying insects can carry *Pectobacterium* to healthy plants and transfer them directly into wounds, where they can cause new infections (Agrios, 2005).

Infected planting material transmits the pathogen to new areas. Foliar cuttings and potato tubers can be internally infected with bacteria inside their vascular bundles. The disease can also spread with contaminated knives or by people during handling, including pruning, cutting, and harvesting. Wounded, soft succulent tissues, like stem cuttings produced during the propagation cycle are most susceptible.

Damage Potential: On Napa cabbage (*Brassica pekinensis*), lesions initiated at petiole base, expanded, and rapidly covered entire plant (Xie et al., 2018). On calla lilies (*Zantedeschia aethiopica*) disease incidence in the field can vary from 20-60% with extensive water-soaked areas on stems (Chen et al., 2020). A high incidence, (about 80%) of soft rot was observed in green and ripe zucchini, with water soaking and macerating of fruit (Moraes et al., 2017). In gardens in Brazil, 5% of lettuce plants and 45% of Chinese cabbage plants showed wilting of leaves, foul-smelling soft rot, and pith disintegration (Barroso et al, 2019).

Worldwide Distribution: Brazil, China, Costa Rica, Lebanon, Taiwan, and United States (Florida) (Barroso, et al., 2019; CDFA PDR database, 2023; Chen et al., 2020; Liang et al., 2022; Moraes et al., 2017; Moretti et al., 2015; Tang et al., 2021; Wei et al., 2020; Xie et al., 2018; Xu et al., 2020).

Official Control: None

California Distribution: None

California Interceptions: Multiple detections have been made on incoming nursery shipments of foliage plant cuttings from Florida and Costa Rica (see “initiating events”).

The risk *Pectobacterium aroidearum* would pose to California is evaluated below.

Consequences of Introduction:

- 1) **Climate/Host Interaction:** *Pectobacterium aroidearum* has a broad host range and has mainly been reported from tropical regions, however, it has hosts that are widely planted crops in California (i.e., peach, pepper, citrus, lettuce, carrot, and pumpkin). Although suitable conditions for the dispersal of
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P.aroidearum would be infrequently found in field situations in California, they would be very common inside greenhouses and in nursery transplant beds.

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: *Pectobacterium aroidearum* has a broad host range.

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: This pathogen reproduces very quickly with binary fission when there is a food source and favorable environmental conditions. It disperses with water, insects, people, tools, and infected plant material.

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: *Pectobacterium aroidearum* is a demonstrated cause of crop losses, in the field and in post-harvest storage.

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

Economic Impact: A, G

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

5) Environmental Impact: Infected growing areas must improve phytosanitary methods to prevent the spread of the pathogen by movement of diseased plants or contaminated water.

Evaluate the environmental impact of the pest to 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 *Pectobacterium aroidearum*: Medium

Add up the total score and include it here. 12

- 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.

There have been many detections of *P. carotovora* in California. *Pectobacterium aroidearum* was separated from *P. carotovora* only 10 years ago. To date, all detections of *P. aroidearum* have been made from incoming shipments.

Evaluation is 'Not established'.

Score: 0

- Not established (0) Pest never detected in California or known only from incursions.**
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-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 = 12*

Uncertainty:

In the past, soft rotting bacteria were often identified as *Pectobacterium carotovorum* subsp. *carotovorum*. *Pectobacterium aroidearum* was separated from *P. carotovorum* subsp. *carotovorum* in 2013, leaving uncertainty regarding how older detections would be classified today. It is reasonable to assume some isolates in the past that were identified as *P. carotovorum* could today be classified as *P. aroidearum*.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for *Pectobacterium aroidearum* is C.

References:

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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](mailto:permits[@]cdfa.ca.gov).

***Comment Period: 02/21/2023 through 04/07/2023**

***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](mailto: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.
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Proposed Pest Rating: C
