CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Pectobacterium brasiliense (Portier et al. 2019)

blackleg disease of potato; soft rot of potato

Current Pest Rating: Q

Proposed Pest Rating: B

Kingdom: Bacteria, Phylum: Proteobacteria,
Class: Gammaproteobacteria, Order: Enterobacterales,
Family: Pectobacteriaceae

Comment Period: 05/26/2021 through 07/10/2021

Initiating Event:

In December 2018, agricultural inspectors from San Diego County submitted a sample of *Dracaena deremensis* 'Warneckii' cuttings with symptoms of soft rot to CDFA's Pest Diagnostics Center at Meadowview. They were part of an incoming shipment from Costa Rica destined for a wholesale nursery. Plant pathologist Sebastian Albu detected *Pectobacterium carotovorum* subsp. *brasiliense* in culture and confirmed his diagnosis by PCR, DNA sequencing, and phylogenetic analysis. This was the first detection of this pathogen in California, and it was assigned a temporary Q rating. The same soft-rotting pathogen, now named *P. brasiliense*, was detected in March 2021 from a shipment of *Codiaeum variegatum* 'Gold dust' plugs were inspected by San Diego County as part of an incoming shipment from a wholesaler in Miami-Dade County, Florida.. The risk to California from *P. brasiliense* is described herein and a permanent rating is proposed.

History & Status:

Background: Bacteria belonging to the genus *Pectobacterium* generally have broad host ranges are adapted to a wide range of temperatures, causing soft rots on important crop plants, both in the field and after harvest. Significant crop losses in China, South Africa, Brazil, Netherlands, Switzerland, and the UK have been reported (Meng et al., 2017). A serious blackleg disease of potato was first observed in Brazil by Duarte et al. in 2004. They described it as an atypical strain of *Erwinia carotovora,* giving it the name *E. carotovora* subsp. *brasiliensis,* meaning 'from Brazil'. It has since been reported from diverse climatic regions in Europe, Asia, Africa, Australia, North, and South America. *Pectobacterium*

spp., including *P. brasiliense*, are considered more aggressive than other soft rot bacteria in the genera *Erwinia* and *Dickeya* because lower inoculum levels can cause infection and they spread more readily through plant vascular systems (USDA, 2015). Nabhan et al. (2012) transferred *E. carotovora* subsp. *brasiliensis* to *P. carotovorum* subsp. *brasiliense*, but this name was not validly published. In 2016, a first report of field decay of sugar beet caused by *Pectobacterium carotovorum* subsp. *brasiliense* in North America was made from Minnesota and North Dakota by Secor et al.

In 2019, Portier et al. examined the taxonomic status of *Pectobacterium* strains isolated from a wide range of plant species, geographical origins, and waterways, and described *P. carotovora* as a species complex. They elevated *P. carotovora* subsp. *brasiliense* to a species level based on completely sequenced *Pectobacterium* species, phylogenetic analysis, average nucleotide identity calculation, and in silico DNA–DNA hybridization. Although it is recognized as a valid genus and species, the designation as *P. brasiliense* has not yet been uniformly adopted, with some still using the name *P. carotovora* subsp. *brasiliensis or P. carotovora* subsp. *brasiliense* (CABI-ISC, 2021).

This pathogen is emerging as one of the most destructive species in the genus *Pectobacterium*, responsible for causing blackleg of potato and many additional diseases of cucurbits and other vegetables (CABI-ISC, 2021). Arizala et al. (2020) published a first report of blackleg disease of potato in Hawaii from field samples collected on Oahu. This was followed quickly by two additional *P. brasiliense* reports from Hawaii; Boluk et al. (2020) published a report of soft rot on kale (*Brassica oleracea* var. *sabellica)*, and Klair et al. (2021) described a soft rot disease on pak choi (*Brassica rapa* subsp. *chinensis*).

Hosts: Allium cepa (onion), *Apium graveolens* (celery), *Beta vulgaris* (beet), *Beta vulgaris* var. *saccharifera* (sugar beet), *Brassica oleracea* (cabbages, cauliflowers), *Brassica oleracea* var. *capitata* (cabbage), *Brassica oleracea* var. *italica* (broccoli), *Brassica rapa* subsp. *chinensis* (pak choi), *Brassica rapa* subsp. *pekinensis* (Chinese cabbage), *Brassica oleracea* var. *sabellica* (kale), *Capsicum annuum* (bell pepper), *Citrullus lanatus* (watermelon), *Codiaeum variegatum* 'Gold dust' (croton), *Cucumis sativus* (cucumber), *Cucurbita pepo* (pumpkin), *Cynara cardunculus* var. *scolymus* (globe artichoke), *Daucus carota* (carrot), *Dracaena deremensis* 'Warneckii', *Neobuxbaumia tetetzo* (tetecho cactus), *Raphanus raphanistrum* (wild radish), *Solanum lycopersicum* (tomato), *Solanum melongena* (eggplant), *Solanum tuberosum* (potato), and *Spinacia oleracea* (spinach) (CAPI-ISC, 2021; Klair et al., 2021; Arizala et al., 2020; Boluk et al., 2020; Mejía-Sánchez et al., 2019; CDFA PDR database, 2021).

Symptoms: *Pectobacterium brasiliense* is a soft rotting pathogen, like other species in this genus and in the genus *Dickeya*. It produces the plant cell-wall degrading enzymes pectate lyase, polygalacturonase, cellulase, and protease. When a plant is infected, the symptoms generally start with soft, watery leaking from the plant tissues (often the stems) or wet lesions on fruits or tubers, which can turn slimy and black, ultimately macerating in the infected areas. Plant wilting or collapse generally accompanies the lesions or rotting. Symptoms are typically worse under wet conditions or high humidity, but can vary depending on host susceptibility, temperature, humidity, and field conditions, as well as pathogen concentration and days after infection. Under dry conditions, symptoms like stunting, yellowing, wilting, stem desiccation and tuber soft rot with exudates are more common (CABI-ISC, 2021).

On potatoes, *P. brasiliense* is responsible for blackleg in aerial parts of the potato. Black discoloration starts below ground and moves up the stem, and severe disease can hollow out or macerate stems. The black discoloration of the stems is accompanied by rapid wilting, yellowing and necrosis of leaves. Infected tubers first exhibit water-soaked lesions and the entire tuber can become soft with a cream or black color that spreads through the tuber. These primary symptoms can lead to secondary colonization by saprotrophic soil bacteria that accelerate decay and give off foul odors (Jiang et al., 2019). On sugar beets, *P. brasiliense* symptoms are like those caused *P. betavasculorum*, including soft decay of internal root tissues, reddening of affected tissue after cutting, blackening of petiole vascular bundles, half-leaf yellowing, and frothing (Secor et al., 2016).

On tomatoes and artichokes, stem rots, basal discoloration and basal leaf drop, water soaking and internal vascular brown discoloration in the pith, with possible hollow stems and plant collapse have been observed (Caruso et al., 2016; Cariddi and Bubibi, 2016). For cucumbers, Meng et al. (2017) described a white, thick liquid produced on infected stem and fruits, turning into a brown and wet rot of fruits, stem pith and leaves wilting. Symptoms on brassicas include soft rot, wet lesions, macerated infected stems and necrotic leaves (Klair et al., 2021).

Transmission: Pectobacterium brasiliense can survive as a saprotroph in soil, irrigation water, and plant debris. It enters a host plant through wounds or natural openings (stomata, lenticels, and potato eyes), colonizing and translocating through the vascular system. It can remain in a quiescent state until favorable environmental conditions such as high humidity and temperatures of 17-37°C occur, at which point the pathogen begins to synthesize lipopolysaccharides and plant cell wall-degrading enzymes that allow it to acquire nutrients from the host and protect itself from host defenses (van der Merwe et al., 2010; du Raan et al., 2016).

Pectobacterium brasiliense is transmitted primarily through infected seeds (Czajkowski et al., 2011). Planting infected tubers will release bacteria into the soil. Once present in the field, it will spread through irrigation and with workers and farm equipment to healthy plants or tubers. Because it can be present but asymptomatic under unfavorable conditions, it can avoid detection and be easily transmitted to other tubers through cuttings or other postharvest handling and processing. And because it infects the vascular system, it can infect an entire potato plant including progeny tubers.

Damage Potential: This pathogen is major threat to economically important cultivated vegetables, including potatoes; there are no existing curative measures. Serious yield losses have been reported worldwide, including Canada, USA, the Netherlands, Switzerland, South Africa, Kenya, Korea Republic, and Japan. Large losses on potatoes were reported by Werra et al. (2015), and Fujimoto et al. (2017). Onkendi et al., (2014) reported as much as one-quarter of the annual potato crop lost to bacterial infection in Kenya. Meng et al., 2017 reported significant crop loss on cucumber caused by *P. brasiliense* in northern China. In Hawaii, it has been described as of one of the most devastating bacterial pathogens within genus *Pectobacterium* (Klair et al, 2021), when found attacking potatoes and brassicas.

Worldwide Distribution: Africa: *Algeria, Egypt, Kenya, Morocco, Reunion, South Africa, Zimbabwe.* Asia: *China, Israel, Japan, South Korea, Syria, Thailand, Turkey*. Europe: *Austria, France, Germany, Italy, Netherlands, Poland, Russia, Serbia, Spain, Switzerland*. North America: Canada, Martinique, Mexico United States (Florida, Georgia, Hawaii, Minnesota, North Dakota, Wisconsin). Oceania: *New Zealand*. South America: *Brazil, Colombia, Peru, Venezuela* (CABI-ISC, 2021).

Official Control: *Pectobacterium brasiliense* is on the EPPO's A1 list for Egypt (EPPO, 2021), and on the USDA's PCIT's Harmful organism list for Ecuador and Egypt (USDA PCIT, 2021).

California Distribution: None

California Interceptions: There have been two interceptions, both on incoming shipments of ornamental foliage plants (propagative material), one from Costa Rica and one from Florida (see 'initiating events').

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

Consequences of Introduction:

1) **Climate/Host Interaction:**
   Pectobacterium brasiliense has a broad host range and has apparently adapted to many environments as it is present from tropical regions (Brazil) to temperate regions (Europe and Canada).

   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 for this pathogen is large, including many vegetable crops.

   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:** Under favorable conditions of temperature and humidity, *Pectobacterium* spp. increase very rapidly. They are dispersed by moving water and moving infected plants or plant parts.

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:** Large losses have been reported in the field and post-harvest in multiple crops in multiple countries (CABI-ISC, 2021). It is a quarantine pest in some countries.

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

Economic Impact: A, B, C, D, 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: **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:** With a large host range and ability to survive in the soil as a pathogen, *P. brasiliense* would likely be persistent in California soils, with no curative treatments available

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 brasiliense:* 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.

   There have only been two official detections in California, both were on incoming shipments of foliage plants.

   Evaluation is 'Not established'.

   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: (Score)

   Final Score: *Score of Consequences of Introduction – Score of Post Entry Distribution and Survey Information* **= 14**

Uncertainty:

It is not possible to separate soft rotting bacterial species from symptoms. Lab testing is required and thus the presence of this pathogen in California is likely to be under reported. A state-wide survey for pectinolytic bacteria would be required.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for ***Pectobacterium brasiliense*** is **B**.

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Responsible Party:

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***Comment Period: 05/26/2021 through 07/10/2021**

***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: B
