

California Pest Rating Proposal for
***Pectobacterium carotovorum* (Waldee 1945) Hauben et al. 1998**

Bacterial soft rot

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

Current Pest Rating: C

Proposed Pest Rating: C

Comment Period: 12/04/2020 through 01/18/2021

Initiating Event:

On August 9, 2019, USDA-APHIS published a list of “Native and Naturalized Plant Pests Permitted by Regulation”. Interstate movement of these plant pests is no longer federally regulated within the 48 contiguous United States. There are 49 plant pathogens (bacteria, fungi, viruses, and nematodes) on this list. California may choose to continue to regulate movement of some or all these pathogens into and within the state. In order to assess the needs and potential requirements to issue a state permit, a formal risk analysis for *Pectobacterium carotovorum* (Pc) is given herein and a permanent pest rating is proposed.

History & Status:

Background: Bacterial soft rots can cause a greater total loss of produce than any other type of bacterial pathogens. They attack crops in the field, in transit, and especially in storage. Nearly all fresh vegetables are susceptible to soft rots, which reduce their quantity and quality, requiring integrated measures to control them.

Pectobacterium spp. can live epiphytically (on the surface) of many plant parts before attacking living plant tissues in the field or in storage. This is unusual among plant pathogenic bacteria, especially for one like Pc, which produces strong pectolytic enzymes for pathogenesis. These pectinases macerate the parenchymatous tissue of a wide range of plant species. This is a distinction from other soft rotting

bacteria that only grow in tissues already killed by other pathogens or environmental causes, or in tissues so weakened or old that they are unable to resist attack by any organism.

Erwinia carotovora subsp. *carotovora* was transferred to the genus, *Pectobacterium* by Hauben et al. (1998), based on 16S rDNA analysis. It was known as *Pectobacterium carotovorum* subsp. *carotovorum* until 2019 when Portier et al. elevated it to species. However, this change in nomenclature has not yet been widely accepted by plant pathologists and the older *Erwinia* name is still in use.

Hosts: Allium cepa (onion), *Allium chinense* (spring onion), *Allium porrum* (leek), *Allium tuberosum* (Oriental garlic), *Aloe arborescens* (candelabra aloe), *Apium graveolens* (celery), *Artemisia vulgaris* (mugwort), *Beta vulgaris* var. *saccharifera* (sugarbeet), *Brassica juncea* var. *napiformis* (Chinese mustard), *Brassica napus* var. *napobrassica* (swede), *Brassica oleracea* var. *botrytis* (cauliflower), *Brassica oleracea* var. *capitata* (cabbage), *Brassica oleracea* var. *gongylodes* (kohlrabi), *Brassica oleracea* var. *italica* (broccoli), *Brassica rapa* cultivar group Mizuna, *Brassica rapa* subsp. *oleifera* (turnip rape), *Brassica rapa* subsp. *pekinensis*, *Capsicum annuum* (bell pepper), *Carthamus tinctorius* (safflower), *Cichorium* (chicory), *Cucumis melo* (melon), *Cucumis sativus* (cucumber), *Cucurbita* (pumpkin), *Cyclamen*, *Cymbidium*, *Cynara cardunculus* var. *scolymus* (globe artichoke), *Daucus carota* (carrot), *Dioscorea* (yam), *Dracaena deremensis*, *Dracaena sanderiana*, *Foeniculum vulgare* (fennel), *Glycine max* (soybean), *Helianthus annuus* (sunflower), *Ipomoea batatas* (sweet potato), *Iris* (irises), *Kalanchoe blossfeldiana* (flaming katy), *Lactuca sativa* (lettuce), *Manihot esculenta* (cassava), *Musa* (banana), *Musa x paradisiaca* (plantain), *Nicotiana tabacum* (tobacco), *Oncidium* (dancing-lady orchid), *Onobrychis viciifolia* (sainfoin), *Opuntia ficus-indica* (prickly pear), *Oryza sativa* (rice), *Pandanus* (screw-pine), *Papaver somniferum* (Opium poppy), *Phalaenopsis amabilis* (moth-orchid), *Phaseolus* (beans), *Pothos*, *Primula* (primrose), *Primula malacoides* (fairy primrose), *Primula obconica* (top primrose), *Primula polyantha*, *Pyrus communis* (European pear), *Raphanus sativus* (radish), *Silybum marianum* (variegated thistle), *Solanum lycopersicum* (tomato), *Solanum melongena* (eggplant), *Solanum tuberosum* (potato), *Sorghum bicolor* (sorghum), *Sorghum sudanense* (Sudan grass), *Strelitzia reginae* (Queens bird-of-paradise), *Triticum aestivum* (wheat), *Ullucus tuberosus* (ulluco), *Xanthosoma sagittifolium* (elephant ear), *Zantedeschia* (calla-lilies), *Zantedeschia aethiopica* (calla lily), *Zingiber officinale* (ginger).

Symptoms: Soft-rot symptoms begin as small water-soaked lesions which enlarge rapidly (as fast as within hours) in diameter and in depth under favorable environmental conditions. The affected area is soft and mushy with a discolored and somewhat depressed surface. Infected tissues become cream colored and slimy as they disintegrate into a mush of leaking, disorganized plant cells and bacteria. Pc multiplies profusely in the intercellular spaces, producing pectinase enzymes that dissolve the middle lamella, separating the cells, and causing maceration. The cells first lose water and their contents shrivel; parts of their walls are subsequently dissolved (Agrios, 2005).

The external surface may remain dry and intact while the entire contents of a stem, fruit, or tuber become a turbid liquid. Cracks can develop and a slimy mass will exude to the surface. When exposed to air, the liquids turn tan, gray, or dark brown. The transformation of an organ such as a potato tuber to a slimy rotted mass can take as little as three to five days (Otazu and Secor, 1980).

Basal stem areas of field-grown root crops may become watery and turn black and shrivel, causing the plants to become stunted, wilt, and die. Infections of succulent leaves and stems in the field can lead to stock rot in crops such as tobacco (McIntyre, et al. 1978). Hosts such as lettuce suffering from pith infection rapidly become soft and disintegrate and can be reduced to a wet, green, slimy mass within 1 or 2 days (Cho, 1983). Infected fruits and tubers are usually odorless until they collapse, and then secondary, saprophytic bacteria grow rapidly and produce volatile substances that have a foul odor. This is especially common for cruciferous crops (Agrios, 2005).

Transmission: The dissemination of Pc between plants or to other parts of the same plant is carried out primarily by water splashing, direct contact, hands, tools, soil movement, and insects, other animals, and humans. Rain has a washing or spattering effect that carries and distributes Pc on the crop and from the soil to the lower parts of plants. Water also moves bacteria through the soil. Pc can survive in infected fleshy organs in storage and in the field, in debris, on roots or other parts of plants, in ponds and streams used for water irrigation, occasionally in the soil, and in the pupae of several insects. Insects can carry bacteria to plants, and inoculate the plants at vulnerable sites. Farm workers can spread bacteria by handling plants, with standard cultural practices, and over long distances, by transporting infected plants or plant parts to new areas.

Pc may survive in infected tissues, in the soil, and in contaminated equipment and containers. They enter plants or plant tissues primarily through wounds or natural openings. The control of bacterial soft rots is difficult and depends on proper sanitation, avoiding injuries, keeping storage tissues dry and cool, assuring good insect control, and practicing crop rotation. The disease may first appear in the field on plants grown from previously infected seed pieces. Some tubers, rhizomes, and bulbs become infected through wounds or lenticels after they are set or formed in the soil. The inoculation of bacteria into fleshy organs and their further dissemination in storage and in the field are facilitated greatly by insects (Agrios, 2005).

Damage Potential: Pc affects a wide range of plants causing soft rot of potatoes and many fruits and vegetables. The economic losses can be great, depending on the value of the crop and the severity of the attack. Disease damage is influenced by temperature and moisture levels at harvest and during and storage (Agrios, 2005). Tuber soft rot limits potato storage, especially in tropical environments. Tuber infections in the field occur when there is high soil moisture and high temperatures. During and after harvest, soft rot is favored by immature tubers, adverse temperatures (pulp temperatures above 70°F at harvest), mechanical damage, and free water on tuber surfaces (Nunez and Aegerter, 2019). Mature roots of carrots are most susceptible during warm temperatures and when standing water is present (Nunez et al., 2012). Soft rots on onions and garlic generally appear just before or at harvest, or during storage (Swett et al., 2019). Large losses have been reported in mushroom production (Okamoto et al., 1999).

Worldwide Distribution: Africa: *Algeria, Central African Republic, Republic of the Congo, Egypt, Ethiopia, Libya, Malawi, Mauritius, Morocco, South Africa, Sudan, Zimbabwe.* Asia: *Bangladesh, China, India, Indonesia, Iran, Iraq, Israel, Japan, Jordan, Malaysia, Philippines, Saudi Arabia, Singapore, South*

Korea, Syria, Taiwan, Thailand, Turkey. Europe: Bulgaria, Czechia, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Lithuania, Montenegro, Netherlands, Poland, Romania, Russia, San Marino, Serbia, Slovenia, Spain, Sweden, Switzerland, Ukraine, United Kingdom. North America: Canada, Costa Rica, Cuba, Honduras, Martinique, Mexico, Panama, Puerto Rico, Saint Kitts and Nevis, United States (Arizona, California, Colorado, Florida, Georgia, Hawaii, Idaho, Louisiana, Maine, Minnesota, New Jersey, North Carolina, North Dakota, Ohio, Oregon, Tennessee, Texas, Washington, Wisconsin. Oceania: American Samoa, Australia, New Zealand, Papua New Guinea. South America: Argentina, Bolivia, Brazil, Chile, Colombia, Peru, and Venezuela.

Official Control: Pc is on USDA PCIT's harmful organism list for Jordan and Mexico (USDA, 2020). From the EPPO, it is a quarantine pest in Mexico, on the A2 list for Jordan, and a regulated non-quarantine pest in Bahrain and Egypt (EPPO, 2020).

California Distribution: Alameda, Fresno, Marin, Monterey, Orange, Placer, Riverside, San Bernardino, San Diego, San Luis Obispo, Santa Barbara, Santa Clara, Santa Cruz (CDFA database, French, 1989)

California Interceptions: None

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

Consequences of Introduction:

- 1) Climate/Host Interaction:** Although favored by warmer temperatures, Pc can establish on host plants over a range of climatic conditions and the hosts are widespread.

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 Pc is very large, including hosts in many plant families.

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:** Pc can multiply very rapidly under ideal conditions. It is dispersed mainly with water and disease plant parts, plus insects
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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:** With a very large host range, Pc often attacks right at harvest or during storage and transport, which is a large economic cost to producers. It can move and survive in irrigation water and soil.

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

Economic Impact: A, B, 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:** None reported, Pc is mainly a problem in irrigated agriculture.

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 *Pectobacterium carotovorum*: 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'. Pc is widespread in California

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 = 10*

Uncertainty:

None

Conclusion and Rating Justification:

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

References:

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Responsible Party:

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***Comment Period: 12/04/2020 through 01/18/2021**

***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](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
