CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Erwinia rhapontici (Millard 1924) Burkholder 1948

Current Pest Rating: Q

Proposed Pest Rating: B

Comment Period: 09/27/2019 through 11/11/2019

Initiating Event:

On May 5, 2019, a Santa Cruz County agricultural inspector submitted a sample from container-grown *Delphinium* sp. (larkspur) with leaf spots from a commercial regulatory nursery inspection. The inspector reported that 85% of plants were affected in a scattered pattern in a 1.5 acre block. On June 6, 2019, CDFA plant pathologist Sebastian Albu detected *Erwinia rhapontici* from the leaf spots. His identification was made by PCR testing of pure cultures isolated from symptomatic plants using 16S primers and others targeting a portion within the β subunit of the RNA polymerase gene (rpoB). The PCR amplicons were of the expected size for *Erwinia* spp. and were sequenced. The sequences were compared to others within the NCBI GenBank database and used to generate a phylogenetic tree that included type strains of every species within the genus *Erwinia*. The *Delphinium* isolates fell within the *E. rhapontici* clade and were clearly distinguishable from *E. aphidicola* and *E. persicina,* closely related species also recently detected in California. This bacterium is known to cause soft rots and pink seed disease on diverse plant species, but has not previously been reported as a pathogen of *Delphinium* spp., nor has it been reported from California prior to this detection. It was assigned a temporary Q rating. The risk of *E. rhapontici* to California is evaluated herein and a permanent rating is proposed.

History & Status:

Background: *Erwinia rhapontici* is an opportunistic plant pathogenic bacterium. It can affect all growth stages of plants and has been isolated from vegetables, ornamentals and small grains, and it attacks a wide range of hosts causing pink seed and crown rot or soft rot. It produces a distinct, diffusible pink pigment that is a virulence factor that enhances pathogenicity (Feistner et al., 1997). Mechanical injuries, such as those caused by wind, hail, contact with irrigation equipment, or insect feeding, are pathways for infection (Huang et al., 2003b; Huang and Erikson 2004; Huang et al., 2007). There are two distinct kinds of plant diseases caused by *E. rhapontici*. The first, called “pink seed”, is a seed-associated disease of cereal and pulse crops. Research on pink-seed diseases have shown that *E.*

rhapontici is a weak plant pathogen and does not infect seeds internally. However, using contaminated seeds for planting can have serious impacts when the disease occurs in the field, leading to losses in stand establishment, seedling vigor, seed yield, and seed quality (McMullen et al., 1984; Huang and Erickson, 2004). The pink seed color is due to the production of proferrosamine A by the pathogen. This compound occurs within the pink pigment and has been linked with iron deficiency in plants and is thought to contribute the pathogenicity and virulence of *E. rhapontici* (Huang et al., 2003). The second disease type is soft rotting of the stems, crowns, leaves or blossoms of a diverse number of hosts, symptoms first described from rhubarb. This pathogen also occurs epiphytically and saprophytically in lesions caused by other bacterial pathogens (Sellwood and Lelliott, 1978; Kokoskova, 1992) and has been isolated from water, soil and plant surfaces.

Hosts: PINK SEED DISEASE: *Erwinia rhapontici* is a seed-associated disease of cereal and pulse crops (Huang et al., 2003b). It was first reported on common wheat (*Triticum aestivum*) (Howe and Simmonds, 1937; Campbell, 1958; Roberts, 1974 ; Forster and Bradbury, 1990), and later on durum wheat (*Triticum durum*) (McMullen et al., 1984), peas (*Pisum sativum*) (Huang et al., 1990; Schroeder et al., 2002), common beans (*Phaseolus vulgaris*) (Huang et al., 2002), chickpeas (*Cicer arietinum*) (Huang et al., 2003a), lentils (*Lens culinaris*) (Huang et al., 2003a), and Lucerne (*Medicago sativa*) (Zhang et al., 2018).

BACTERIAL SOFT ROT AND LEAF SPOTS: *Erwinia rhapontici* also causes soft rot diseases of multiple tissues including stems, crowns, and fruits of important horticultural crops, and leaf spots on ornamentals and trees. Hosts include citrus (*Citrus limon, C. paradise,* and *C. sinensis*) (Volcani, 1955), garlic (*Allium sativum*) (Choi and Han, 1989), kiwifruit (*Actinidia chinensis*) (Wang et al., 2017), cyclamen (*Cyclamen persicum*) (Carta, 1993), hyacinth (*Hyacinthus orientalis*) (Sellwood and Lelliott, 1978; Kokoskova, 1992), onion (*Allium cepa*) (Ohuchi et al., 1983; Ohuchi, 1986), rhubarb (*Rheum rhaponticum*) (Millard, 1924; Metcalfe, 1940; Letal, 1976), lucerne (*Medicago sativa*) (Zhang et al., 2018), tomato (*Solanum lycopersicum*) (Volcani, 1955; Shaban et al., 1991), wasabi (*Eutrema wasabi*) (Goto and Matsumoto, 1986), verbena (*Verbena x hybrida*) (Garibaldi et al., 2009), mulberry (*Morus* spp.) (Choi et al., 1990), pigweed (*Amaranthus hybridus*) (Gonzalez-Mendosa and Rodriguez, 1990), Roman chamomile (*Chamaemelum nobile*), lemon balm (*Melissa officinalis*) and peppermint (*Mentha piperita*) (Tharreau et al.,1992), amaryllis (*Hippeastrum* sp.) and carnation (*Dianthus* sp.) (Snieskiene, 1995), sugar beet (*Beta vulgaris*) (Hassanzadeh, 1983), and gerbera daisy (*Gerbera* sp.) (Gvozdyak et al., 1987).

Symptoms: For pink seed disease, symptoms include brown lesions on pea pods and pink or shriveled seeds. For many hosts studied, pink seeds have a decreased ability to germinate and show reduced growth as seedlings (Luisetti and Rapilly, 1967). For crown rot, rhizome rot, soft rot of stems and leaves, bulb rot, leaf spot and blossom rot diseases, *E. rhaphontici* can cause lesions, necrosis, and softening of both new and older tissues, often with a pink discoloration in the decayed tissues (Huang et al., 2003).

Transmission: Erwinia rhaphontici spreads through the movement of infected seeds and plants, with wind-blown rain and splashing water, and (as is the case with other closely related species) probably with contaminated tools, equipment, and with people and clothing (Agrios, 2005). Infection requires a

wound and a period with available free water and high humidity. Epidemics often follow prolonged rainy weather or hailstorms. The pathogen can also overwinter in very cold Canadian winter weather and survive as a pathogen or epiphyte on weeds (Huang et al., 2003). *E. rhapontici* can penetrate young fruits through insect wounds or mechanical injuries.

Damage Potential: The disease may be more significant in affecting the quality of the seed rather than yield. In dry yellow peas in Nebraska, pea fields exhibited a high incidence of bacterial disease-like symptoms from this pathogen that resulted in crown and soft rot plus pink seed (Adesemoye et al., 2016). A three-year field study concluded that use of *E. rhapontici*-infected seeds for planting reduced seedling emergence, seedling vigor, and seed yields of pea in Canada (Huang and Erickson, 2004). A study of pea, bean, and wheat seed showed that the pathogen could spread from infected seeds to the lower parts of the plant tissues, but failed to spread further to the seeds produced on those plants, and it was concluded that *E. rhapontici* did not establish systemic infection throught the plants (Hsieh et al., 2010).

On kiwifruit in China, numerous foliar lesions led to premature defoliation of several orchards, impacting fruit marketability and yield (Wang et al., 2017). Infected hyacinth bulbs had an internal, yellow-brown necrosis of the scales, and the discolored tissues had a slightly flaccid, sticky texture but were not soft (Kokoskova, 1992). On mulberry plants in Korea, *E. rhapontici* was described as virulent and was isolated frequently from diseased tissues and was characterized as a major pathogen causing shoot and stem rot. On rhubarb (*Rheum rhaponticum*), a crown rot begins at the soil level and extends into the root. A cavity may form and the flesh below the crown turns brown, then black. The plants are weakened and the crown decays or breaks away (Bradbury, 1977). Wounding is necessary for bacterial ingress and can occur accidentally during cultivation and vegetative propagation.

Worldwide Distribution: North America: *Canada* (Alberta), *United States* (Colorado, Idaho, Kentucky, North Dakota, Oklahoma, South Dakota), *Mexico*; Europe: *Belgium, Czech Republic*, *France, Italy, Lithuania, Netherlands, Norway, Poland, United Kingdom, Ukraine;* Asia: *China Iran, Israel*, *Japan, Republic of Korea*, *Malaysia*; Oceania: *Australia* (Wang et al., 2017; CABI, 2019; EPPO, 2019)

Official Control: *Erwinia rhapontici* appears on the USDA PExD 'harmful organisms' lists for Argentina, Colombia, Costa Rica, Guatemala, Namibia, Nicaragua, South Africa and Taiwan (USDA-PCIT, 2019) and is a quarantine pest on the A1 Lists of the NPPO for East Africa and Southern Africa (EPPO Global Database).

California Distribution: Santa Cruz County (see "initiating event")

California Interceptions: None

The risk *Erwinia rhapontici* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** The pathogen is established worldwide in a range of temperatures but the water requirements for multiplication and dissemination could be a limiting factor in more arid parts of California.

   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:** The host range of *E. rhapontici* is very large and covers many plant families, including monocots and dicots, grains, pulses, legumes, edibile and medicinal herbs, berries, vegetables, ornamentals, and tree fruit.

   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:** *Erwinia rhapontici* is associated with seed, plants reproduced with bulbs and cuttings, and with harvested fruit. Under favorable conditions it can multiply at an exponential rate. However, it requires wounding to infect a host plant and is not systemically seed-borne. Hailstorms have been most commonly implicated in large disease outbreaks and hail rarely occurs in California.

   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:** There is a large host range and many reports of serious crop damage from *E. rhapontici* and it can be isolated from soil and water.

   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: No environmental impacts have been noted

Environmental Impact: Low
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 *Erwinia rhapontici is Medium:*

Add up the total score and include it here. **11**
-Low = 5-8 points
-Medium = 9-12 points
-High = 13-15 points

6) Post Entry Distribution and Survey Information: *Erwinia rhapontici* has been confirmed only in Santa Cruz County infecting *Delphinium* sp. See "initiating event"

Evaluation is 'Low'.
Score: -1 (score followed by bolded bullet)
-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: **11-1**

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 *Erwinia rhapontici* is B.**

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Responsible Party:

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*Comment Period: 09/27/2019 through 11/11/2019

*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 plant.health[@]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
