California Pest Rating Proposal for

Curtobacterium flaccumfaciens pv. *flaccumfaciens* (Hedges) Collins & Jones (Hedges, 1922)

Bacterial wilt of bean

Current Pest Rating: Q

Proposed Pest Rating: B

Domain: Bacteria, Phylum: Actinobacteria,
Class: Actinobacteria, Subclass: Actinobacteridae,
Order: Actinomycetales, Suborder: Micrococcineae,
Family: Microbacteriaceae

Comment Period: 10/10/2022 through 11/24/2022

Initiating Event:

During October 2018, CDFA Plant Pathologist Sebastian Albu diagnosed the bacterial plant pathogen *Curtobacterium flaccumfaciens* pv. *flaccumfaciens* (Cff) from preserved cultures isolated from tomato leaves. The leaves were collected from a phytosanitary quarantine field in Sutter County during a field inspection conducted in 2016. The diagnosis of the pathogen was based on DNA sequence and phylogenetic analyses. Subsequently, in June 2019, Jennifer Romero, CDFA Senior Environmental Scientist, and Sebastian Albu surveyed the field where the tomato was collected which was found to be fallow except for the presence of weed plants that were sampled. Samples of tomato seeds produced from crops cultivated in the same field in 2016 and 2017 were taken from stored supplies. All tomato seed and weed samples tested negative for Cff.

Over the past four years, Cff has been detected from various counties in California, mostly from non-bean seed plant material (tomato in Colusa County, citrus in Ventura County, avocado in San Bernardino County, and watermelon in San Joaquin County). In spring 2022, there was a *Vigna* sp. (black eyed peas) seed detection, and this is the first report in California from Fabaceae, a family which includes many plant hosts susceptible to the characteristic wilt caused by this pathogen. It is unknown if the *Vigna* seeds associated with this detection were grown in California or purchased elsewhere. The risk of this pathogen in California is assessed and a permanent rating is proposed.

History & Status:

Curtobacterium flaccumfaciens pv. *flaccumfaciens* causes bacterial wilt of bean and bacterial tan spot disease of soybean and is an economically important pathogen of edible legumes (i.e., common bean, soybean, mung bean and cowpea) around the world (Hedges, 1922, 1926; Dunleavy, 1983). Bacterial wilt was first described in South Dakota, USA, in 1922 (Hedges, 1922). With a dry summer climate and geographic isolation from major bean production areas of the United States, California enjoys freedom-from status for many foliar and pod pathogens and therefore has an effective bean and pea seed export industry. Although Cff is widespread geographically, imported seed is often subject to declaration of disease status. For seeds to qualify for federal phytosanitary certification for export, they must be free of several important seed-borne diseases including Cff. Phytosanitary requirements against Cff apply to common, mung, adzuki, lima, fava, and soybeans plus peas. As a seedborne pathogen, Cff is included in the A2 (high risk) list of quarantine pathogens by the European and Mediterranean Plant Protection Organization (EPPO); hence, it is under quarantine control and there is zero tolerance for it in the dry bean industry in several countries (CABI ISC, 2022).

The genus name *Curtobacterium* is derived from a Latin word ‘cutus’ or ‘shortened’ to describe the short and rod-shape of the bacterial cells (Yamada and Komagata, 1972) while the specific epithet ‘flaccumfaciens’ is a two-part term (flaccum+faciens) derived from the Latin words 'flaccus' meaning ‘flabby or flaccid’ and ‘faciens’ meaning ‘making’. Hence, the name of the pathogen describes the cell morphology and symptomology of the bacterium as ‘wilt-inducing, short, rod-shaped bacterium’

Hosts: The major host of Cff is common bean (*Phaseolus vulgaris*) (Tegli, 2011). There are other Leguminosae crops also reported as hosts, specifically several other species of beans belonging to the genus *Phaseolus* (Osdaghi, 2014), in addition to members of the genera *Vigna* and *Dolichos*, including hyacinth bean (*Lablab purpureus*), peas (*Pisum sativum*), soybeans (*Glycine max*), chickpeas (*Cicer arietinum*), fava bean (*Vicia faba*), fodder vetch (*Vicia villosa*), lentil (*Lens culinaris*) (Osdaghi et al., 2016), and *Zornia* spp. (Lenné et al., 1985). Garden lupin (*Lupinus polyphyllus*) is an ornamental host (Schuster and Sayre, 1967). Additionally, there are weed hosts in Amaranthaceae (American pigweed [*Amaranthus retroflexus*] and lamb’s quarters [*Chenopodium album*]) and Colvolvulaceae (cowvine morning glory [*Ipomoea lonchophylla*]) (Condè and Diatloff, 1991; Schuster, 1959).

The known host range of Cff continues to increase with additional reports of detections on novel hosts. The pathogen was recently detected and isolated from several crops often grown in rotation with beans, such as wheat, corn, sunflower, alfalfa, barley, black oat, white oat, canola, ryegrass, and from some solanaceous plants (Harveson et al., 2015; Gonçalves et al., 2017; Osdaghi et al., 2018). Tomatoes are not a recorded host.

Symptoms: *Curtobacterium flaccumfaciens* pv. *flaccumfaciens* causes a systemic vascular disease in host plants. Leaves of infected bean plants become flaccid and the whole plant can wilt, particularly during the hottest hours of the day when the plants are under moisture stress. Plants may seem to recover overnight. This is due to bacterial plugging of the vascular system and blocking the water movement through the plant. Other foliar symptoms consist of the production of interveinal necrotic lesions called ‘firing’, with irregular margins that are sometimes surrounded by yellow borders and haloes. On bean seedlings and young plants, disease severity and mortality are higher than on adult

plants. Generally, plant death occurs around 18–23 days after infection. The development of the disease is most rapid above 27–30°C and when the plants are under water stress, because these conditions seem to promote Cff multiplication and host systemic colonization, as well as to enhance the negative effect of bacterial-suppressed water supply (Hedges, 1926). Infected seeds and pods are often asymptomatic and may be discolored with brown or yellow, orange or purple irregular pigments on their surface or in the cavity where the seed develops (Schuster and Christiansen, 1957; Schuster et al., 1968; Huang et al., 2006; Harveson and Vidaver, 2008; Harveson et al., 2015; Osdaghi and Lak, 2015; Osdaghi et al., 2016).

Bacterial wilt symptoms may be confused with those caused by the common bacterial blight pathogen, *Xanthomonas axonopodis* pv. *phaseoli* and both pathogens occur in the same field (Harveson et al., 2011). Bacterial wilt lesions occur between veins, often accompanied by wilting and death of severely infected plants. This is less likely to occur in common bacterial blight and other bacterial diseases, i.e., halo blight caused by *Pseudomonas savastanoi* pv. *phaseolicola* or and brown spot caused by *P. syringae* pv. *syringae* (Schwartz et al., 2005; Harveson and Schwartz, 2007), although neither of these pathogens is systemic. Laboratory diagnostics are necessary to distinguish these pathogens.

Transmission: Seeds produced by plants with bacterial wilt caused by Cff are systemically infected via the vascular system (Schuster and Smith, 1983; Hsieh et al., 2006). Infected seeds are considered the most important source of inoculum and means for the pathogen to spread over long and short distances (Hedges, 1926; Zaumeyer, 1932; Zaumeyer and Thomas, 1957; Hsieh et al., 2006; Camara et al., 2009; Bastas and Sahin, 2017). Contaminated seeds carry the pathogen both externally and internally. It can also be found on overwintering bean straw (Schuster and Smith, 1983).

The pathogen can overwinter and remain viable in seeds for up to 24 years under laboratory conditions. Under field conditions, it survives for about eight months on infected bean crop residues, depending on soil type, moisture content, and climatic conditions (Silva Júnior et al., 2012). If clean seed is planted in contaminated fields, the seedlings can become infected when the pathogen gains entrance to the vascular system through the foliage and stems. Cff-infected mother plants can produce infected seeds (Hedges, 1926; Hsieh et al., 2006; Camara et al., 2009).

Damage Potential: Disease incident levels from seed borne and secondary spread of Cff in a crop can reach above 90% depending on variety and climate (Harveson et al., 2011). Bacterial wilts are difficult to manage due to a present lack of effective chemical management options. Genetic resistance is generally considered to be the most effective means of disease management (Harveson et al., 2015).

Worldwide Distribution: *Africa*: Mauritius, Tunisia, Zambia; *North America*: Canada (Alberta, Manitoba, Ontario, Quebec, Saskatchewan), United States (Colorado, Connecticut, Idaho, Iowa, Michigan, Montana, Nebraska, North Dakota, Ohio, Oregon, Virginia, Wisconsin, Wyoming); *South America*: Brazil, Colombia, Venezuela; *Asia*: Iran; *Europe*: Belgium, Russia, Turkey. *Oceania*: Australia. Cff has sporadically been recorded in the European Union but is not considered widespread and is under surveillance (EPPO, 2022).

Official Control: *Curtobacterium flaccumfaciens* pv. *flaccumfaciens* is on the harmful organisms lists of the following 28 countries: Albania, Argentina, Brazil, Chile, China, Ecuador, Egypt, Guatemala, Honduras, India, Indonesia, Israel, Japan, Jordan, Madagascar, Morocco, Namibia, New Zealand, Nicaragua, Nigeria, Oman, Panama, Paraguay, Peru, South Africa, Timor-Leste, United Arab Emirates, and Uruguay. There are specific requirements related to hosts of Cff for entry into Argentina, Brazil, Chile, Guatemala, Honduras, India, Israel, and New Zealand. In the United States, Idaho restricts hosts of Cff from all states west of the Continental Divide when used for planting without a phytosanitary certificate or official field inspections from origin.

California Distribution: *Curtobacterium flaccumfaciens* pv. *flaccumfaciens* been detected in multiple counties in California on a variety of non-bean hosts (see: 'Initiating Event').

California Interceptions: none

The risk *Curtobacterium flaccumfaciens* pv. *flaccumfaciens* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** It is presumed to be able to survive in any range of conditions suitable for its host plants and it could establish everywhere host plants grow. Disease symptoms and losses would be higher in growing areas with higher temperatures.

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 Cff is wide including multiple plant families with more hosts reported each year.

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 Dispersal Potential:** The pathogen has high reproductive potential. It can move with wind, wind-driven rain, sprinkler irrigation, cultivation tools, and human contact. It can move long distances with asymptomatic but systemically infected seed.

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: The pathogen causes mortality of its hosts and its establishment anywhere in the state could reduce or eliminate export seed markets

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

Economic Impact: A, B, C

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: The pest significantly impacts cultural practices, home/urban gardening or ornamental plantings.

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 *Cutrobacterium flaccumfacians* pv. *flaccumfacians:* 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.

Evaluation is 'medium'.

Score: -2
-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:

Final Score: *Score of Consequences of Introduction – Score of Post Entry Distribution and Survey Information* ***= 12***

Uncertainty:

The biology and the epidemiology of diseases caused by this pathogen are still incompletely understood, for example the role of irrigation water on secondary infections (Harveson et al., 2015). *Cff* may be associated with other crops acting as alternative hosts, including some grown in rotation with dry beans. Seed transmission in other minor or alternative hosts has not been demonstrated yet.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for ***Curtobacterium flaccumfaciens*** **pv. *flaccumfaciens* is B**.

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*Comment Period: 10/10/2022 through 11/24/2022

*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 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
