California Pest Rating Proposal for

Pantoea stewartii subsp. *stewartii* (Smith) Mergaert, Verdonck & Kersters 1993

Stewart's wilt of corn

Current Pest Rating: None

Proposed Pest Rating: B

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

Comment Period: 07/29/2022 through 09/12/2022

Initiating Event:

This pathogen has not been through the pest rating system. The risk to California from *Pantoea stewartii* subsp. *stewartii* is described herein and a permanent rating is proposed.

History & Status:

Background: *Pantoea stewartii* subsp. *stewartii* (syn. *Erwinia stewartii*) is the causal agent of Stewart's wilt of corn. The disease was first described on Long Island, New York in the late 1890s by F. C. Stewart (Stewart, 1897). Stewart's wilt caused severe losses for the United States corn industry in the last century, but the importance of the disease has diminished dramatically with the adoption of resistant corn hybrids (Claflin, 2000; Freeman and Pataky, 2001). It is now considered endemic to parts of the United States, from the Mid-Atlantic States to the Ohio River Valley, and the southern portion of the corn belt (Robert, 1955; Pepper, 1967; Pataky, 2004). The disease has been reported in many parts of the world and can be seed transmitted at a low rate (CABI, CPC, 2022: Claflin, 2000). Stewart's wilt has not been reported from Alaska, Hawaii, or most of the western United States including Arizona, California, Colorado, Montana, Nevada, Oregon, Utah, and Wyoming (CDFA Database, 2022; Pepper, 1967). The pathogen has not become established in Idaho or Washington although it was reported in 1920 in Washington and on a few plants in Idaho in 1964. Failure of the pathogen to persist in these areas is presumably due to dry climatic conditions and absence of the corn flea beetle (Pepper, 1967).

Pantoea stewartii subsp. *stewartii* (*Pss*) is a facultative anaerobic, Gram-negative, nonflagellate, nonspore-forming, rod-shaped bacterium. Pathogenicity is related to the production of extracellular polysaccharides that contribute to occlusion or plugging of xylem vessels (Pataky, 2004). *Pss* primarily infects sweet corn and has been used extensively to study how xylem-dwelling bacteria establish themselves and incite disease in their hosts. It has been an excellent model for understanding quorum sensing signals and controlled gene regulation and expression in a plant-pathogenic bacterium. As a member of the Erwiniaceae, the plant interactions of *Pss* may be extrapolated to other related plant pathogenic bacteria, such as *Erwinia, Dickeya* and *Pectobacterium* spp., or human pathogens associated with plants, such as *Escherichia coli* and *Salmonella* spp. (Roper, 2011).

Stewart's wilt is vectored by the corn flea beetle (*Chaetocnema pulicaria*). The bacteria overwinter in the gut of the adult beetles (Correa et al., 2008). When it emerges in the spring, the beetle deposits bacterial cells with its feces into the feeding wounds it causes on corn plants (Claflin, 2000). Plant-to-plant spread is accomplished only by the movement of corn flea beetles and disease incidence is correlated directly with the number of beetles present in the corn fields (Claflin, 2000; Menclas et al., 2006).

Stewart's wilt infection occurs with two major cycles during the growing season. The first cycle starts when the emerged overwintering adult beetles transmit the bacteria to young corn seedlings. This is the most damaging cycle because the corn is most vulnerable at the seedling stage. The plants usually die when infected at the seedling stage. The second cycle of infection happens when the bacteria are transmitted by the first summer generation of the insect that have acquired the bacterium from feeding on infected plants. The timing of the emergence of first summer generation coincides with reduced susceptibility of the corn plant after tasseling. Plants infected at this stage usually only develop leaf blight symptoms of Stewart's wilt and do not develop wilting as the seedlings do. There is a second generation of corn flea beetles that occurs 4–6 weeks later than the first generation, and subsequent generations may lead to late season infections, which also only progress to the leaf blight stage (not to wilting). The last beetle generation of the season acquires the bacterium from infected plants and overwinters with it (Pataky, 2004).

There are no official records of *C. pulicaria* in California although there are sporadic and rare reports of its presence in several counties from multiple unofficial sources (A. Tishechkin, pers. comm). The desert flea beetle, *C. ectypa*, is present in California and reportedly spreads both *P. ananatis* and *P. stewartii* during the hot months of July and August in the desert Southwest in sudangrass (Guerrero, 2008).

Hosts: Coix lacryma-jobi (adlay millet), *Dracaena sanderiana* (lucky bamboo), *Oryza sativa* (rice), *Saccharum* sp. (sugarcane), *Setaria helvola* (yellow foxtail), *Tripsacum dactyloides* (eastern gamagrass), *Zea mays* (corn), *Zea mexicana* (teosinte), *Zea perennis* (perennial teosinte) (EPPO, 2022).

Symptoms: The seedling wilt phase occurs when young plants are infected systemically. Leaf tissue surrounding beetle feeding wounds initially becomes water soaked. Pale green to yellow linear streaks with irregular or wavy margins develop parallel to leaf veins. These lesions become necrotic with age and may extend the entire length of the leaf on susceptible cultivars. When plants are infected systemically, symptoms appear on new leaves emerging from the plant whorl, and cavities may form in the stalks near the soil line. If infection occurs when seedlings are emerging, main stalks can be killed which may result in profuse growth of tillers. Main stalk death probably results from infection of the primary growing point when flea beetles transmit the pathogen while feeding on emerging coleoptiles (the tissue sheathing the first true leaf) or very young seedlings Bacteria spread throughout the vascular system of systemically infected plants and occasionally infect the kernels. In resistant cultivars, symptoms usually are limited to within 2 to 3 cm surrounding beetle feeding wounds, and systemic infection occurs rarely.

The leaf blight phase occurs when plants are infected after the seedling stage. Foliar symptoms of the leaf blight phase are like those of the seedling wilt phase. Chlorotic or necrotic tissues may extend the entire length of leaves, or symptoms may be limited to a few centimeters depending on the susceptibility of the cultivar. Premature leaf death due to Stewart's wilt may predispose the weakened plant to stalk rot, resulting in reduced yields (Pataky, 2004; Claflin, 2000).

Transmission: Infected seed is thought to be unimportant in the epidemiology of Stewart's wilt in areas where the disease is endemic; however, the bacterium can be actively excluded from areas where it does not already occur by ensuring that the seed is pathogen-free. The probability of transmitting *Pss* in seed is extremely low, but over 60 countries place some type of quarantine restriction on corn seed to prevent the introduction of the pathogen to new areas (EPPO, CABI, 2022). Corn flea beetles transmit the pathogen while feeding on corn. They create wounds on the plants and since the pathogen resides in the beetle's alimentary tract, it is present in their feces and regurgitated materials that are left behind. The bacteria are unable to spread from plant to plant without the vector (Pataky, 2004).

Damage Potential: Stewart's wilt is a serious bacterial disease in parts of the United States where it has become established, where it substantially reduces yields of susceptible crops of sweet and dent corn. Yield losses in sweet corn are related to systemic infection. Infection of susceptible varieties at the young seedling stage leads to rapid wilting and death of the plant, whereas infections that occur in more mature plants later in the season result primarily in vascular chlorosis and necrosis with little wilting but pronounced stunting of growth.

Losses are minimal in resistant and moderately resistant hybrids. For susceptible varieties, losses frequently range from 40% to 100% when sweet corn grown with large populations of corn flea beetles is infected prior to the 5-leaf stage (Pataky, 2004). There are quarantine restrictions placed on seed producers to prevent the movement of the bacterium into areas in which it does not occur (Michener et al., 2002).

Worldwide Distribution: Argentina, Benin, Bolivia, Canada, China, Costa Rica, Guyana, India, Jordan, Korea, Republic, Malaysia, Mexico, Peru, Philippines, Puerto Rico, Russia, Thailand, Togo, United States of America (*Alabama, Arkansas, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Mississippi, Missouri, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Dakota, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Vermont, Virginia, West Virginia, Wisconsin*).

Official Control: *Pantoea stewartii* subsp. *stewartii* is on the EPPO's A1 list for Azerbaijan, Bahrain, Brazil, China, Eurasian Economic Union (EAEU), East Africa, Egypt, European Union, Georgia, Inter-African Phytosanitary Council (IAPSC), Kazakhstan, Russia, Southern Africa, Turkey, Ukraine, United Kingdom, Uruguay, and Uzbekistan. It is on the A2 list for Asia and Pacific Plant Protection Commission (APPPC), Comite de Sanidad Vegetal del Cono Sur (COSAVE), European Plant Protection Organization (EPPO), Jordan, and the Pacific Plant Protection Organization (PPPO). It is a quarantine pest for Belarus, Israel, Mexico, Moldova, Morocco, New Zealand, and Tunisia (EPPO, 2022).

Pantoea stewartii subsp. *stewartii* is on the USDA PCIT's harmful organisms list for China, Eurasian Customs Union, European Union, India, Islamic Republic of Iran, Jordan, Morocco, New Zealand, United Kingdom and Uruguay (USDA, 2022). It is listed as *Pantoea stewartii* pathovar *stewartii* for Egypt, Israel, and the United Arab Emirates. Additionally, the following countries list *Pantoea stewartii* without a subspecies or pathovar designation on their harmful organisms list: Argentina, Bosnia and Herzegovina, Brazil, Colombia, Ecuador, French Polynesia, Guatemala, Honduras, India, Japan, Madagascar, Mexico, Morocco, Nepal, New Zealand, Nicaragua, Panama, Paraguay, Republic of North Macedonia, Taiwan, Turkey, Uruguay, and Viet Nam (USDA PCIT, 2022).

California Distribution: There is a report of *Pantoea stewartii* (without a subspecies designation) infecting sudangrass (*Sorghum sudanense*) in commercial fields in the Imperial Valley (Azad et al., 2000).

California Interceptions: None

The risk *Pantoea stewartii* subsp. *stewartii* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** Although the disease has been reported infrequently from various parts of the world, the bacterium has never become established outside of where the vector occurs. In models developed for the mid-west, if the average daily temperature for December through February is above freezing, >1°C, corn flea beetles survive, and Stewart's wilt is likely to be severe on susceptible hybrids. If the average daily temperature is less than -3°C, flea beetles are not likely to survive, and it is unlikely that Stewart's wilt will be severe.

   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 is mainly *Zea* spp. with a few other grasses.

Evaluate the host range of the pest.

Score: 1

- 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:** The pathogen only spreads at a low rate with infected seed, or through the feeding action of its vector

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:** Stewart's wilt can cause high losses when susceptible sweet corn varieties are fed upon by corn flea beetles while they are seedlings. The disease is less damaging as the plants age and is highly correlated to the population size of the vector. It is a quarantine pest with seed under phytosanitary regulation in many countries.

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

Economic Impact: A, C, E

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 limited host range, none are expected.

Evaluate the environmental impact of the pest to California using the criteria below

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 *Pantoea stewartii* subsp. *stewartii:* Medium

Add up the total score and include it here. **9**
-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 '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 =* ***9***

Uncertainty:

Several other monocot species have been reported to serve as hosts of *P. stewartii*, including sudangrass, oats and triticale, sorghum, millet, and sugarcane (Azad et al., 2000; Claflin, 2000). The *P. stewartii* isolates from infected sudangrass in the Imperial Valley were pathogenic when inoculated on corn, although the disease progressed beyond the lesion stage, it never induced wilting in the corn plants (Azad et al., 2000). It should be emphasized that the isolates were not characterized to the subspecies level and did not produce symptoms of Stewart's wilt during inoculation studies.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for *Pantoea stewartii* subsp. *stewartii* is B.

References:

Azad, H.R., Holmes, G.J. and Cooksey, D.A., 2000. A new leaf blotch disease of sudangrass caused by *Pantoea ananas* and *Pantoea stewartii*. Plant Disease, 84(9), pp.973-979.

CABI Crop Production Compendium 2022. https://www.cabi.org/cpc/datasheet/21939. Accessed 6/30/22

Claflin, L.E. 2000. Stewart's bacterial wilt. In: Compendium of Corn Diseases (White, D.G., ed.), pp. 3–4. St. Paul, MN: The American Phytopathological Society.

Correa, V.R., Majerczak, D.R., Ammar, E., Merighi, M., Coplin, D.L., Pratt, R.C., Redinbaugh, M.G. and Hogenhout, S.A., 2008. Characterization of a *Pantoea stewartii* TTSS gene required for persistence in its flea beetle vector. Phytopathology, 98, p.S41.

EPPO Global Database. 2022. https://gd.eppo.int/taxon/ERWIST Accessed 6/30/22

Freeman, N.D., and Pataky, J.K. 2001. Levels of Stewart's wilt resistance necessary to prevent reductions in yield of sweet corn hybrids. Plant Dis.85: 1278-1284

Guerrero, J.N., 2008, December. Sudangrass quality and yield traits: what to look for. In Proceedings, Alfalfa & Forage Symposium and Western Seed Conference (pp. 2-4).

Michener, P.M., Pataky, J.K. and White, D.G. 2002. Rates of transmitting *Erwinia stewartii* from seed to seedlings of a sweet corn hybrid susceptible to Stewart's wilt. Plant Dis.86, 1031-1035

Pepper, E. H., 1967. Stewart's bacterial wilt of corn. In: Monographs. American Phytopathology Society, (4). 36 pp.

Robert, A.L. 1955. Bacterial wilt and Stewart's leaf blight of corn. USDA Farmer's Bull. No. 2092

Roper, M.C., 2011. *Pantoea stewartii* subsp. *stewartii*: lessons learned from a xylem ‐ dwelling pathogen of sweet corn. Molecular plant pathology, 12(7), pp.628-637.

Pataky, J.K. 2004. Stewart's wilt of corn. The Plant Health Instructor. DOI:10.1094/PHI-I-2004-0113-01. Available at: http://www.apsnet.org/edcenter/intropp/lessons/prokaryotes/Pages/StewartWilt.asp

Stewart, F.C. 1897. A bacterial disease of sweet corn. N. Y. Agric. Exp. Sta.Bull.130, 422–439.

USDA Phytosanitary Certificate Issuance and Tracking System, Phytosanitary Export Database (PExD) Harmful Organisms Database Report. *Pantoea stewartii*. Accessed 2/26/2022

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.

---

*Comment Period: 07/29/2022 through 09/12/2022

*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 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