CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Profile for

Dickeya chrysanthemi (Burkholder et al., 1953) Samson et al., 2005

Bacterial wilt

Pest Rating: C

Domain: Bacteria; Phylum: Proteobacteria

Class: Gammaproteobacteria; Order: Enterobacteriales

Family: Enterobacteriaceae

Comment Period: 6/30/2020 through 8/14/2020

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 *Dickeya chrysanthemi* (syn= *Erwinia chrysanthemi* pv. *chrysanthemi*) is given herein and a permanent pest rating is proposed.

History & Status:

Background:

Plant-pathogenic bacteria that belong to the family Enterobacteriaceae were originally classified into one genus named *Erwinia* by Winslow et al. (1920). *Erwinia* spp. that can produce large quantities of pectolytic enzymes, macerate parenchymatous tissue of plants, and cause "soft rots" were moved into a separate genus, *Pectobacterium,* by Waldee (1945). New *Pectobacterium* and *Erwinia* species, subspecies, varieties, biovars, pathovars, and formae speciales were subsequently named by plant pathologists as strains were isolated from different host plants. Dye (1969) studied their phenotypic

---

characteristics and showed they were almost all synonyms and proposed using only one species name, *E. carotovora*, including three varieties: *atroseptica*, *carotovora*, and *chrysanthemi*.

This classification system largely held until early DNA studies by Lelliott and Dickey (1984) reinstated two distinct species: *E. carotovora* and *E. chrysanthemi*. Because at least 60 different host plants were already known to be infected by *E. chrysanthemi,* a biovar (strains that differ physiologically or biochemically from other strains in a particular species) and serogroup (strains that have different antigenic properties) system was proposed by Samson et al. (1987) to replace the pathovar (strains with distinctive pathogenicity to one or more plant hosts) system. Young et al. (1996) detailed six new pathovars below *E. chrysanthemi*: pv. *chrysanthemi*, pv. *dianthicola*, pv. *dieffenbachiae*, pv. *paradisiaca*, pv. *parthenii*, and pv. *zeae* and dropped the biovars and serogroups. Using phylogenetic analysis, Hauben et al. in 1999 synonymized *E. carotovora* with *E. chrysanthemi* and moved it to the genus *Pectobacterium* as *P. chrysanthemi*. In 2005, Samson et al. transferred some members of *P. chrysanthemi* to a new genus named *Dickeya* based on phylogenetic analysis of 16S rDNA sequences, DNA:DNA hybridization, phenotypic traits and biochemical and serological characteristics.

Today, the preferred name for the pathogen that causes bacterial wilt of chrysanthemum (and soft rot and wilt of many other plants) is *Dickeya chrysanthemi*, but the taxonomic history of this species is complex. Over the past 100 years, different species, subspecies, biovar, and pathovar names have been applied to the species. *Dickeya chrysanthemi* can be separated by sequence analysis from other *Dickeya* spp. (Marrero et al., 2013) and from *Pectobacterium carotovora*, another soft rotting bacterium of regulatory significance.

Hosts: Aechmea fasciata (silver vase plant), *Aglaonema commutatum*, *Aglaonema modestum*, *Aglaonema pictum* (camouflage plant), *Allium cepa* (onion), *Allium fistulosum* (Welsh onion), *Ananas comosus* (pineapple), *Anemone* (anemone), *Apium graveolens* (celery), *Begonia* hybrids (begonia), *Brassica rapa* subsp. *chinensis* (bok choy), *Capsicum* spp. (pepper), *Cenchrus purpureus* (napier grass), *Cichorium intybus* (common chicory), *Colocasia esculenta* (taro), *Cyclamen persicum* (Persian cyclamen), *Daucus carota* subsp. *sativus* (carrot), *Dendranthema* x *grandiflorum* (florist's chrysanthemum), *Dianthus caryophyllus* (carnation), *Dahlia* hybrids (dahlia), *Dianthus* (dianthus), *Dieffenbachia maculata* (dumb cane), *Dracaena marginata* (dragon tree), *Euphorbia pulcherrima* (poinsettia), *Elettaria cardamomum* (true cardamom), *Hyacinthus orientalis* (common hyacinth), *Hylotelephium spectabile* (live-forever), *Ipomoea batatas* (sweet potato), *Kalanchoe blossfeldiana* (florist's kalanchoe), *Leucanthemum vulgare* (ox-eye daisy), *Medicago sativa* (alfalfa), *Musa* x *paradisiaca* (plantain), *Nicotiana tabacum* (tobacco), *Opuntia* spp. (prickly pear), *Oryza sativa* (rice), *Parthenium argentatum* (guayule), *Pelargonium* spp. (geranium), *Phalaenopsis* hybrids (moth orchid), *Philodendron* spp. (philodendron), *Pinellia ternate* (crow-dipper), *Polyscias filicifolia* (angelica), *Raphanus sativus* (radish), *Rhynchostylis gigantea* (foxtail orchid), *Saccharum officinarum* (sugar cane), *Schefflera* sp. (schefflera), *Solanum lycopersicum* (tomato), *Solanum tuberosum* (potato), *Sorghum bicolor* (sorghum), *Streptocarpus ionanthus* (African violet), *Syngonium podophyllum* (arrowhead plant), *Tulipa* hybrids (tulip), *Urochloa eminii* (Surinam grass), *Urochloa maxima* (Guinea grass), *Urochloa mutica* (buffalo grass), *Zantedeschia* spp. (calla lily), and *Zea mays* (corn).

Symptoms: Soft rotting bacteria including *Erwinia*, *Pectobacterium,* and *Dickeya* produce enzymes able to degrade plant cell wall components. Pectinases produced by these bacteria are believed to be the most important factor for pathogenesis. They macerate tissue by degrading the pectic substances in the middle lamella and are indirectly responsible for cell death. The invaded tissues become soft and are transformed into a slimy mass consisting of bacteria swimming in the liquefied plant cell contents. The epidermis of most plants is not directly attacked by the bacteria; however, if cracks are present, the slimy mass can extrude through them into the soil or in storage. If the slime meets other fleshy organs, they can be infected (Agrios, 2005).

Wilting occurs on hosts such as chrysanthemum, carnation, dahlia, and poinsettia when *D. chrysanthemi* spreads into the plant's vascular system. Wilting due to root rot occurs on some hosts and leaves of systemically infected plants can show light and dark mottles. Soft rot spots appear on leaves and petioles of some hosts including *Aechmea, Philodendron*, and *Syngonium*, on stems of tomato and tobacco seedlings, and on fruits of bananas. Top rot of maize stalk appears as a wilting of the whorl, where the cluster of leaves can easily be pulled off because of soft rotting at the base. Succulent storage plant organs such as tubers or fleshy roots are reduced to a pulpy mass by soft rot in the field but are first noticed as a wilting of the aerial parts of the host. Under unfavorable dry weather conditions, infected leaves wither and finally dry up without showing soft rot symptoms (Agrios, 2005, CABI-CPC, 2020). Bacterial wilt caused by *D. chrysanthemi* could be confused with wilting symptoms caused by fungal pathogens, such as species of *Fusarium* or *Verticillium*. Soft rot in the field can be confused with other pectinolytic bacterial pathogens, such as *P. carotovora*.

Transmission: Dickeya chrysanthemi appears to mainly be a soil-borne pathogen. It survives between crops by infecting alternative weed host plants, especially in tropical regions. It is commonly found in association with plant residues. It has been be isolated from water and can infect plants via contaminated irrigation water (Cother and Gilbert, 1990). Dispersal within and between crops can also occur with contaminated wind-driven water splashing and aerosols.

The pathogen survives in infected fleshy organs in storage and in the field, in debris, on roots, stems and leaves. Some tubers, rhizomes, and bulbs become infected through wounds or lenticels after they are formed in the soil and the disease may first appear on daughter plants grown from previously infected propagules. Soft-rot bacteria can move with different stages of several insects. The bodies of maggots can become contaminated with bacteria when they crawl around on rotting seed pieces and move to clean pieces. Flying insects can carry *D. chrysanthemi* to healthy plants and put them directly into wounds where they can cause new infections (Agrios, 2005).

Infected planting material transmits the pathogen to new areas. Cuttings of carnation, dahlia, dieffenbachia, and chrysanthemum and tubers of dahlia and potato can be internally infected with bacteria inside their vascular bundles. The disease can also spread with contaminated cutting knives or with people during handling, including pruning, cutting, and harvesting. Wounded, soft succulent tissues like stem cuttings are most susceptible (Burkholder et al., 1953; McGovern et al., 1985; Serfontein et al., 1991).

Damage Potential: Dickeya chrysanthemi has the potential to damage any plant part including roots, stems, leaves, and storage organs, depending on host resistance and favorable environmental conditions. Plants can be killed by the soft rotting habit or lethal wilting from bacteria inside the vascular system. Storage rots can occur when bacteria continue to grow and spread from infected to healthy tubers, post-harvest. High economic losses of potato have been reported in Europe when *D. chrysanthemi* was introduced with contaminated potato seed pieces (Sławiak et al., 2009). It causes serious losses as bacterial heart rot of pineapple in Hawaii (Kaneshiro et al., 2008) and can be very damaging to vegetatively propagated tropical foliage plants in greenhouses, especially in the summer under high temperatures (Norman, 2017). Use of clean stock practices, including tissue culture and indexing, has greatly reduced losses for ornamental plant propagators.

Worldwide Distribution: Africa: *Algeria, Comoros, Congo, Cote d'Ivoire, Egypt, Morocco, Reunion, South Africa, Sudan,* and *Zimbabwe*; Americas: *Aruba, Bolivia, Brazil, Colombia, Costa Rica, Cuba, Ecuador, French Guiana, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Panama, Peru, Puerto Rico, Saint Lucia, United States* (California, Colorado, Connecticut, Florida, Georgia, Massachusetts, Minnesota, Nebraska, New York, North Carolina, North Dakota, Ohio, Pennsylvania, South Dakota, Texas, Virginia, and Wisconsin), and *Venezuela*; Asia: *Bangladesh, China, India, Iran, Israel, Japan, Japan, Democratic People's Republic of Korea, Republic of Korea, Malaysia, Myanmar, Nepal, Philippines, Saudi Arabia, Sri Lanka, Syria,* and *Taiwan*; Europe: *Austria, Belarus, Belgium, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Netherlands, Norway, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Spain, Sweden, Switzerland,* and *United Kingdom*; Oceana: *Australia, Cook Islands, New Zealand, Papua New Guinea,* and *Solomon Islands.*

Official Control: EPPO: A1 list Egypt, A2 list RPPO/EU, Quarantine pest Israel, Morocco, Norway. USDA PCIT Harmful organism list: Argentina, Chile, China, Ecuador, European Union, French Polynesia, Guatemala, Holy See (Vatican City State), Iceland, India, Indonesia, Israel, Jamaica, Jordan, Mexico, Monaco, Morocco, Namibia, New Caledonia, Norway, Panama, San Marino, Serbia, South Africa, Taiwan, and Timor-Leste.

California Distribution: Multiple pest detection reports on tropical foliage plants from southern and central coastal counties of California (French, 1989).

California Interceptions:

The risk *Dickeya chrysanthemi* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:**

Dickeya chrysanthemi has most often been associated with tropical crops and climates. In California, detections have been limited to greenhouse-grown tropical foliage plants.

Evaluate if the pest would have suitable hosts and climate to establish in California.

Score: **1**

- 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 *D. chrysanthemi* is very large including many agronomic and ornamental hosts

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, bacteria increase at an exponential rate. Dry conditions slow or stop their multiplication and spread.

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:**

Soft rotting bacteria can be internal to the plants and difficult to detect pre-planting. Once inside vegetatively propagated stock, they are difficult to eliminate. Soils and irrigation systems can become contaminated and both can spread the pathogen. It can be transmitted by multiple types of insects.

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

Economic Impact: A, 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:** There have been no detections of *D. chrysanthemi* in the environment in California, but it has been found in waterways and irrigation systems in Australia and Europe.

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 *Dickeya chrysanthemi* is Medium:

Add up the total score and include it here. **10**
-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'. The pathogen has been reported in multiple southern and central coast counties, from greenhouse grown ornamentals.

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* **= 8**

Uncertainty:

This pathogen mainly occurs in more tropical climates and on tropical crops. However, more cold-tolerant strains have been observed in related species and could pose a risk to temperate crops.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for *Dickeya chrysanthemi* is C.

References:

Agrios, G. N. 2005. Plant Pathology, 5th Edition. Elsevier Academic Press. 922 pg

Burkholder, W. H., McFadden, L. A., and Dimock, A. W. 1953. A bacterial blight of chrysanthemums. Phytopathology, 43:522-526.

CABI Crop Production Compendium 2020. *Dickeya chrysanthemi*. https://www.cabi.org/cpc/datasheet/21912. Accessed 5/13/2020

Cother, E. J., and Gilbert, R. L. 1990. Presence of *Erwinia chrysanthemi* in two major river systems and their alpine sources in Australia. Journal of Applied Bacteriology, 69(5):729-738

Dickey, R. S. 1979. *Erwinia chrysanthemi*: a comparative study of phenotypic properties of strains from several hosts and other *Erwinia* species. Phytopathology, 69(4):324-329

Dye, D. W. 1969. A taxonomic study of the genus Erwinia. III. The 'herbicola' group. New Zealand Journal of Science, 12(2):223-236.

French, A. M. 1989. California plant disease host index. CA Division of Plant Industry. 2nd Edition. 394 pg

Hauben, L., Moore, E. R. B., Vauterin, L., Steenackers. M., Mergaert, J., Verdonck, L., and Swings, J. 1998. Phylogenetic position of phytopathogens within Enterobacteriaceae. Systematic and Applied Microbiology, 21:384-397.

Kaneshiro, W.S., Burger, M., Vine, B.G., de Silva, A.S. and Alvarez, A.M., 2008. Characterization of *Erwinia chrysanthemi* from a bacterial heart rot of pineapple outbreak in Hawaii. Plant disease, 92(10), pp.1444-1450.

Lelliott, R. A., Dickey, R. S. 1984. Genus VII. *Erwinia* Winslow, Broadhurst, Krumwiede, Rogers and Smith 1920. In: Krieg, NR, Holt JG, eds. Bergey's Manual of Systematic Bacteriology. Baltimore, USA: Williams & Wilkins.

Marrero, G., Schneider, K. L., Jenkins, D. M., and Alvarez, A. M. 2013. Phylogeny and classification of *Dickeya* based on multilocus sequence analysis. International journal of systematic and evolutionary microbiology, 63(9), 3524-3539.

McGovern, R. J., Horst, R. K., and Dickey, R. S. 1985. Effect of plant nutrition on susceptibility of *Chrysanthemum morifolium* to *Erwinia chrysanthemi*. Plant Disease, 69(12):1086-1088

Norman, D. 2017. Dieffenbachia Diseases: Identification and Control in Commercial Greenhouse Operations. UF/IFAS Extension PP286. https://edis.ifas.ufl.edu/pdffiles/PP/PP28600.pdf

Samson, R., Poutier, F., Sailly, M., and Jouan, B. 1987. Characterization of *Erwinia chrysanthemi* isolated from *Solanum tuberosum* and other host plants according to biovars and serogroups. Bulletin OEPP, 17(1):11-16

Samson, R., Legendre, J. B., Christen, R., Fischer-le Saux, M., Achouak, W., and Gardan, L. 2005. Transfer of *Pectobacterium chrysanthemi* (Burkholder et al. 1953) Brenner et al. 1973 and *Brenneria paradisiaca* to the genus *Dickeya* gen. nov. as *Dickeya chrysanthemi* comb. nov. and *Dickeya paradisiaca* comb. nov. and delineation of four novel species, *Dickeya dadantii* sp. nov., *Dickeya dianthicola* sp. nov., *Dickeya dieffenbachiae* sp. nov. and *Dickeya zeae* sp. nov. International Journal of Systematic and Evolutionary Microbiology, 55(4):1415-1427.

Sławiak, M., Łojkowska, E., and Van der Wolf, J. M. 2009. First report of bacterial soft rot on potato caused by *Dickeya* sp. (syn. *Erwinia chrysanthemi*) in Poland. Plant Pathology, 58(4).

Serfontein, S., Logan, C., Swanepoel, A.E., Boelema, B. H. and Theron, D. J. 1991. A potato wilt disease in South Africa caused by *Erwinia carotovora* subspecies *carotovora* and *E. chrysanthemi*. Plant Pathology, 40(3):382-386; 20 ref.

USDA Phytosanitary Certificate Issuance and Tracking System, Phytosanitary Export Database (PExD) Harmful Organisms Database Report. Dickeya chrysanthemi. Accessed 5/13/2020

Waldee, E. L. 1945. Comparative studies of some peritrichous phytopathogenic bacteria. Journal of Iowa State College of Science, 19:435-484

Winslow, C. E. A., Broadhurst, J., Buchanan, R. E., Krumwiede, C. Jr., Rogers, L. A., Smith, G. H. 1920. The families and genera of the bacteria. Final report of the committee of the Society of American Bacteriologists on characterization and classification of bacterial types. Journal of Bacteriology, 5:191-229.

Young, J. M., Saddler, G. S., Takikawa, Y., Boer, S. H. de, Vauterin, L., Gardan, L., Gvozdyak, R. I., Stead D. E. 1996. Names of plant pathogenic bacteria 1864-1995. Review of Plant Pathology, 75(9):721-763; 10 pp.

Responsible Party:

Heather J. Scheck, Primary Plant Pathologist/Nematologist, California Department of Food and Agriculture, 204 West Oak Ave, Lompoc, CA. Phone: 805-736-8050, permits[@]cdfa.ca.gov.

***Comment Period: 6/30/2020 through 8/14/2020**

***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.

Pest Rating: C