CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Xanthomonas hortorum pv. *carotae* Vauterin, Hoste, Kersters & Swings 1995 (syn = *X. campestris* pv. *carotae*)

Bacterial blight of carrot

Current Pest Rating: C

Proposed Pest Rating: C

Kingdom: Bacteria, Phylum: Proteobacteria,
Class: Gammaproteobacteria, Order: Lysobacterales,
Family: Lysobacteraceae

Comment Period: 12/19/2022 through 02/02/2023

Initiating Event:

This pathogen has not been through the current pest rating process. The risk to California from *Xanthomonas hortorum* pv. *carotae* is described herein and a permanent rating is proposed.

History & Status:

Background:

California has four main production areas for carrots: The southern San Joaquin Valley and the Cuyama Valley (Kern and Santa Barbara counties); the southern desert (Imperial and Riverside counties); the high desert (Los Angeles County); and the central coast (Monterey County). California is the largest producer of carrots in the country, with 92% of the US crop grown on 60,000 acres. Carrots rank 18th on the list of the top 20 commodities produced in California in 2020 with a value of $657M (https://www.cdfa.ca.gov/Statistics/PDFs/2021_Ag_Stats_Review.pdf).

Xanthomonas is a genus of phytopathogenic bacteria with many species that cause diseases such as citrus canker, vascular wilts, leaf and fruit spots, and blights of annual and perennial plants. Unlike other genera of phytopathogenic bacteria that typically occupy a diversity of ecological niches, almost all *Xanthomonas* species are plant pathogens and are found only in association with plants or plant materials. Some begin their plant host associations as epiphytes, using surface polysaccharides and

forming biofilms, then transition to a pathogenic lifestyle under favorable conditions. *Xanthomonas* spp. produce xanthomonadins, pigments that protect them from natural light and which can give them yellow colors, in axenic culture. Most *Xanthomonas* species are limited in their host range and subspecific pathovar designations have been assigned to some to reflect that specificity (Agrios, 2005).

In the past, bacterial taxonomists worked from what they thought were the most important phenotypic characteristics of their strains. The taxonomy of xanthomonads was based on a single feature, host specificity, and this was used to name species. This method, over time, resulted in an unreasonable number of nomenspecies. Dye et al. (1980) drastically reduced this into one species, *X. campestris*, and developed a special use classification system below species with pathovar names for phytopathological variants. In 1995, Vauterin et al. created a new taxonomic system based on DNA homology data that considered both the genomic relationships among strains, and the needs of plant pathologists to have a rational nomenclature for practical daily use.

The earliest reports of diseases caused by *Xanthomonas hortorum* (first called *Bacterium hederae*) date back to the 1890s, with the reports describing a bacterial leaf spot and blight disease of English ivy (*Hedera helix*) in Germany (Lindau, 1894). Vauterin et al. (1995) described and separated *X. hortorum* sp. nov. from *X. campestris* with *X. hortorum* pv. *hederae* designated as the species' type strain. *Xanthomonas hortorum* was determined to be monophyletic by Morinière et al., (2020) by combining the pathovars of *X. hortorum* with *X. cynarae* (which is now *X. hortorum* pv. *cynarae* and *X. hortorum* pv. *gardneri*).

Each *X. hortorum* pathovar has its own natural host range and the experimental host ranges of multiple pathovars have been studied. Most of the reported natural hosts of *X. hortorum* belong to the Geraniaceae, Araliaceae, and Asteraceae families. *Xanthomonas hortorum* pv. *carotae* is primarily known as a pathogen of carrots and cilantro (Apiaceae).

Bacterial blight of carrot was first described in 1931 in California (Kendrick, 1934). The disease occurs in Africa, Asia, Australia, Europe, North and South America, but is particularly important in North America. Warm and humid conditions especially with sprinkler irrigation, favor disease development. *Xanthomonas hortorum* pv. *carotae* is seedborne and a quarantine pest in many countries (CABI-CPC, 2022). Infections can occur on roots, foliage, stems, umbels, and seed with the primary symptom as leaf blight.

Leaf blights on carrots can be caused by several pathogens and can be difficult to identify in the field. Two fungal diseases, Alternaria leaf blight (*Alternaria dauci*), and carrot early blight (*Cerocospora carotae*), also appear as dark brown to black necrotic lesions along the margins of the leaves and on the petioles. Bacterial blight symptoms are similar except the lesions are not as dark and may be surrounded by a yellow halo. Bacterial oozing may also be seen from the lesions under optimal conditions (Nunez et al., 2012).

Hosts: Coriandrum sativum (coriander, cilantro), *Daucus carota* (wild carrot, Queen Anne's lace), *D. carota* subsp. *sativus* (cultivated carrot) (CABI-CPC, 2022).

Symptoms: Symptoms of bacterial blight initially appear as small, yellow, angular, water-soaked lesions on leaves. These expand to water-soaked lesions that may become a greasy green, black color or a tan color as they dry. The center of these areas becomes dry and brittle causing irregular spots typically surrounded by an irregular yellow halo. Additional symptoms include dark-brown streaks on the petioles, peduncles, and stems, as well as blight of some or all the flowers and a gummy bacterial exudate may develop. Lesions are commonly observed at the 'V'-shaped junction of leaf lobes. Entire leaflets may be affected or only the divided leaf segments. Microscopic examination of symptomatic leaf sections will reveal bacterial streaming from the cut ends of each leaf piece (Toit et al., 2005; Toit et al., 2014; Gilbertson, 2002).

Additionally, the pathogen can cause a blighting of floral parts. Umbel infection usually takes place just before or after the umbel expands. The entire umbel may be killed if infection occurs early, with no seed produced. Infections of more mature umbels result in partial blighting. The disease may develop in an asymmetric pattern and may be confined to one side of the plant. When the bacteria blight the peduncle, the umbel curves downward on the infected side. Around the base of the infected umbellet's flowers, copious sticky exudate may appear. During severe disease outbreaks, the entire umbel can be encased in a mass of exudates (Gilbertson, 2002).

Transmission: The bacterium can survive on and is spread short and long-distances on and in carrot seeds. *Xanthomonas hortorum* pv. *carotae* can persist in infected plant residues in the soil for up to a year (Gilbertson, 2002). Within a field, splashing water, insects, and machinery also disperse *X. hortorum* pv. *carotae*. Water is necessary for infection to occur, with the pathogen reproducing most rapidly under warm and wet conditions. Symptoms can appear within 10 to 12 days of infection (Scott and Dung, 2020).

Damage Potential: Infection of seed can reduce germination, resulting in significant losses to seed production, with infected seed lots being rejected from some markets (CABI-CPC, 2022). Seed yield may then be affected, and seed may be infected internally or contaminated on the surface. Disease development is highly dependent on environmental factors, but once established, it can be difficult to manage. The use of pathogen-free seed is an important management strategy (Umesh et al., 1998). In most carrot-growing areas, bacterial blight loss does not warrant chemical control. In a few areas of California, such as the Antelope Valley, severe outbreaks may occur (Nunez et al., 2016).

Worldwide Distribution: Africa: *Mauritius, South Africa*; Americas: *Brazil, Canada, United States of America* (California, Idaho, Indiana, Iowa, Oregon, Washington, Wisconsin); Asia: *Japan, Kazakhstan, Republic of Korea*; Europe: *Italy, Poland, Russia*; Oceania: *Australia*.

Official Control: *Xanthomonas hortorum* pv. *carotae* is on the USDA PCIT's Harmful Organism list for Chile, Colombia, Costa Rica, Ecuador, Egypt, Guatemala, Honduras, India, Israel, Jordan, Mexico, Morocco, Nicaragua, Panama, Peru, Philippines, and Taiwan, the EPPO's A1 list for Egypt and Chile, and the A2 list for Jordan.

California Distribution: Older official records list the distribution in California as Valley North, Valley South, and Coast South. CDFA's PDR database has records in Monterey and Santa Barbara counties. Published University of California reports include Kern, Los Angeles, Santa Barbara, and Yolo counties (Barak and Gilbertson, 2003).

California Interceptions: none

The risk *Xanthomonas hortorum* pv. *carotae* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** This pathogen is widespread in the carrot growing regions that include the coast, the Central Valley, and the high desert.

   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 is limited to a few members of Apiaceae.

   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:** Xanthomonads can reproduce at a nearly exponential rate under ideal environmental conditions. This pathogen is highly dependent on water to reproduce and spread, and epidemics can occur with sprinkler irrigation

   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:** This is mainly an issue for seed exporters. The impact in production fields is generally below the threshold for treatment, but seed lots can be rejected if this pathogen is detected by seed wash or field inspection of mother plants (CDFA Field Inspection Manual https://www.cdfa.ca.gov/plant/pe/nsc/docs/seed/CPTM-PhytosanitaryFieldInspectionCropLists.pdf)

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

Economic Impact: A, B, C, 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: This disease impacts cultural practices and sprinkler irrigation should be minimized and foliage allowed to dry. Seed treatments are often used but they can lower germination rates.

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

Environmental Impact: 2

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 *Xanthomonas hortorum* pv. *carotae:* 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**: 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'.

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* ***= 8***

Uncertainty:

The taxonomy of *X. hortorum* is under revision and strains that attack carrots could be re-assigned to new or different pathovars in the future.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for *Xanthomonas hortorum* pv. *carotae* is C.

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Responsible Party:

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***Comment Period: 12/19/2022 through 02/02/2023**

***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: C
