CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Xanthomonas campestris pv. *armoraciae* (McCulloch) Dye 1978

Bacterial leaf spot of crucifers

Current Pest Rating: Z

Proposed Pest Rating: C

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

Comment Period: 07/12/2021 through 08/26/2021

Initiating Event:

In April 2021, a Santa Barbara County agricultural inspector submitted a sample of cauliflower leaves from an export seed field to CDFA's Plant Pest Diagnostics Center in Meadowview. The leaves had symptoms of a bacterial leaf spot disease. *Xanthomonas campestris* pv. *armoraciae* (Xca) was detected in culture and was confirmed by PCR, DNA sequencing, and phylogenetic analysis by CDFA plant pathologist Sebastian Albu. He assigned it a temporary Z rating.

It is difficult to discriminate between pathovars that cause leaf spot diseases on brassicas. In the past, isolates have been identified as either *X. campestris* pv. *raphani* (Xcr) which causes a non-vascular disease like Xca, or as *Xanthomonas campestris* pv. *campestris* (Xcc) which causes systemic, vascular black rot, but can also cause spots on leaves of *Brassica* spp. Comparisons with other isolates in our collections has revealed that Xca has been found previously in California causing disease on broccoli, cauliflower, and kohlrabi. The risk to California from *Xanthomonas campestris* pv. *armoraciae* is described herein and a permanent rating is proposed.

History & Status:

Background: The majority of xanthomonad bacteria are plant pathogens. They are found in tropical and temperate climates. They live as plant pathogens and epiphytes and can survive only a short time in the soil. A bacterial leaf spot pathogen was first reported as *Bacterium campestris* var. *armoraciae* and named after the initial host, *Armoracia rusticana* (horseradish), in Ohio by McCulloch (1929). There

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are other closely related pathovars of *X. campestris* that cause similar leaf spots on brassicas including *aberrans, armoraciae, barbarae, campestris, incanae*, *and raphani* (Vincente et al., 2006; Wetcher et al., 2008; Berg et al., 2005).

Hosts: Members of the family Brassicaceae including *Armoracia rusticana* (horseradish), *Brassica oleracea* varieties (cabbage, broccoli, cauliflower, kale, Brussels sprouts, collard greens, Savoy cabbage, and kohlrabi), *Brassica rapa* varieties (turnip, spinach mustard), *Iberis* sp. (candytuft), and *Raphanus sativus* (radish).

Symptoms: Typical symptoms on leafy brassicas include small, necrotic water-soaked leaf spots, at first visible only on the undersides but soon visible on both leaf surfaces, bordered by a distinct margin. These spots become olive green lesions with a yellow halo. The expanding lesions are eventually limited by the large leaf veins. The veins in the immediate area may blacken, although invasion of the vascular system does not follow. They can form black, sunken, and elongated lesions on stems and petioles, and young plants may be killed rapidly. The symptoms are not diagnostic and closely resemble those of bacterial leaf spot of cauliflower caused by *Pseudomonas syringae* pv. *maculicola*, and other pathovars of *X. campestris* (Zhau et al., 2000; Kamoun et al., 1992).

Radish foliage in Ohio developed numerous small, circular, water-soaked black spots, eventually with yellow halos on the underside of the leaves, giving the foliage a yellowish, ragged appearance. Spots were also visible on the upper surface of leaves and on petioles (Sahin and Miller, 1997).

Transmission: Black rot can enter the field on transplants or seeds and can stay in the soil for over a year, where it survives on infected crop debris that breaks down slowly. The bacteria can be carried within the seed, often attached to the funiculus, or on the outside of the seed, just associated with the surface (Cook et al., 1952). Both infected and infested seeds can develop disease and act as a reservoir of infection for surrounding plants.

Pathogen movement within the field is with water – from rain or irrigation. Xca enters the plant through natural openings such as hydathodes, stomates, or wounds caused by hail, insects, and mechanical injuries. It can also be spread by workers and equipment moving through the field. Many brassicaceous weeds are susceptible to black rot and must be removed to prevent continued contamination of crop plants (Koenraadt et al., 2017).

Damage Potential: Black rot of crucifers caused by *X. campestris* pathovars is a worldwide problem of economic significance and can cause considerable yield loss (Zhao et al, 2000; Sahin and Miller, 1997). Pathovar *campestris* has received a B-rating; https://blogs.cdfa.ca.gov/Section3162/?p=6691 due to its severity and wider status as a quarantine pathogen for seed. Xca is also seed borne. However, it does not cause a systemic rot; it is a leaf spotting pathogen that does not become systemic inside the plant.

Worldwide Distribution: Africa: *Zimbabwe*. Asia: *China, India, Japan, Turkey*. Europe: *Ukraine*. North America: *United States* (California, Connecticut, Delaware, District of Columbia, Florida, Illinois, Iowa, Louisiana, Maryland, Missouri, North Carolina, Ohio, Oklahoma, Texas, Virginia). Oceania: *Australia*. South America: *Brazil*

Official Control: Xca is on the EPPO's list of quarantine pests for Mexico, and on the USDA's harmful organism list for Indonesia, Mexico, Panama, Taiwan, Thailand, and Timor-Leste (EPPO, 2021; USDA PCIT, 2021).

California Distribution: There is one official record from Santa Barbara County, but isolates from previous detections in that county that were originally assigned a different pathovar have been re-examined and match with Xca. There are reports published by University of California plant pathologists of detections of Xca from brassicas in California in 1992 (Barak and Gilbertson, 2003).

In the past, the diagnosis of black rot did not always include a pathovar designation, so the diagnosis could have been for any of the pathovars: *campestris, raphani*, or *armoraciae*, or a combination of these.

California Interceptions: none

The risk *Xanthomonas campestris* pv. *armoraciae* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** This pathogen is likely to be found everywhere its hosts can grow. In general, brassicas prefer a cooler climate and are primarily grown in coastal parts of the state

   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 natural host range is limited to brassicas.

   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:** This pathogen reproduces at an exponential rate under ideal environmental conditions, dispersed with water and with 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:** Black rot diseases of crucifers are very damaging to vegetable yields, especially where the leaves are the edible part of the crop. They are spread by water and can be quarantine pests for seed.

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

Economic Impact: A, 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:** No impacts have been reported, but there are native and naturalized brassicas that could be hosts.

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

Environmental Impact: A

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 campestris* pv. *armoraciae:* 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 '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: (Score)

Final Score: *Score of Consequences of Introduction – Score of Post Entry Distribution and Survey Information* ***= 9***

Uncertainty:

Some prior detections of leaf spotting *Xanthomonas* on brassicas may have been incorrectly identified as pv. c*ampestris* instead of pv. *amoraciae* as they cause similar symptoms. In the past, diagnosticians had to inoculate different host to discriminate among pathovars and results could be ambiguous. More accurate molecular methods are now being utilized, although they require advanced skills to employ.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for *Xanthomonas campestris* pv. *armoraciae* is C.

References:

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Responsible Party:

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***Comment Period: 07/12/2021 through 08/26/2021**

***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
