cdfa CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Streptomyces scabiei (ex Thaxter 1892) Lambert & Loria, 1989

Common scab

Current Pest Rating: C

Proposed Pest Rating: C

Kingdom: Procaryotae; Division: Firmicutes

Class: Thallobacteria; Order: Actinomycetales

Family: Streptomycetaceae

Comment Period: 3/16/2020 through 4/30/2020

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 *Streptomyces scabiei* is given herein and a permanent pest rating is proposed.

History & Status:

Background: Bacterial scabs include diseases that affect belowground parts of plants and whose symptoms consist of localized scabby lesions. *Streptomyces scabiei* (syn. *S. scabies*) causes scab diseases on tuber and tap root crops and inhibits the growth of the seedlings of both monocot and dicot plants (Leiner et al., 1996; Stevenson et al., 2001). Common scab is widespread and found in all potato-growing areas of North America and Europe (CABI-CPC, 2020).

Streptomyces are gram-positive bacteria in the kingdom Prokaryotae, but they resemble fungi with a filamentous morphology and the ability to produce spores. They are well studied and valued for their ability to synthesize complex secondary metabolites including many antibiotics. Additionally, they

undergo complex multicellular development that provides model systems for research. They grow as aerial filamentous mycelial threads and produce cylindrical uninucleate spores on specialized spiral hyphae. These hyphae develop cross walls from the tip toward their base, and, as the cross walls constrict, spores are pinched off at the tip (Lambert and Loria, 1989).

Potatoes are the main economic host of this pathogen. Potato varieties differ in their susceptibility to different strains of the pathogen; resistant varieties tend to have fewer, tougher lenticels and a thicker skin (Clarke et al., 2019). The virulence of pathogenic *S. scabiei* strains depends on their ability to produce phytotoxins called thaxtomins (King et al., 1989). Thaxtomins cause dramatic plant cell hypertrophy and/or seedling stunting by altering the development of primary cell walls and the ability of the plant cells to go through normal cell division cycles.

Common scab is most prevalent and important in neutral or slightly alkaline soils, especially during relatively dry years. Superficial blemishes on tubers and roots reduce the value but usually not the yield of the crop. Occasionally, severe infections may reduce yields, and deep scabs increase the waste in peeling potatoes (Agrios, 2005).

Synonyms for *S. scabiei* include *Actinomyces scabies, Oospora scabies*, and *Streptomyces scabies*

Hosts: *Arachis hypogaea* (peanut), *Beta vulgaris* (beet), *Brassica napus* var. *napobrassica* (rutabaga), *Daucus carota* (carrot), *Pastinaca sativa* (parsnip), *Raphanus sativus* (radish), *Solanum tuberosum* (potato) (CABI- CPC, 2020; Goyer and Beaulieu, 1997).

Symptoms**:** *Streptomyces scabiei* infects tubers and other underground plant organs including roots. Infected potato tubers at first develop small, brownish, raised spots. Later, the spots enlarge, coalesce, and become corky. Sometimes the lesions appear as numerous russeted areas that almost cover the tuber surface, or they may appear as slight protuberances with depressed centers covered with corky tissue. The lesions usually extend 3 to 4 millimeters deep in the tuber.

In the tubers or roots, the bacteria grow mainly in the intercellular spaces of parenchyma cells, but these cells are sooner or later invaded as the bacterial populations increase and they break down. The scabs form when the cells below and around the lesion divide and form layers of corky cells. These cells push the infected tissues outward. Scab lesions often serve as points of entry for secondary parasitic or saprophytic organisms including fungi, bacteria, arthropods, or nematodes that may cause the tissues to rot. The severity of common scab of potato increases as the pH of the soil increases from pH 5.2 to 8.0 and decreases above or below these limits. Potato scab incidence is reduced greatly by maintaining high soil moisture during the period of tuber initiation and for several weeks afterward. (Agrios, 2005, Stevenson et al., 2001; Davis et al., 1974).

Transmission: This pathogen is spread through soil with water, by windblown soil, and on infected potato seed tubers. Scab bacteria survive in infected plant debris and in the soil and penetrate tissues through natural openings including lenticels and stomata, and through wounds. Young tubers are more susceptible to infection than older ones. *Streptomyces scabiei* can be a saprophyte and survive indefinitely in most soils except very acidic ones. Although common scab does not spread in storage,

infected seed can lead to infection of daughter tubers and contamination of soil (Stevenson et al., 2001).

Damage Potential: Losses due to common scab are most significant in fresh-market potatoes as consumers will reject unsightly, scabby tubers. Continuous cropping to potatoes increases disease severity. The incidence of common scab on potato tubers in one survey was 82% (Hill and Lazarovits, 2005). Pathogenic *Streptomyces* spp. do not have a high level of host specificity under controlled conditions (Goyer and Beaulieu, 1997).

Leiner et al. (1996) inoculated seedlings of 14 crop plants (monocots and dicots) with virulent *S. scabies* strains. The bacteria negatively altered shoot growth in 11 of the species tested, and plants had reduced fresh weights of roots, necrosis on root tips, and reduced development of lateral roots.

The infection process in the field appears to be governed by complex plant–microbe interactions. Hiltunen et al. (2005) separated potato cultivars as resistant or moderately sensitive to the disease while Clarke et al. (2019) described variability between resistant potato cultivars and isolates of the pathogen with different levels of virulence. Plants can escape disease in irrigated or wet soils because disease is exacerbated by water stress, and because the bacteria are lysed or otherwise inhibited by other microorganisms favored by high moisture. The bacteria can also persist in un-composted manure from animals that have fed on infested tubers. Although common scab seldomly affects yield, the unsightly and often deep-pitted corky lesions on tubers results in substantial economic losses through reduction in the value of fresh produce and rejection of seed lots that fail to meet certification standards. There can be losses during processing, where normal steam-peeling processes do not remove all diseased tissues from deep-pitted lesions, necessitating additional processing steps (Wilson et al., 1999).

Worldwide Distribution: Africa, Asia, Australia, Europe, North America, and South America.

Official Control: *Streptomyces scabiei* is on the harmful organism list for Argentina, Guatemala, Honduras, El Salvador, Israel, Jordan, Morocco, Namibia, and South Aftrica (USDA-PCIT, 2020).

California Distribution: Widespread in the Central Valley and along the Coast (French, 1989).

California Interceptions: none.

The risk *Streptomyces scabiei* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** *Streptomyces scabiei* is adapted to irrigated soils and can survive indefinitely as a saprophyte.

   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 large, mainly on herbacous plants. In California, most detections have been on potatoes.

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:** This pathogen is unique in that it is a spore-forming bacterium. The spores are dispersed with water, soil, and infected planting material including potato tubers.

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:** The pathogen can damage the roots of seedlings. Most serious is the damage from scabs on fresh market potatoes.

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

Economic Impact: A, B

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: **2**
- 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:** Common scab is mainly a cosmetic problem; environmental impacts are not described in literature.

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 *Streptomyces scabiei:* 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: 8

Final Score: *Score of Consequences of Introduction – Score of Post Entry Distribution and Survey Information* **= 8**

Uncertainty:

None

Conclusion and Rating Justification:

Based on the evidence provided above **the proposed rating for *Streptomyces scabiei* is C.**

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Responsible Party:

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*Comment Period: 3/16/2020 through 4/30/2020

*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.

Proposed Pest Rating: C