cdfa CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Thecaphora solani (Thirum & M.J. O'Brien) Mordue 1988

Potato smut

Current Pest Rating: None

Proposed Pest Rating: A

Domain: Eukaryota, Kingdom: Fungi,
Phylum: Basidiomycota, Subphylum: Ustilaginomycotina,
Class: Ustilaginomycetes, Order: Urocystidiales
Family: Glomosporiaceae

Comment Period: 12/03/2021 through 01/17/2022

Initiating Event:

This pathogen has not been through the pest rating process. The risk to California from *Thecaphora solani* is described herein and a permanent pest rating is proposed.

History & Status:

Background:

California ranks 4th in the United States in potato production with 418,000 harvested acres in 2019/20. California has four major potato growing regions 1) Klamath/Tulelake Basin in Siskiyou and Modoc Counties (fresh, processing, and seed potatoes), 2) Delta Basin in San Joaquin County (seed potatoes), 3) Kern and Los Angeles counties (fresh and chipping potatoes), 4) desert and mountain valleys of Imperial, Riverside and San Diego counties (fresh potatoes). California is unique in that potatoes can be grown here year-round. We are the nation's largest producer of spring potatoes, with the majority grown in Kern County (USDA NASS, 2021).

The smut genus *Thecaphora* resides in the Glomosporiaceae and includes approximately 60 described species, which produce sori within various plant organs including seeds, flowers, leaves, stems, and roots. Many smut fungi can grow as nonpathogenic, saprotrophic sporidia until they find a mating partner with which they fuse to form a filamentous, pathogenic dikaryon. After mating, they switch from saprophytic growth to pathogenic filament formation. For these filaments, plant signals from the tissue surfaces induce appressorium formation and penetration of the plant tissue. Upon successful

penetration, fungal hyphae rapidly proliferate inside plant tissue and induce tumor formation for the deposition of diploid teliospores (Vollmeister et al., 2012).

Potato smut caused by the fungus *Thecaphora solani* is indigenous to the Andean region of South America, but also occurs in Mexico. It is a quarantine pest in many countries and presents a high risk to commercial potato-growing areas around the world because it attacks tubers directly with an immediate effect on yield and quality. Regulations are required because it can contaminate seed tubers as latent infections or come in as surface contamination by teliospores. It is soil-borne and would be virtually impossible to eradicate if it became established (Torres, 2001).

Hosts: The principal host of this fungus is *Solanum tuberosum* (potato). *Solanum lycopersicum* (tomato) is also a host along with other tuber-bearing species of *Solanum* (nightshades) including *S. ajanhuiri*, *S. curtilobum*, *S. phureja*, *S. stenotomum*, *S. stoloniferum*, *S. tuberosum* subsp. *andigenum*, *S.* x *chaucha* and the solanaceous weed *Datura stramonium* (jimsonweed) (Mordue, 1988; Farr and Rossman, 2021).

Symptoms: Symptoms appear mainly on underground parts of potato plants, and disease is often not noticed before harvest. Symptoms caused by *T. solani* on potato tubers could be confused with those caused by scab (*Spongospora subterranea* f. sp. *subterranea*), potato wart (*Synchytrium endobioticum*) or the root-knot nematodes (i.e., *Meloidogyne incognita*). Diagnosis is made with microscopy and molecular methods and, in general, smut fungi are very difficult to culture (Andrade et al., 2004).

The main symptom is the appearance of galls developing below the soil line on stems, stolons and tubers of potatoes (Torres, 2001). There are no galls or symptoms on aerial parts of potatoes or roots of the infected plants. Galls are formed on underground stems are the largest, from 1 to 10 centimeters long and weighing over 300 g (Untiveros and de Icoechea, 1980). Galls may form anywhere along the length of the stolons and generally are smaller than those found on stems. On tubers, small galls develop mostly at the apical end, and as slight protuberances on the surface of the tubers (not present for all varieties). After 2–3 months in storage, the protuberances become sunken and suberised (Torres, 2001). When these tubers sprout, new galls develop on the young sprouts or on the tuber surface near sprouts. The size of the galls formed on tubers can range from less than 1 mm to 4 cm or more in diameter (Acuna, 1981). Infected tubers are hard and misshapen (Chalkley, 2018). Oval to irregular locular sori of mixed sizes develop within the galls which contain a reddish-dark, granular-powdery masses of teliospores (Mordue, 1988).

On tomato, galls develop at the junction of the stem and roots (Andrade, 2012).

Transmission: Thecaphora solani has only a limited capacity for spread by natural means. Torres (2001) reported that teliospores can be dispersed within a field or between neighboring fields by irrigation water. Anything that contacts or moves infested soil including boots, equipment, machinery, containers and implements can potentially spread spores. It could also be spread via hoofs of animals moving from one field to another as well as through manure from livestock fed on infected potato tubers or having grazed in infested fields (Torres, 2001; Andrade, 2012). The activity that carries the greatest risk of long-distance spread is planting of infected seed potatoes. Since 1984, *T. solani* has

been intercepted by the USDA over 125 times in tubers of *S. tuberosum* and *S. stoloniferum*, almost all from Mexico (USDA, CABI).

Damage Potential: Potato smut is one of the most destructive fungal diseases affecting the potato in the Andean region of South America, producing yield losses of approximately 85% (Torres and Henfling, 1984). In Chile, Andrade (2012) indicated yield losses ranging from 20% to 75%, depending on the region and inoculum sources (i.e., infested soil, infected tubers). Likewise, in Chile, Torres et al. (1998) reported disease incidence of 80% on harvested tubers of susceptible varieties. A detection in the United States would have quarantine and phytosanitary implications for intrastate, interstate, and international movement of seed tubers.

Worldwide Distribution: North America: *Mexico, Panama*. South America: *Bolivia, Chile, Colombia, Ecuador, Peru, Venezuela* (USDA-ARS, 2019).

Official Control: *Thecaphora solani* is on the USDA PCIT's harmful organism list for Albania, Algeria, Brazil, Canada, Chile, China, Egypt, Eurasian Customs Union, European Union, French Polynesia, Georgia, Holy See (Vatican City State), Honduras, Iceland, Israel, Jordan, Korea; Republic of, Mexico, Moldova; Republic of, Monaco, Morocco, Nicaragua, Norway, San Marino, Serbia, Taiwan, Thailand, Tunisia, Turkey, Ukraine, United Kingdom, Uruguay, and Uzbekistan (USDA, 2021). It is on the EPPO's A1 list for Argentina, Azerbaijan, Asia and Pacific Plant Protection Commission, Brazil, Egypt, Eurasian Economic Union, European Plant Protection Organization, European Union, Jordan, Kazakhstan, Russia, Southern Africa, Turkey, Ukraine, Uruguay, Uzbekistan, on the A2 list for Chile, China, Comite de Sanidad Vegetal del Cono Sur, and a quarantine pest for Belarus, Canada, Israel, Mexico, Moldova, Morocco, Norway, and Tunisia (EPPO, 2021).

California Distribution: None

California Interceptions: None

The risk *Thecaphora solani* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** Because it has a very limited distribution in Mexico and South America, it is uncertain what climatic conditions are needed for pathogen establishment and which areas of California would be the most threatened. Given that potatoes are grown from far northern to far southern California, it is likely some area(s) would be suitable.

   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 includes multiple species in the genera *Solanum* and *Datura*.

Evaluate the host range of the pest.

Score: 2

- 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 is a soilborne pathogen that produces masses of smut spores. There is no known aerial stage and dispersal relies on the movement of infected plants or soil.

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 pathogen causes high economic losses in South America on susceptible potato varieties. It is also a quarantine pathogen in many countries and regions, including the United States

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:** Jimson weed (*Datura stramonium*) is non-native but widespread and is a proven host of *T. solani*. As a USDA-regulated pest, any detection of *T. solani* would likely trigger an Emergency Action Notice requiring eradication of infect hosts and longer-term restrictions on growing hosts or potential hosts in infested fields.

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

Environmental Impact: A, D, E

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: 3
- 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 *Thecaphora solani:* Medium

Add up the total score and include it here. **12**
-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* ***= 12***

Uncertainty:

It is not known whether native or non-native species of *Datura* or *Solanum* present in California are hosts of the pathogen.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for *Thecaphora solani* is A.

References:

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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.

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*Comment Period: 12/03/2021 through 01/17/2022

*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: A