CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Setophoma terrestris (H.N. Hansen) Gruyter, Aveskamp & Verkley 2010

≡ *Phoma terrestris* H.N. Hansen 1929, R.K. Saksena, Nand & A.K. Sarbhoy 1966
≡ *Pyrenochaeta terrestris* (H.N. Hansen) Gorenz, J.C. Walker & Larson 1948

Pink root of onion/Red root rot of corn

Current Pest Rating: none

Proposed Pest Rating: B

Kingdom: Fungi, Phylum: Ascomycota,
Subphylum: Pezizomycotina, Class: Dothideomycetes,
Subclass: Pleosporomycetidae, Order: Pleosporales
Family: Phaeosphaeriaceae

Comment Period: 09/20/2022 through 11/04/2022

Initiating Event:

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

History & Status:

Background: California is the largest onion producing state in the United States and is the only state to produce both spring and summer-harvested onions. Roughly half of California onions are grown for the fresh market and about half for processing. Onions are grown throughout California on 43,000 acres. The counties with the top acreage are Fresno, Imperial, Kern, Siskiyou, and San Joaquin, with over a third of the state's acreage located in Fresno County. The high desert region of Antelope Valley in Los Angeles County and the Salinas Valley in Monterey County also include some fresh market onion

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acreage (Lazicki et al., 2016). The value of California's onion crop in 2020/21 was reported as $338M (CDFA Crop Statistics; https://www.cdfa.ca.gov/Statistics/PDFs/2021_Ag_Stats_Review.pdf).

Setophoma terrestris is recognized as a widespread saprophyte and weak parasite on the underground parts of a variety of hosts (Farr and Rossman, 2022). Pink root of onion is an economically destructive disease that it causes and together they are the best-studied host-pathogen combination. Additionally, this fungus attacks corn in some climates, causing red root rot. It also grows as a saprophyte in association with the roots of many cereals, legumes, vegetables, and grasses.

The infection can cause a noticeable pink or red coloration of the roots, especially in regions with warm climates or in seasons with high temperatures. Because so many other plant species are hosts of this pathogen, rotation is an effective management method only if appropriate rotational crops are grown. Long-term rotations out of onions for six years are recommended to allow the inoculum to decline (Swett et al., 2019). If hosts are grown continuously without interruption, the level of soil borne inoculum and the incidence of disease increases with each crop, especially if onions follow cereals or corn.

The genus *Setophoma* (Phaeosphaeriaceae) was introduced to accommodate *phoma*-like species with dark brown to black "setose" or bristly setae around the ostioles of the pycnidia. Some strains of the fungus produce toxins that negatively impact crops (Schwartz and Mohan, 2016). *Setephoma terrestris* is the type strain for the genus (de Gruyter et al. 2010). Additional *Setophoma* species have been described since the genus was introduced, and all except *S. terrestris* are reported to occur only on unique host plants.

Hosts: The primary hosts are onions and corn, but *P. terrestris* has been isolated from hosts in 45 diverse genera that include many cereals, vegetables, and grasses plus woody plants.

Symptoms: The pathogen is soil-borne and exclusively invades plant roots. Infected roots first appear water soaked, later developing the striking symptom of pink roots. Infected roots first turn light pink, then darken through red and purple, shrivel, and later turn black and die. The pinkish-red discoloration may extend up into the scales of onion bulbs. New roots are produced, sometimes in excess of normal, but quickly become infected. The vascular tissue in the center of the root can turn very dark red to purple (Swett et al., 20019). Foliar symptoms include wilting, etiolation, flaccidity, and dieback of the tips. If infected early, seedlings are retarded in growth and may die. Older plants will look stunted and show symptoms resembling drought stress. Bulb size can be reduced in onions (Schwartz and Mohan, 2008).

Foliar symptoms on corn develop over a period of five to eight days, approximately one to two weeks after anthesis. Symptoms on corn include desiccation of leaves and poor development of ears. A dark reddish discoloration and necrosis on rotted roots and basal stalks is accompanied by greenish gray discoloration on wilted leaves. These symptoms usually occur late in the growing season. The disease may be more severe when corn is densely planted (Ma et al., 2007). For some varieties of sweet corn, the crowns and the first aboveground internode of affected plants will be rotted and reddish colored,

but roots can appear normal. The root mass of affected sweet corn plants can be less, equal to, or sometimes greater than that of unaffected plants (Carrol, 1999; Koenning et al., 2007).

Transmission: In naturally infested soil, the infective fungal parts are hyphae and microsclerotia. Microsclerotia are thought to play an important role in the overwintering cycle and can survive in the soil for many years even in the absence of a host. These structures serve as the primary inoculum. And although it is produced, the importance of the pycnidial stage and conidia have not been demonstrated in pathogenesis. No sexual stage has been observed. The microsclerotia can be moved with soil and irrigation water, and by infected planting material such as onion and garlic bulbs.

Hyphal infection occurs quickly at 25-28^{o}C. Root epidermal and cortical tissues are invaded, and hyphal penetration occurs through a release of enzymes that break down host tissue. The fungus survives on root debris, saprophytically on roots of non-host plants and as resting microsclerotia, which have been found in the soil down to a depth of 45 cm (Grove and Campbell, 1987). Root color alone is not a reliable diagnostic method (Swett et al., 2019). *Fusarium* sp. can also cause pink roots, particularly on dead or old roots, and field diagnosis of pink root can only be made by observing pink roots on actively growing plants. The dark-red-to-purple stele combined with a collapsed outermost layer of root tissue can help distinguish pink root from root rot caused by other fungi.

Damage Potential: Setophoma terrestris occurs in many types of soils, and populations increase rapidly with successive host crops (Klinger and Pontis-Vedela, 1961). Wounds are not necessary for infection; however, weak plants are more susceptible. The more years onions are grown in the field, the moredestructive the disease becomes (Swett et al., 2019). The incidence of symptomatic plants was greater than 30% in some corn fields and was lower on crops planted and harvested early. Diseased plants were more common in fields of sweet corn that followed soybean or a double crop of onions than in fields that followed other crops (Koenning et al., 2007).

The disease is enhanced by co-infection with other fungal pathogens such as *Pythium irregulare* and *Fusarium acuminatum*, which attack the plant first and weaken the root system making it easier for *S. terrestris* to invade the roots (Mao et al., 1998; Carrol, 1999). The disease may develop so rapidly that within 10 days, entire corn plants wilt and stalk lodging occurs, resulting in severe yield loss (Mao et al., 1998)

Worldwide Distribution: Africa: *Senegal*. Asia: *India, Israel*. Europe: *Greece, Netherlands, Poland*. North America: *Mexico, United States* (California, Delaware, Iowa, Maryland, North Carolina, Oregon, Utah, Virginia). Oceania: *Australia*. South America: *Argentina, Venezuela* (CABI- CPC, 2022).

Official Control: This fungus is on the USDA's harmful organism list for China, Ecuador, Guatemala, India, Indonesia, Republic of Korea, and Timor-Leste (USDA PCIT, 2022). CDFA has a State Miscellaneous Ruling, 3559 GARLIC PRODUCTION IN MONO COUNTY. This ruling establishes a quarantine area for maintaining the pest cleanliness of garlic plantings for stem and bulb nematode (*Ditylenchus dipsaci*), white rot fungus (*Sclerotium cepivorum*), Garlic yellow stripe virus, and pink root (*Pyrenochaeta terrestris = Setaphoma terrestris*), which are not known to occur in the garlic production areas of Mono County. Under this regulation, no garlic plant or part thereof shall be planted or

maintained in any state of cultivation in the quarantine area unless a written application has been received and a permit has been issued by the Secretary of Agriculture or the Agricultural Commissioner for Mono County. Such permit shall be issued provided the garlic is the progeny of plants meet the requirements of "California Certified Seed Garlic," or is accompanied by a certificate issued by a State or county agricultural regulatory official verifying the garlic is of equivalent pest status as garlic produced under said provisions; and provided the Secretary or commissioner determines the garlic covered by the permit is free of the pests specified, and other serious pests of garlic. http://pi.cdfa.ca.gov/pqm/manual/pdf/450.pdf

California Distribution: There are official records statewide on garlic, lima bean, oat, onion, sweet potato, strawberry, and wheat in California (French, 1989).

California Interceptions: None

The risk *Setophoma terrestris* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** The fungus is a common soil inhabitant. It is well adapted to sub-temperate, temperate and tropical climates due to its ability to survive well in many soil types and a wide range of temperature and pH. Optimal temperatures for disease development are 75° to 85°F.

   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 primary economic hosts are onions and corn, but it causes disease as a weak parasite and can survive as a saprophyte on many types of plants from diverse families.

   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:** Reproduction is limited to hyphae and microsclerotia; it is not known to have other types of functional spores. The natural spread of microsclerotia is rather limited but moving infested soil and planting material is extremely problematic.

   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 disease is an economic problem on onions and corn. It is a quarantine pest in Mono County and for some trading partners. Microsclerotia can be spread by irrigation water.

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

Economic Impact: A, C, 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:** The presence of microsclerotia in a field can change crop rotation plans.

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

Environmental Impact: 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: 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 *Setophoma terrestris:* High

Add up the total score and include it here. **13**
-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.

This pathogen is already widespread in the state with records on multiple hosts. However, there are garlic production areas of Mono County where planting restrictions have excluded this pathogen along with others.

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* ***= 11***

Uncertainty:

none

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for *Setophoma terrestris* is B.

References:

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De Gruyter, J., Woudenberg, J.H.C., Aveskamp, M.M. 2010. Systematic reappraisal of species in *Phoma* section *Paraphoma, Pyrenochaeta* and *Pleurophoma*. Mycologia 102: 1066–1081.

EPPO Global Database. 2022. *Setophoma terrestris*. https://gd.eppo.int/taxon/PYRETE

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Mao, W., Carroll, R. B., and Whittington D. P. 1998. Association of Phoma terrestris, Pythium irregulare and Fusarium acuminatum in causing red root rot of corn. Plant Dis. 82:337-342.

Schwartz, H.F. and Mohan, S.K. eds., 2008. Compendium of onion and garlic diseases and pests (pp. 11-15). St. Paul, MN: American Phytopathological Society.

Swett, C. L., Aegereter, B. J., Turini, T. A, and Putman, A. I. 2019. Pink root. UC IPM Pest Management Guidelines: Onion and Garlic UC ANR Publication 3453

USDA Phytosanitary Certificate Issuance and Tracking System, Phytosanitary Export Database (PExD) Harmful Organisms Database Report. *Setophoma terrestris*. Accessed 8/22/2022

Responsible Party:

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***Comment Period: 09/20/2022 through 11/04/2022**

***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: B