

California Pest Rating Proposal for

Fusarium clavum Xia et al., 2019

Current Pest Rating: Q

Proposed Pest Rating: B

Kingdom: Fungi, Phylum: Ascomycota,
Subphylum: Pezizomycotina, Class: Sordariomycetes,
Subclass: Hypocreomycetidae, Order: Hypocreales,
Family: Nectriaceae

Comment Period: 09/30/2024 through 11/14/2024

Initiating Event:

In July 2023, Santa Clara County agricultural biologists submitted a cucumber plant with rotted roots and crown rot to CDFA's Plant Pest Diagnostics Center. CDFA plant diagnostician Wei Belisle isolated *Fusarium clavum* from the diseased tissues. She confirmed her diagnosis by performing multiple gene sequencing analyses. The field was growing to produce export seed. As a first report in California, it received a temporary Q-rating. In August 2024, three seed fields in Monterey County, growing beans and squash, had detections on symptomatic mother plants. This species is part of the *Fusarium incarnatum-equiseti* complex. The risk to California from *Fusarium clavum* is described herein and a permanent rating is proposed.

History & Status:

Background:

Fusarium species are agriculturally important fungi with a broad host range that can be found as endophytes, pathogens, or saprophytes in many agricultural and native plants in a variety of settings, including forests. Members of the *Fusarium incarnatum-equiseti* species complex (FIESC) are generally associated with diseases of agricultural crops, cereals in particular. Like other *Fusarium* species complexes, FIESC contains plant pathogens and species that cause human opportunistic infections, generally detected in immunocompromised people (O'Donnell et al., 2009). Multi-locus sequence typing (MLST) based on modern taxonomic concepts is necessary for the precise identification of FIESC species.

The FIESC has been resolved into two clades, the Incarnatum clade and the Equiseti clade. Between them, they contain more than 40 phylogenetically different species (phylo-species) (O'Donnell et al.,

2009; Xia et al., 2019). The majority of these phylo-species are cryptic, making identification based solely on phenotypic characters problematic.

Each of the phylo-species is assigned an alphanumeric designation, and almost all species have also received Latin binomial names. Xia et al. (2019) studied FIESC-5, describing and naming it *Fusarium clavum*. The name refers to the lateral phialidic pegs born on the aerial mycelium. It produces abundant chlamydospores in culture. *Fusarium clavum* is well-supported in the Equiseti clade. Isolates of *F. clavum* included in the study by Xia et al. were obtained from environmental, plant, and human samples collected in Africa, Asia, Europe, and North America, indicative of a broad distribution. Leafy vegetables are highly susceptible to FIESC-caused diseases at high temperatures (25 to 35°C). There is also the risk of a further spread of these pathogens to new geographical areas and hosts as they are transmitted by seeds (Gilardi et al., 2017; Gilardi et al., 2021).

Hosts: The host range of FIESC is large and includes monocots, dicots, and woody plants. Records specifying *F. clavum* are more limited as this name came into use in 2019, so this list, which follows, is likely incomplete: *Citrullus lanatus* (watermelon), *Cucurbita* sp. (squash), *Diplotaxis tenuifolia*, *Disphyma crassifolium*, *Lactuca sativa*, *Leucopoa sclerophylla*, *Phalaris minor*, *Phaseolus vulgaris* (bean), *Rosa* sp., *Secale montanum*, *Solanum lycopersicum*, *Solanum tuberosum*, *Spinacia oleracea*, *Syzygium cordatum*, *Triticum* sp., *Valerianella locusta* (Farr and Rossman, 2024; Xia et al., 2019; Maganiello et al., 2021; CDFFA PDR database, 2024).

Symptoms: Symptoms on cucurbit plants from *F. clavum* crown and root rot are distinct from species such as *F. oxysporum* that cause vascular wilts. On squash, crown and foot rot begins as water-soaked lesions on the stem at the soil line. Infected plants collapse when their stems are girdled. Leaf spots and fruit rot disease were observed in tomato plants in plastic tunnels as small circular, brown leaf spots (1 to 5 mm in diameter), with a well-defined border, surrounded by a yellow halo. Lesions expanded up to 30 mm in diameter, becoming necrotic and broken in the center, and eventually dried out (Gilardi et al., 2021). On melons, brown water-soaked lesions were observed on the fruit side in contact with soil initially, which gradually extended across the entire fruit. Internal decay was observed with white to dark brown mycelium on the fruit surface (Cao et al., 2019). On garlic, the infected plants were stunted with reddish dying leaves. The stalks and bulbs were soft, and their root system was poorly developed (de Jesús Díaz Aguilar et al., 2023). In seedling sugar beets, the diseased seedlings exhibited water-soaked brown to blackish lesions in hypocotyls with poor root systems (Khan et al., 2024). Foliar symptoms on leafy greens consisting of circular to angular lesions that later become necrotic and cracked.

Transmission: *Fusaria* that form chlamydospores, including *F. clavum*, can be spread through contaminated soil, when soil and roots are moved with equipment, and with surface run-off water. Conidia can be spread through the air to infect above-ground parts. *Fusarium clavum* has been detected as a seed contaminant (Gilardi et al., 2017).

Damage Potential: In Italy, Matic et al. (2020) considered FIESC an emerging problem in leafy greens and recommended strict seed inspection procedures to prevent the further spread of these pathogens to new hosts and new geographical areas. On garlic in Mexico, it is considered a severe threat to garlic

cultivation (de Jesús Díaz Aguilar, 2023). On tomatoes in Italy, this new disease poses a threat to tomatoes and needs to be properly monitored and managed to prevent severe yield loss (Gilardi et al, 2021).

Worldwide Distribution: Germany, Iran, Italy, Mexico, Namibia, USA (California, Wyoming) (Farr and Rossman, 2024; Xia et al., 2019, CDFA PDR database 2024).

Official Control: None

California Distribution: Official detections have been made in Monterey and Santa Clara counties.

California Interceptions: None

The risk that *Fusarium clavum* would pose to California is evaluated below.

Consequences of Introduction:

- 1) **Climate/Host Interaction:** This pathogen is likely to be found wherever its hosts can grow.

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 be established 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 plants in multiple 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:** This *Fusarium* has conidia and chlamyospores. It can spread with soil, inside infected plants, and with seeds.

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:** This species can damage leaves, roots, crowns and fruits of multiple crop plants.
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Evaluate the economic impact of the pest on California using the criteria below.

Economic Impact: A

A. The pest could lower crop yield.

- B. The pest could lower crop value (including increasing crop production costs).
- C. The pest could trigger the loss of markets (including 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: 1

- **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 host range of this pathogen could include native plants.

Evaluate the environmental impact of the pest on 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 *Fusarium clavum*: 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 'Low'.

Score: -1

-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 the 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 = 10*

Uncertainty:

As species are defined from a much larger species complex, it takes time to complete research on their pathogenicity and to understand if they are seed-transmitted.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for *Fusarium clavum* is **B**.

References:

de Jesús Díaz Aguilar, R., Chávez, E.C., Velázquez Guerrero, J.J., Roque Enriquez, A., Rodríguez Pagaza, Y. and Ochoa Fuentes, Y.M., 2023. First report of *Fusarium clavum* causing garlic bulb rot in Mexico. *Plant Disease*, 107(10), p.3317.

Farr, D.F., and Rossman, A.Y. Fungal Databases, U.S. National Fungus Collections, ARS, USDA. Retrieved 9/13/2024, from <https://nt.ars-grin.gov/fungalDATABASES/>

Gilardi G., Pintore I., Gullino M.L., Garibaldi A., 2017. Occurrence of *Fusarium equiseti* as a contaminant of *Diplotaxis tenuifolia* seeds. *Journal of Plant Pathology* 99: 245–248

Gilardi, G., Matic, S., Guarnaccia, V., Garibaldi, A. and Gullino, M.L., 2021. First report of *Fusarium clavum* causing leaf spot and fruit rot on tomato in Italy. *Plant Disease*, 105(8), p.2250.

Khan, M.F.R., Bhuiyan, M.Z.R., Lakshman, D.K., Del Rio Medoza, L.E., Wimmer, L., Otto, M., Ismaiel, A. and Azizi, A., 2024. *Fusarium clavum* causes sugar beet seedling root rot in Wyoming, USA. Canadian Journal of Plant Pathology, 46(3), pp.257-264.

Manganiello, G., Traversari, S., Nesi, B., Cacini, S. and Pane, C., 2021. Rose: A new host plant of *Fusarium clavum* (*F. incarnatum-equiseti* species complex 5) causing brown spot of petals. Crop Protection, 146, p.105675.

Matic, S., Tabone, G., Guarnaccia, V., Gullino, M.L., and Garibaldi, A. 2020. Emerging leafy vegetable crop diseases caused by the *Fusarium incarnatum-equiseti* species complex. Phytopathol. Medit. 59(2):303-317

O'Donnell, K., Sutton, D.A., Rinaldi, M.G., Gueidan, C., Crous, P.W. and Geiser, D.M., 2009. Novel multilocus sequence typing scheme reveals high genetic diversity of human pathogenic members of the *Fusarium incarnatum-F. equiseti* and *F. chlamydosporum* species complexes within the United States. Journal of Clinical Microbiology, 47(12), pp.3851-3861.

Xia, J.W., Sandoval-Denis, M., Crous, P.W., Zhang, X.G. and Lombard, L., 2019. Numbers to names—restyling the *Fusarium incarnatum-equiseti* species complex. Persoonia-Molecular Phylogeny and Evolution of Fungi, 43(1), pp.186-221.

Responsible Party:

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***Comment Period: 09/30/2024 through 11/14/2024**

*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[[@](mailto:permits@cdfa.ca.gov)]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.
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Proposed Pest Rating: B
