

California Pest Rating Proposal for

Tilletia indica Mitra 1931

≡ *Neovossia indica* (Mitra) Mundk. 1940

Karnal bunt/partial bunt of wheat

Current Pest Rating: Q

Proposed Pest Rating: A

Domain: Eukaryota, Kingdom: Fungi,
Phylum: Basidiomycota, Subphylum: Ustilaginomycotina,
Class: Ustilaginomycetes, Subclass: Exobasidiomycetidae,
Order: Tilletiales, Family: Tilletiaceae

Comment Period: **03/18/2022 through 05/02/2022**

Initiating Event:

This pathogen has not been through the pest rating system. The risk to California from *Tilletia indica* is described herein and a permanent rating is proposed.

History & Status:

Background: *Tilletia indica* (syn. *Neovossia indica*) belongs to the phylum Basidiomycota, in the family of smut fungi, containing 17 genera and 607 species. Karnal bunt is the preferred common name of the disease. It is a pathogen of wheat, durum wheat, and triticale (a hybrid of wheat and rye). Typically, only a portion of the kernel is affected, and the disease is sometimes called 'partial bunt'. The damage is twofold: Infected plants produce less grain, and the quality of the grain is reduced. Flour made from bunted kernels is discolored and has an unpleasant, though harmless, fishy odor and taste.

The disease was first reported in 1931 in wheat-growing areas near the city of Karnal in the Indian State of Haryana. Since then, it has been found in all major wheat-growing states of India, and spread to limited areas of south Asia, South Africa, and Brazil. The disease was first detected in Mexico in the Yaqui Valley in the late 1960s, but the first significant outbreaks occurred in the 1980s. Today it is considered established in some areas in northwestern Mexico where it has a relatively minor effect on yield; losses are less than 1% per year (Fuentes Davila, 1992). The presence of the disease in a region or

country results in quarantine restrictions. There are three counties in Arizona where the disease has been found over the last 25 years that are under federal and Arizona state regulation. Restrictions prevent domestic and international movement of wheat from regulated areas, with most wheat importing countries have zero-tolerance limit for *T. indica*, which is also considered a biosecurity threat (Singh et al., 2020).

California mainly grows hard red winter wheat and durum wheat. The hard red varieties are classed as winter wheat due to the timing of its market entry. The main winter wheat production areas in California are in the San Joaquin Valley, in Fresno, Kern, Kings and Tulare counties, and some production occurs in Northern California. Durum wheat is a high-protein spring wheat primarily used to make pasta. The production area of durum wheat is split between the San Joaquin Valley and the desert in Riverside and Imperial counties. A total of 420,000 acres of wheat were planted during 2019, and 122,000 acres of this total were harvested for grain, yielding 217,000 tons (CDFA AG Stats Review, 2020).

Hosts: *Tilletia indica* is reported to infect several grass species under artificial infection conditions (Carris et al., 2006). However, under natural conditions, the pathogen is restricted only to wheat (*Triticum aestivum* and *T. vulgare*), durum wheat (*T. durum*), and triticale (*Triticum aestivum* × *Secale cereale*) a hybrid of wheat and rye (Farr and Rossman, 2022; Gaudet et al., 2001).

Symptoms: Symptoms depend on climate and are most severe when conditions are relatively cold and humid (Biswas et al., 2013). Airborne teliospores can infect wheat plant from the emergence of florets from boot stage up to soft dough stage (Goates and Jackson, 2006). The fungus causes a reduction in the length of ears as well as in the number of spikelets with bunted ears. Infected plants may be dwarfed. Diseased seeds often keep a partial seed coat, and the embryo and part of the endosperm are converted to masses of small black teliospores. The spores can emit a fishy odor (due to the presence of trimethylamine). Partially bunted seeds often retain their ability to germinate, and grains with trace-to-moderately-low infections generally produce healthy plants.

Symptoms will be seen at the soft-dough stage of grain development in the form of blackened areas surrounding the base of the grains, which extend upward along the suture to varying degrees. Karnal bunt is usually not noticed until broken and/or partially smutted kernels are seen in threshed grain. Unless the disease is severe, only a few florets per spike are affected and diseased spikes are not conspicuous because the glumes appear normal and are not distorted by the presence of infected kernels. In severely infected spikes, however, the glumes may spread apart near maturity, exposing the bunted grains. Infected grains are irregularly distributed in the spike; some are completely infected, but most are partially infected (Carris et al., 2006).

Transmission: Spread of the fungus can occur by transporting infested and infected seed. Unlike other smut and bunt fungi, *T. indica* does not infect seedlings. However, teliospores that heavily contaminate seeds germinate in the soil and are an important inoculum source of the pathogen (Bains and Dhaliwal, 1989). The teliospores germinate in response to free moisture and produce numerous sporidia at the soil surface that are forcibly ejected and then dispersed by wind, splashing water and insects. Sporidia are fragile and may be able to move only short distances. This fungus must infect plants between the

beginning of spike emergence and the end of flowering (Smilanick et al., 1985). Spores can be carried on a variety of surfaces, plants and plant parts, seeds, soil, elevators, buildings, farm equipment, tools, and even vehicles.

Damage Potential: Karnal bunt is regarded as a minor disease most places where it occurs. Losses ranging from 5 to 20% have been reported. However, even during years of severe epidemics in India, the total damage to the wheat crop ranged from 0.3 to 0.5% of total production (CABI, 2022). The weight of infected grains is directly related to the severity of infection; as the degree of infection increases, the weight of the grains correspondingly decreases (Wright et al., 2006).

The disease seems to be favored by cool temperatures and high relative humidity at heading. Temperatures of 8-20° C and high humidity with rain and cloudy weather are most favorable for infection of the ears (Royer and Rytter, 1985). Dry weather, high temperatures (20-25° C) and bright sunlight are unfavorable for disease development (Holmes et al., 1996).

Worldwide Distribution: Afghanistan, Brazil, India, Iran, Iraq, Mexico, Nepal, Pakistan, South Africa, United States (*Arizona- La Paz, Maricopa, and Pinal counties*) (CABI-CPC, 2022).

Official Control: *Tilletia indica* has long been an important quarantine pest. The pathogen is regulated by the European Union and by other EPPO countries (Belarus, Russia, Turkey, Ukraine). It is also considered to present a risk in Africa, Asia, Near East and South America (CABI, 2022).

Tilletia indica is on the USDA PCIT's harmful organism list for Albania, Algeria, Angola, Argentina, Azerbaijan, Benin, Plurinational State of Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Burkina Faso, Burundi, Cameroon, Canada, Central African Republic, Chad, Chile, China, Colombia, Congo, The Democratic Republic of the Congo, Cote d'Ivoire, Ecuador, Egypt, El Salvador, Equatorial Guinea, Ethiopia, Eurasian Customs Union, European Union, Gabon, Gambia, Georgia, Ghana, Guatemala, Guinea, Guinea-Bissau, Holy See (Vatican City State), Israel, Japan, Jordan, Korea, Republic of, Lesotho, Liberia, Madagascar, Mali, Mauritania, Mauritius, Mexico, Republic of Moldova, Monaco, Morocco, Mozambique, Namibia, New Zealand, Nicaragua, Niger, Norway, Oman, Pakistan, Paraguay, Peru, Qatar, Republic of North Macedonia, Rwanda, San Marino, Senegal, Serbia, Sierra Leone, Somalia, South Africa, Svalbard and Jan Mayen, Taiwan, Tajikistan, United Republic of Tanzania, The Kingdom of Eswatini, Togo, Tunisia, Turkey, Turkmenistan, Uganda, Ukraine, United Arab Emirates, United Kingdom, Uruguay, Uzbekistan, Viet Nam, Zimbabwe (USDA, 2022).

It is on the EPPO's A1 list for Argentina, Azerbaijan, Bahrain, Brazil, Chile, China, Comité de Sanidad Vegetal del Cono Sur, Egypt, Eurasian Economic Union, European and Mediterranean Plant Protection Organization, European Union, Georgia, Inter-African Phytosanitary Council, Jordan, Kazakhstan, Paraguay, Russia, Turkey, Ukraine, United Kingdom, Uruguay, Uzbekistan, on the A2 list for Asia and Pacific Plant Protection Commission, and a quarantine pest for Belarus, Canada, Israel, Mexico, Moldova, Morocco, New Zealand, Norway, Tunisia, United States of America (EPPO, 2022).

There is a Federal Domestic Quarantine against Karnal bunt. <https://www.ecfr.gov/current/title-7/subtitle-B/chapter-III/part-301/subpart-U?toc=1>

The following are regulated articles: (a) Conveyances, including trucks, railroad cars, and other containers used to move host crops produced in a regulated area that have tested positive for Karnal bunt through the presence of bunted kernels; (b) Grain elevators/equipment/structures used for storing and handling host crops produced in a regulated area that have tested positive for Karnal bunt through the presence of bunted kernels; (c) Seed conditioning equipment and storage/handling equipment/structures that have been used in the production of wheat, durum wheat, and triticale found to contain the spores of *Tilletia indica*; (d) Plants or plant parts (including grain, seed, and straw) and hay cut after reaching the dough stage of all varieties of wheat (*Triticum aestivum*), durum wheat (*Triticum durum*), and triticale (*Triticum aestivum* × *Secale cereale*) that are produced in a regulated area, except for straw/stalks/seed heads for decorative purposes that have been processed or manufactured prior to movement and are intended for use indoors; (e) *Tilletia indica* (Mitra) Mundkur; (f) Mechanized harvesting equipment that has been used in the production of wheat, durum wheat, or triticale that has tested positive for Karnal bunt through the presence of bunted kernels; and (g) Any other product, article, or means of conveyance when: (1) An inspector determines that it presents a risk of spreading Karnal bunt based on appropriate testing and the intended use of the product, article, or means of conveyance; and (2) The person in possession of the product, article, or means of conveyance has been notified that it is regulated under this subpart.

Any wheat, durum wheat, or triticale that originates within a regulated area must be tested and found free from bunted wheat kernels and spores before it may be used as seed within or outside a regulated area.

There is a California State Interior Quarantine 3430. KARNAL BUNT DISEASE <http://pi.cdfa.ca.gov/pqm/manual/pdf/413.pdf> At this time (2/22/2022) there are no areas of California under quarantine.

California Distribution: In April 1996, following detections of Karnal bunt in wheat fields in the Palo Verde Valley near Blythe, Riverside County, and in the Bard and Winterhaven areas of Imperial County on the Arizona border, a quarantine was imposed by USDA. In July 1997, USDA lifted the quarantine and established regulated areas classified according to specific risk categories. Following years of negative surveys, it was declared eradicated from the state in 2010.

California Interceptions: None

The risk *Tilletia indica* would pose to California is evaluated below.

Consequences of Introduction:

- 1) Climate/Host Interaction:** The highest incidence of disease occurs when the temperature ranges from 18-22.5° C and relative humidity is above 70% (Aujla et al., 1977). The Imperial Valley has higher
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temperatures and lower relative humidities, but the disease was detected there in 1996. The San Joaquin Valley could have favorable conditions for disease development.

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 natural host range is limited to wheat and wheat hybrids

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: The pathogen reproduces with airborne spores and can move with infected or infested 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: Yield losses from Karnal bunt are generally low. However, the impact on the quality of the grain with the fishy smell is an important reason to impose quarantines to stop the spread.

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

Economic Impact: A, B, C

- 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.
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- High (3) causes 3 or more of these impacts.

- 5) **Environmental Impact:** Imposition of quarantine or regulated areas has a major impact on the ability to harvest and move wheat crops.

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

Environmental Impact: D

- 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 *Tilletia indica*: 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.

Karnal bunt was detected in California in 1996. It was declared eradicated in 2010.

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.
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-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:

Karnal bunt is known to occur in regions of arid and semi- arid climate with hot summers, mild cold winters with some rain. Climatic changes predicted include increased temperature, change in precipitation, increased CO₂, and drought. These changes may make wheat more susceptible in some parts of California.

Conclusion and Rating Justification:

Based on the information provided above the proposed rating for *Tilletia indica* is **A**.

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Responsible Party:

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***Comment Period: 03/18/2022 through 05/02/2022**

***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 [a] 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: A
