

## California Pest Rating Proposal for *Ustilago maydis* (DC.) Corda 1842

### corn smut

**Current Pest Rating: C**

**Proposed Pest Rating: C**

Kingdom: Fungi; Phylum: Basidiomycota;  
Class: Ustilaginomycetes; Order: Ustilaginales;  
Family: Ustilaginaceae

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**Comment Period: 02/27/2020 through 04/12/2020**

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#### **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 *Ustilago maydis* is given herein and a permanent pest rating is proposed.

#### **History & Status:**

##### **Background:**

*Ustilago maydis* (syn. *Ustilago zaeae*) has the common name of corn smut or boil smut. Smut-infected plants display characteristic tumors, consisting of hypertrophied plant tissue and massive numbers of black fungal teliospores. *Ustilago maydis* has been grouped taxonomically with the heterobasidiomycete fungi, whose other members include jelly fungi and rusts. The genetics of the *U. maydis*–maize pathosystem has been studied extensively and provides a model biological system to understand fungal mating, morphogenesis, and fungal–plant interactions (Grandel et al., 2000).

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In Mexico, corn smut is known as “cuitlacoche”. Young fungal galls that form on the ears of corn are collected and eaten, either cooked or raw, like edible mushrooms. They are sometimes referred to as “maize mushrooms” or “Mexican truffles” although biologically they are distinct from both (Pataky and Snetselaar, 2006).

*Hosts:* *Zea mays* (maize), *Zea mays* subsp. *mays* (sweetcorn), *Zea mays* subsp. *mexicana* (teosinte).

*Symptoms:* The fungus produces black, spherical or ellipsoidal, 2-celled teliospores. Teliospores germinate and produce a four-celled basidium from which 8 haploid basidiospores develop. Basidiospores germinate and produce a fine, haploid hypha, which can enter epidermal cells directly. After this initial phase, its growth stops and the hypha usually withers and sometimes dies, unless it contacts and fuses with a haploid hypha derived from a basidiospore of the compatible mating type. If fusion takes place, the resulting hypha becomes dikaryotic, enlarges in diameter, and grows into the plant tissues. It grows mostly intercellularly and causes a localized infection that leads to the formation of large galls on any of the aboveground plant parts (Christianson, 1963; Pataky and Snetselaar, 2006; Grandel et al., 2000).

Smut galls consist of both fungal and host tissues. Young galls are white, firm, and covered with a semi-glossy periderm. As galls begin to mature, interior tissue becomes semi-fleshy and streaks of black tissues develop as teliospores begin to form. Galls become a mass of powdery teliospores and the periderm ruptures releasing the spores. On corn ears, galls mature about three weeks after the ovaries are infected. Galls start to have a gray, silvery appearance as streaks of blackened tissues begin to form. About 70% of the gall tissue is blackened while 30% retain a semi-fleshy, mushroom-like integrity 16 to 18 days after infection. By 21 to 23 days after infection, the periderm ruptures and galls become a sloppy, wet mass of teliospores. When dehydrated, galls become sooty, powdery masses of teliospores (Pataky and Snetselaar, 2006; Agrios, 2005).

*Transmission:* The fungus overwinters as teliospores in crop debris and in the soil, where it can remain viable for several years. In the spring and summer, teliospores germinate and produce basidiospores, which are carried by air currents or are splashed by water to young, developing tissues of corn plants. Released teliospores have the potential to cause new infections during the same season, if they land on young meristematic corn tissues, but most of them fall to the ground or remain in the corn debris, where they can survive for several years (Shurtleff, 1980).

*Damage Potential:* Sweetcorn is generally more susceptible to *U. maydis* than field corn (Christianson, 1963). The number, size, and location of galls depend on the age of plants at the time of infection. Losses vary from a trace to up to 10% or more in different geographic areas (Shurtleff, 1980). Leaf galls differ greatly in size but usually are small when compared to stalk and ear galls. Galls 20-30 cm in diameter are common on the stalk. Rudimentary ear shoots below the fertile ear are commonly infected. Galls can replace most of the tassel or individual florets depending on the time and severity of infection. Galls on the ears usually result from infection of individual ovaries. Commonly, a few kernels at the tip ends of the ear are infected, although nearly every kernel on an ear may be replaced by smut galls if most ovaries are infected (Urecht, 1972; Thakur et al., 1989). No corn varieties or hybrids completely resistant to smut are known, but several corn hybrids show moderate resistance.

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New pathogen races appear constantly, however. Therefore, partial resistance is the major type of resistance selected for in breeding programs. Disease control is achieved via the removal smut galls before they break open, crop rotation, and planting of small, isolated plots (UC IPM; 2020).

**Worldwide Distribution:** Widespread in Asia, Africa, Europe, North America, Central America, the Caribbean, South America, and Oceania (CABI CPC, 2020; Farr and Rossman, 2020).

**Official Control:** *Ustilago maydis* is on the harmful organism list for Cambodia, Egypt, New Caledonia, New Zealand, Oman and the United Arab Emirates (USDA PCIT).

**California Distribution:** Widespread including Butte, El Dorado, Fresno, Glenn, Imperial, Kings, Madera, Monterey, San Joaquin, Solano, Trinity, and Yolo Counties (French, 1989; CDFA PDR database).

**California Interceptions:** none

The risk *Ustilago maydis* would pose to California is evaluated below.

## Consequences of Introduction:

- 1) Climate/Host Interaction:** This pathogen has already been recorded in multiple climates in the state including in the desert, in the Central and San Joaquin valleys, and on the coast.

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 narrow, only *Zea* is susceptible

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 Dispersal Potential:** *Ustilago maydis* spreads by windblown spores but is not seed-borne.

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.**
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- High (3) has both high reproduction and dispersal potential.

- 4) Economic Impact:** This pathogen can lower the yield of some *Zea mays* varieties. However, it can also be a desirable, edible product and can have a positive economic value.

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

**Economic Impact: A**

**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: 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:** There are no native *Zea* species in California. *Ustilago maydis* can occur in home/urban gardens but the impact is generally insignificant

**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 *Ustilago maydis* here:**

Add up the total score and include it here. **8**

**-Low = 5-8 points**

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-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'**. CDFA has detection records from multiple counties statewide.

**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: (Score)

**Final Score:** *Score of Consequences of Introduction – Score of Post Entry Distribution and Survey Information = 5*

**Uncertainty:**

None.

**Conclusion and Rating Justification:**

Based on the evidence provided above **the proposed rating for *Ustilago maydis* is C.**

**References:**

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### Responsible Party:

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**\*Comment Period: 02/27/2020 through 04/12/2020**

### \*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](mailto:permits[@]cdfa.ca.gov).

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### Comment Format:

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- ❖ 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: C**

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