Rice False Smut

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False smut has historically been considered a minor rice disease in the United States. However, in recent years it has emerged as a significant threat to rice production with the potential to cause yield losses in susceptible rice cultivars when weather favors disease development (Zhou et al., 2024). An area that is seldom discussed in relation to the U.S. rice production system is the production of mycotoxins that can accumulate in rice kernels from those plants affected by the false smut fungus.

False smut was first reported in Arkansas in 1997 and is now likely widespread where rice is grown. False smut directly impacts grain yield and quality by partially or completely replacing rice kernels with fungal spore masses. This substitution disrupts normal grain development, leading to significant reductions in both quantity and quality of a harvest. Managing this disease using an integrated approach can minimize its impacts and help growers produce a profitable rice crop.

Causal agent

False smut is caused by the fungus *Ustilaginoidea virens* (syn. *Villosiclava virens*).

Signs and Symptoms

Ustilaginoidea virens infects rice plants during panicle development. The signs and symptoms of false smut (Fig. 1A) become visible generally two to three weeks after flowering. False smut spore balls are typically globose in shape and have a velvety texture (made up of powdery chlamydospores). As the chlamydospores develop and grow, the spore balls break and expose the white chlamydospores in the early stages of infection. Over time, the white spore mass transitions into a light-yellow coloration, followed by a progression to yellow-orange (Fig. 1B). At maturity, the spore balls become green and greenish-black (Fig. 1C). Often, only a few kernels are affected in each rice panicle. The disease incidence is highly dependent on cultivar susceptibility and weather conditions.

Figure 1. False smut signs and symptoms on rice kernels, displaying sequential color changes: initial white smut balls (A), progressing to yellow-orange (B), and maturing to greenish-black (C). *Photo credits: (A) Yeshi Wamishe, (B) Camila Nicolli, (C) Samuel de Paula*

Conditions favoring disease occurrence

The development of false smut is significantly influenced by environmental conditions. The optimal temperature range for disease development is 77°F to 86°F. It is also associated with high relative humidity (>90 %), frequent rainfall and high soil nitrogen content. Elevated soil nitrogen levels are often associated with crop rotation involving soybean or excessive nitrogen fertilizer application. Also, late planting has been reported to contribute to the greater incidence and severity of false smut.

Figure 2. Survival structures of the rice false smut pathogen (*Ustilaginoidea virens*, syn. *Villosiclava virens*), depicting sclerotia (A, B) and chlamydospores (C). *Photo credit: (A) & (B) Bodrun Nessa, (C) Peng Guo*

Disease Cycle

The false smut pathogen survives in both rice seed and soil via sclerotia (Fig. 2A-B; Fig. 3) and chlamydospores (Fig. 2C). Sclerotia, a high-density fungal hyphae mass that is produced at the sexual stage, can remain dormant for several years (Yong et al., 2018). Under favorable environmental conditions (high humidity (>90 %) and temperatures between 77°F and 86°F, sclerotia germinate to produce asci-containing ascospores (sexual phase spore) (Sathiyaseelan et al., 2025; Fan et al., 2016). Ascospores facilitate initial infection during the flowering stage (Sunani et al., 2024; Zhou et al., 2024). Chlamydospores, corresponding to the asexual stage, persist for extended periods and act as the primary inoculum source following overwintering. Chlamydospores produce secondary conidia, further contributing to initial infection.

Figure 3. Smut balls of false smut can contaminate post-harvest rice seed, acting as a primary inoculum source for subsequent growing seasons. *Photo credit: Camila Nicolli*

U. virens infect stamen filaments during the rice booting stage, replacing floral organs with fungal mycelia. Initial symptoms emerge

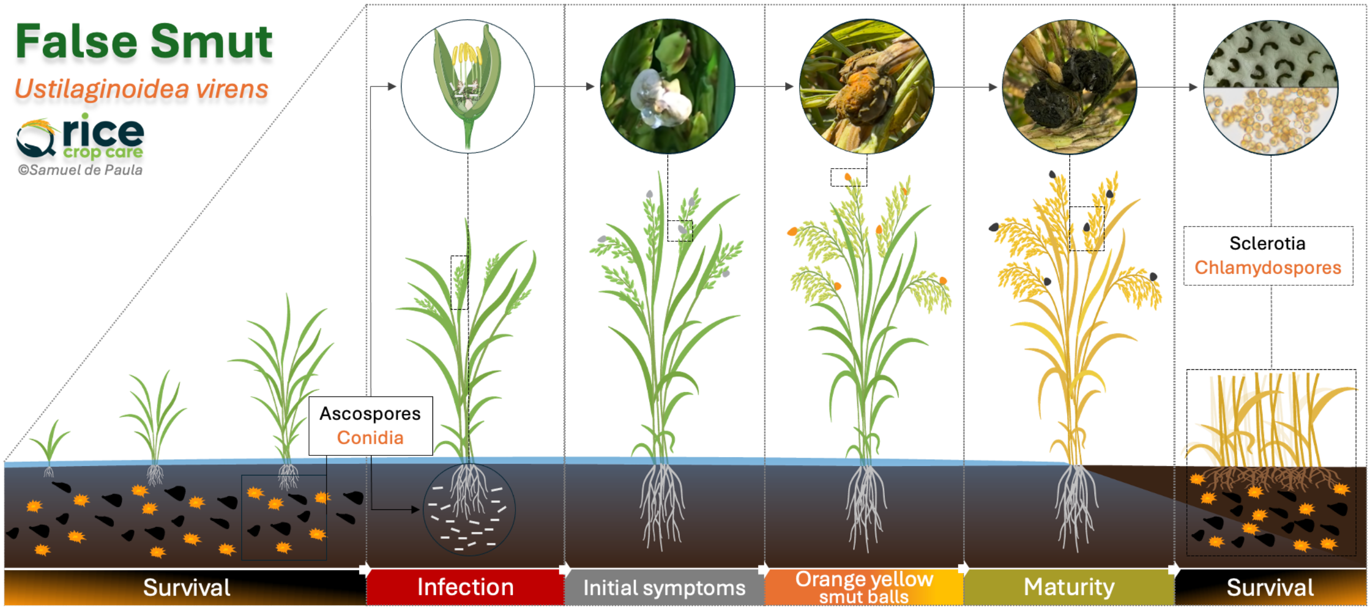

Figure 4. The false smut disease cycle caused by *Ustilaginoidea virens* (syn. *Villosiclava virens*) in rice crops. The figure illustrates the survival of sclerotia and chlamydospores in the soil and post-harvest seed, the pathogen's infection of the stamen and possibly roots, and the progression of the disease through smut ball color changes. At the end of the rice crop season, survival structures (sclerotia and chlamydospores) remain in the soil and harvested seeds until the next growing season. *Photo credit: Samuel de Paula*

two to three weeks post-flowering (Fig. 4). Infected grains are larger than healthy grains, with white, enlarged palea that envelop the seed. Over time, chlamydospores transition from orange-yellow to greenish-black smut balls. At maturity, the smut ball surface becomes covered with sclerotia, surrounded by abundant chlamydospores. Both sclerotia and chlamydospores can survive in field soil and on post-harvest seed for months, serving as sources of inoculum for subsequent growing seasons (Fig. 4).

Despite advances in understanding the *U. virens* life cycle, debates persist regarding the relative importance of sclerotia versus chlamydospores as the dominant primary inoculum source and the potential role of additional hosts in disease epidemiology. Additionally, the hypothesis that *U. virens* infects roots at the seedling stage as a soilborne pathogen, leading to asymptomatic colonization, and stamen by air, with both mechanisms potentially contributing to the initial infection, is still unclear (Sathiyaseelan et al., 2025; Sunani et al., 2024).

Managing False Smut

In Arkansas, cultivars with documented resistance to false smut are limited, with the bulk of the current rice cultivars being on the order of moderately susceptible, or very susceptible phenotypes (Hardke et al., 2024). Therefore, an integrated management approach should include avoiding late planting, the excessive application of pre-flood nitrogen fertilizer and preventative fungicide applications in fields with a history of disease or where cultivars with known susceptibility to false smut are planted.

Fungicide control is limited, as available fungicides can only suppress false smut. Early to mid-boot fungicide application may be beneficial if the most effective chemistries are applied. Propiconazole (e.g., Tilt 3.6 EC at 6.0 fl oz/ac; PropiMax 3.6 EC at 6.0 fl oz/ac) or the combination of trifloxystrobin + propiconazole (e.g., Stratego 2.08 EC at 19.0 fl oz/ac), azoxystrobin + propiconazole (e.g., Quilt Xcel 2.2 EC at 15.75-27.0 fl oz/ac), or azoxystrobin + difenoconazole (e.g., Amistar Top 2.72 SC at 10.0-15.0 fl oz/ac) may effectively suppress false smut.

Resources

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