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SORGHUM SMUTS

Smuts are one of the most important diseases of sorghum in much of the Midwest, especially where untreated seed is planted. Damage is confined almost entirely to the head or panicle, reducing both the grain yield and forage value. Three sorghum smuts are common in the Midwest: covered kernel smut, loose kernel smut, and head smut. Each one is caused by a different species of the fungus *Sporisorium*.

Figure 1. Covered kernel smut on sorghum.

Covered Kernel Smut

Covered kernel smut, caused by the fungus *Sporisorium sorghi* (synonym *Sphacelotheca sorghi*) attacks all groups of sorghums, including johnsongrass. Covered kernel smut is the most common disease of sorghum in Illinois and other states where farmers plant untreated seed. Usually, **all** of the kernels in a smutted head are destroyed and replaced by dark brown, powdery masses of smut spores (teliospores or chlamydospores) covered with a tough, grayish white or brown membrane (Figure 1). The membrane usually ruptures at harvest time. The infected kernels (smut sori) break, and the microscopic spores adhere to the surface of healthy seeds where they overwinter. Only seeedborne spores cause infection. Smut sori are generally smooth; oval, conical or cylindrical; and vary in size from those small enough to be concealed by the glumes to those over one cm long. They may be white, gray, or brown.

When a smut-infested kernel is planted, the teliospores (mostly 4 to 7 microns in diameter) germinate along with the seed forming a 4-celled promycelium (epibasidium) bearing lateral sporidia (Figure 2). The sporidia germinate and infect the developing sorghum seedling. (Sometimes the teliospores germinate directly by producing germ tubes). Once inside the seedling, the fungus grows systemically, apparently without damaging the plant until heading. At that time, the teliospores replace kernels and are surrounded by a membrane. At maturity, the membrane ruptures releasing the teliospores to contaminate seed or soil. Soilborne teliospores are not considered important in infecting seedlings. The incidence of smut decreases when seed is planted in progressively warmer, wet soils that are 60° to 90°F (15.5° to 32°C). Several distinct physiologic races of the covered smut fungus are known.

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Loose Kernel Smut

Loose kernel smut, caused by the fungus *Sporisorium cruentum* (synonym *Sphacelotheca cruenta*) is less widespread than covered kernel smut. Loose kernel smut attacks all groups of sorghums, including johnsongrass, although certain varieties in some groups are immune or highly resistant. Sudangrass is usually not infected.

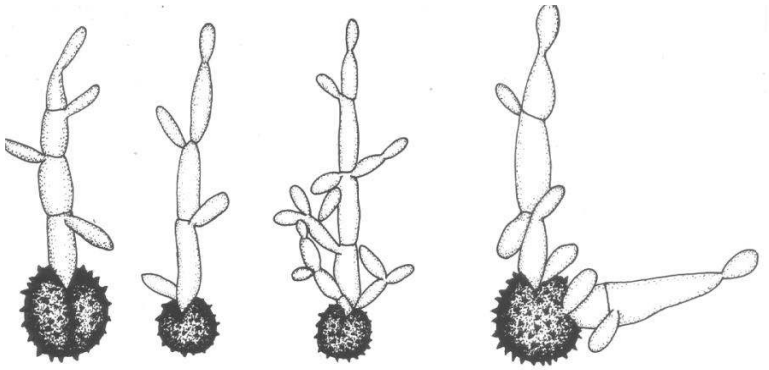

Figure 2. Teliospores of Sporisorium as they would appear under a high-power microscope. Each spiny, dark teliospore has germinated to produce a 4-celled promycelium that bears sporidia terminally and near the septa. The sporidia may sprout to form secondary sporidia or may germinate to form a germ tube that penetrates a sorghum seedling. (Drawing by Lenore Gray.)

Normally, all kernels in an infected panicle are smutted. Partial destruction is rare. Some kernels may be transformed into leafy structures or escape infection completely. Individual kernels are replaced by small smut galls (or sori) that are 2.5 cm or longer, pointed and surrounded by a thin gray membrane. This membrane usually ruptures when or soon after the panicle emerges from the boot (Figure 3B). Smutted panicles appear earlier than the remainder of the crop and are more open than healthy panicles. The powdery, dark brown to black spores (teliospores) are soon blown away, leaving a long, black, pointed, conical, often curved structure (columella) in the center of what was the gall. Some smut spores (6 to 10 microns in diameter) adhere to the surface of healthy kernels on neighboring plants in the same field or ones nearby before and during harvest. When such infested kernels are planted, the teliospores germinate along with the seed by first forming a thick, usually 4-celled promycelium bearing lateral sporidia (Figure 2). The sporidia germinate and infect the developing sorghum seedling. Most infections, however, result from the teliospores producing hyphae which penetrate young seedlings before emergence. Seedling infection occurs over a wide range of soil moisture and pH at a temperature of 68° to 77°F (20° to 25°C). The fungus continues to grow systemically within the plant unobserved until heading, when the long, black, pointed smut galls develop in place of normal kernels.

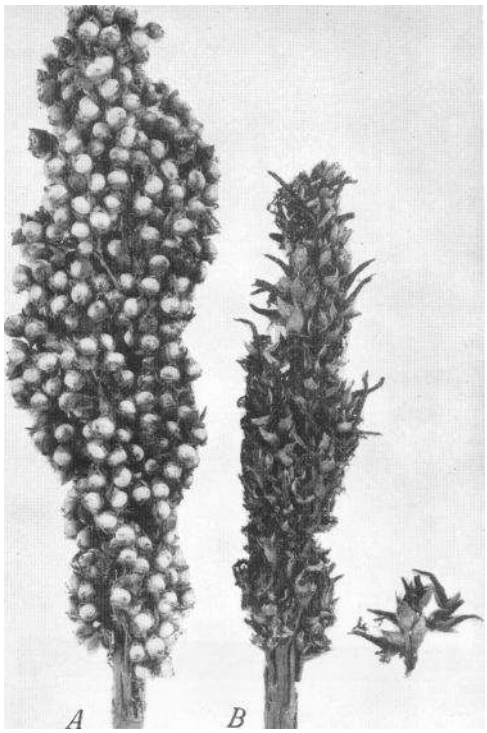

Figure 3. Loose kernel smut of sorghum: A, healthy head; B, head infected with loose kernel smut–kernels have been replaced by smut masses that have been largely blown away, leaving the prominent columellas. (USDA photograph).

Unlike covered kernel smut, plants affected with loose kernel smut are stunted, have thin stalks, and heads emerge earlier than healthy plants. Abundant side branches (tillers) also may develop. Occasionally, the tillers are smutted, while the primary head is not.

Secondary infection may occur in loose kernel smut when spores from a smutted head infect late-developing heads of healthy sorghum plants, causing them to become smutted. Localized infection of floral parts from airborne spores may occur.

Teliospores in the soil are not important in terms of infecting seedlings. Several physiologic races of the loose kernel smut fungus exist. The fungus is heterothallic and is able to hybridize with both the covered kernel and head smut fungi, complicating the problem of developing resistant hybrids.

Head Smut

Head smut caused by *Sporisorium holci-sorghi* (synonyms *S. reilianum* and *Sphacelotheca reiliana*) is not so widespread and damaging in the Midwest as the kernel smuts. Head smut attacks both corn and sorghums, being more common on the latter. Separate physiologic races occur on corn and on sorghums. Head smut has increased in severity proportionately to intensive cultivation of susceptible hybrids. Smutted plants also have weakened root systems and commonly exhibit more severe stalk and root rots than smut-free plants.

Infection first appears when the young head, enclosed in the boot, is usually completely replaced by a large smut gall covered by a thick whitish membrane. The membrane soon ruptures, often before the head emerges, exposing a mass of dark brown to black, powdery teliospores intermingled with a network of long, thin, dark, broomlike filaments of vascular tissue (Figure 4). The head may be totally smutted with characteristic "witches' brooms," i.e., many small, rolled leaves protruding from the heads of suckers at the nodes or joints of some sweet sorghums and sudangrass cultivars. Some cultivars are dwarfed; others are stunted due to a lack of elongation of the peduncle. Wind and rain quickly scatter the smut spores to the soil and plant debris, where they live through the winter.

Figure 4. Head smut (Sphacelotheca reilianum).

Parts of an infected panicle not included in the smut gall or sorus usually show a blasting (sterility) or proliferation of individual florets. Smut galls may occasionally develop on the leaves and stems in some cultivars of sweet sorghums and sundangrass.

When sorghum seed is planted the following spring, the smut spores (9 to 14 microns in diameter) already in the soil germinate along with the seed to form a 4-celled or branched promycelium that bears sporidia terminally and near the septa. The sporidia may sprout to form yeastlike secondary sporidia (Figure 2) or may germinate to form a germ tube that penetrates meristematic tissue in the sorghum seedling. Germination is highest in moist soil where the temperature is 81° to 88°F (27° to 31°C). Like the kernel smuts, head smut is not evident until heading time. The fungus develops only in actively growing meristematic tissue. The smut spores also may cling to the surface of sorghum seed, introducing the smut fungus into the soil of fields not previously infested. Apparently, seedborne spores are not important in causing infection.

Control

1. Covered and loose kernel smuts are easily and effectively controlled by treating the seed with a protectant fungicide. Seed treatment prevents introducing the head smut fungus into uninfested fields. Fungicide seed treatment also improves and stabilizes the stand when soil insects are not a

problem. In addition, it provides protection against seedling blight fungi in the soil. Suggested fungicide for treating sorghum seed are given in the current Illinois Pest Control Handbook. Essentially all commercial sorghum seed is now treated by the seed processor.

2. Because there are a number of physiologic races of the three sorghum smut fungi, which can also hybridize with one another, it is extremely difficult to develop highly resistant or immune hybrids, varieties or cultivars of sorgho (sweet sorghum), gurno, feterita, hegari, kaffir, durra, and milo types of sorghum as well as sudangrass and broomcorn. Check with your seed dealer as to what sorghums have performed best in your area. Those varieties, hybrids, and types of sorghum that are resistant to races of covered kernel smut usually are resistant to races of loose kernel smut. Head smut is most damaging to sorgho, durras, and hybrids between these two sorghum groups, but progress in developing disease resistant varieties has been made. Most sweet sorghum varieties are highly resistant.

3. Where feasible, promptly remove and burn head smut galls before the spores are scattered.

4. Since the head smut fungus may live in the soil for several years grow sorghum in the same field only once in 4 years. Such a rotation also helps to control other diseases that attack the leaves, heads, stalks, and roots.