



fungus diseases affecting grain and seed quality in **WHEAT**

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Diseases affecting wheat grain reduce yield and/or quality. These diseases include black point, ergot, common bunt, loose smut, and scab (*Fusarium* head blight). The fungi causing ergot and scab also produce toxins, which pose a health risk to humans and animals. Yield losses caused by smuts are roughly equal to the percentage of smutted heads in the field; however, losses from black point, scab, or ergot are less easily measured. Grain affected by black point, ergot, common bunt, or scab can be discounted or rejected at the elevator depending on the level of damage or contamination.

Black Point

Black point, also known as kernel smudge, is characterized by a brown to black discoloration of the embryo region of the grain (*Figure 1*). It is caused mainly by fungi in the genera *Alternaria* and *Bipolaris*. These fungi live as saprophytes on crop residue and in the soil but also can parasitize plants, causing disease. Their spores are abundant in the air. Infection of wheat heads takes place during wet weather from flowering to grain maturation. Expanding green kernels are most susceptible; however, because the causal fungi are saprophytic, premature grain senescence also favors black point. The disease adversely affects grain quality. Discolored grain is discounted in value because the milled flour contains dark specks. In U.S. Wheat Grades No. 1 and No. 2, only 2 percent and 4 percent, respectively, of darkened kernels are allowed.

Black point is favored by prolonged rainfall during grain maturation. Wet weather promotes sporulation and infection by the black point-causing fungi. These fungi are endemic to soils and crop residue, which ensures a source of pathogen inoculum.

Symptoms

- Brown to black discoloration around the embryo region of the grain.
- Endosperm turns brownish-gray.
- Reduced germination.
- Dark brown discoloration on the coleoptile of infected seedlings.

Management

- Store grain under cool, dry, and well-ventilated conditions.
- Avoid using affected grain as seed.
- Treat seed with a systemic fungicide to improve germination and reduce seedling infection.



Figure 1. Black point is characterized by a brown to black discoloration of the embryo region of the grain (arrow).

Ergot

The ergot fungus, *Claviceps purpurea*, is endemic to the Great Plains wheat producing region of North America. This disease occurs, to some extent, every year in cereal grains and pasture and roadside grasses in Nebraska. Rye is the principal small grains host. Spores of the ergot fungus infect floral tissues on the head prior to fertilization or within the first few days after fertilization. The closed glumes of self-pollinated grasses, such as wheat, present a physical barrier to infection, resulting in a relatively low incidence of ergot in wheat. However, commercial winter wheat cultivars grown in Nebraska are not immune to infection, and the disease occasionally causes problems with grain quality. Ergot is a potential threat to hybrid wheat production because the open-floreted, male-sterile wheat lines used for hybrid seed production are often susceptible.

Primary infections are caused by spores produced by fruiting structures on germinating sclerotia on the soil surface. Secondary infections originate from spores produced in honeydew exuding from infected florets. These spores are wind blown, rain-splashed, or disseminated by insects to nearby wheat heads. Infected grasses in roadsides, waterways, or fence rows contribute to primary and secondary inoculum, infecting adjacent wheat. Sclerotia from the previous year's infections present on the soil surface germinate in response to moisture by forming stromata (compact masses of specialized vegetative hyphae). Fruiting structures produced on the stromata release infective spores. Following infection of florets, the ovaries enlarge and are converted from base to tip into sclerotia (ergots). If heading of the grasses roughly coincides with that of the wheat, both crops may become infected. More likely, spores in the honeydew



Figure 2. Wheat grain contaminated with ergot sclerotia also known as ergot bodies or ergots (arrows).

of infected grasses are blown into receptive wheat heads at flowering.

Wheat heads are most susceptible just before anthesis (stage in flowering at which anthers rupture and shed pollen). Cool, wet weather that accompanies or prolongs flowering in the grasses and wheat favors infection and honeydew formation.

Not all the sclerotia in harvested wheat may have originated from infected wheat heads. Some may be from infected grasses or rye in the field and mixed in with the wheat, contaminating the grain and causing the wheat to be graded as ergoty. Sclerotia from grasses usually are more slender or flattened in shape than those produced in wheat, whereas those from rye are usually fairly large.

Federal grain standards classify wheat as ergoty if the harvested grain contains more than 0.30 percent sclerotia. These low tolerances are necessary because the sclerotia contain several compounds (alkaloids) that are toxic to humans and animals. Because ergotism in livestock is a real threat, it is best if livestock producers adopt a zero tolerance for sclerotia in either hay or grain feed. Suspect hay or grain can be assayed for alkaloids by the University of Nebraska–Lincoln Veterinary Diagnostic Center. Mail samples or packages to:

**Veterinary Diagnostic Center
P. O. Box 832646
Fair Street and East Campus Loop
University of Nebraska–Lincoln
Lincoln, NE 68583-2646**

Symptoms

- Initial symptoms are the presence of thick, amber-colored droplets called “honeydew” exuding from infected florets and adhering to the head.
- Purple-black hornlike sclerotia (ergots) protrude from the glumes of mature heads.
- Intact or broken sclerotia contaminate harvested grain (*Figure 2*).
- Sclerotia may be similar in size and shape to a wheat kernel, or they may be more irregularly shaped and larger than the kernel.

Management

- Use sclerotia-free seed.
- Mow grasses in headlands, roadsides, and waterways before they head.
- Survival rate of sclerotia on the soil surface is about one year; therefore, crop rotations or longer (14 month) fallow periods reduce the risk of carryover infections from sclerotia within the field.
- Grain cleaning removes most but not all sclerotia.
- Removal of sclerotia by flotation in brine (20 percent salt solution) is useful for small, high-value seed lots. The sclerotia float and the grain sinks in the brine solution.

Common Bunt

Common bunt, also known as stinking smut, is caused by two fungi, *Tilletia tritici* and *T. laevis*. Grain contaminated with bunt spores (Figure 3) has a darkened appearance and gives off a pungent, fishy smell. Bunted grain can be discounted or rejected at the elevator. Livestock often refuse to eat it because of the smell and low palatability.

Large masses of bunt spores are easily ignited and can cause explosions and fires during harvesting and in grain storage facilities. Workers handling bunted grain should wear dust masks because inhaling spores may create respiratory problems for people with allergies. Bunted grain produces off-white flour with an objectionable odor.

Because it requires cool, moist soil conditions for infection, common bunt is less of a problem on spring wheats than on winter wheats. The disease cycle is similar to that of other covered smuts of small grains. When infected grains are harvested, the bunt balls break and contaminate the grain, combine, storage facilities, and soil with spores. In the field, the bunt spores can survive up to two years in arid regions. If infested seed is planted, the spores on the seed coat or in the soil germinate in response to moisture. The mycelium penetrates directly through the cuticle of the seedling coleoptile before emergence. Optimum temperatures for spore germination and mycelial infection of the coleoptile are 42-50°F (6-10°C). The

mycelium grows within the terminal meristem (growing point) of the developing wheat plant and eventually colonizes the developing ovary where it displaces the seed tissues with spores. There are no signs or symptoms of infection until the head matures. Normally, tillers also are infected and entire plants, including heads, are smutted.

Symptoms

- Bunted heads are slender, have an open appearance and stay green longer than healthy heads.
- Glumes are normal in size and shape but are more open on infected heads.
- Seed contaminated with bunt spores has a darkened appearance and a pungent, fishy odor.
- Bunt balls in harvested grain are dull gray and they resemble kernels but are more rounded (Figure 3).
- Cloudy masses of black spores may be present during harvesting.

Management

- Use certified pathogen-free seed.
- Treat seed with a fungicide before planting.
- Plant resistant cultivars.



Figure 3. Common bunt of wheat. The kernels are filled with masses of black spores (arrows).

Loose Smut

Like common bunt, loose smut, caused by the fungus *Ustilago tritici*, also is a seed-borne disease of wheat. *U. tritici* is unique among the wheat smuts in that it is incorporated into the developing kernel and persists inside the grain. Affected grain shows no symptoms and outwardly appears healthy. Generally, yield losses attributed to loose smut in the Great Plains are low (less than 1 percent annually). However, up to 40 percent yield loss can occur in individual fields. Unlike common bunt, the presence of *U. tritici* in grain has little effect on quality for milling or feed, but the infected grain should not be used as seed without first being treated with a systemic fungicide.

The disease cycle starts when the infected seed is planted. Mycelium of *U. tritici* is present in all parts of the seed. When the infected seed germinates, dormant mycelium in the embryo becomes active and growth keeps pace with the growing point of the developing seedling. When the growing point terminates in a head, the fungus replaces the grain and other tissues with a mass of spores. Smutted heads emerge slightly earlier than healthy heads. Spores from these heads are blown to healthy heads during flowering where they germinate and become established as dormant mycelium in the developing kernel. Infection is favored by wet, humid weather and a temperature range of 60-70°F (16-22°C).

Other than symptoms, loose smut differs from common bunt in that it is an embryo-infecting

pathogen that is carried inside the seed as dormant mycelium. Common bunt is a seedling-infecting pathogen that has spores that are carried on the outside of the seed coat or are present in the soil.

Symptoms

- Smutted heads are transformed into olive-black masses of smut spores visible only at heading (*Figure 4*).
- Initially, the spore masses are covered by a delicate gray membrane that soon breaks.
- After the membrane ruptures, the spores are dislodged, leaving behind the naked rachis and some spores clinging to fibers on the head.
- When spikelet tissues are not completely destroyed, the rachis may bear remnants of glumes and awns.
- All or only a few of the heads on an infected plant may be transformed into smut spores.

Management

- Use certified pathogen-free seed.
- Treat seed with a systemic fungicide before planting.
- Plant resistant cultivars.



Figure 4. A loose-smutted wheat head with kernels transformed into olive-black masses of smut spores.

Scab

Scab, or *Fusarium* head blight, is caused primarily by the fungus *Fusarium graminearum*, but other species of *Fusarium* including *F. culmorum* and *F. avenaceum* can cause the disease. These pathogens occur as soil inhabitants as well as saprophytes on crop residues and are always present. In addition to causing scab, they also cause seed decay, seedling blight, and crown and root rot of wheat. They cause stalk and ear rots of corn and sorghum.

Scab occurs sporadically in Nebraska due to a variable climate. In 2007 and 2008, major epidemics of the disease occurred in the south central and eastern parts of the state due to excessively wet weather during the growing season. The economic significance of scab is manifested by its effects on grain quality. Grain from blighted fields has reduced value as seed because blighted seedlings may develop from *Fusarium*-infected seed. Scabby grain (Figure 5) may contain the mycotoxins deoxynivalenol (DON) and, to a lesser extent, zearalenone. These mycotoxins reduce the milling, food, and feed value of the grain and pose health risks to humans and animals. Mycotoxin-contaminated grain can be discounted or rejected at the elevator.



Figure 5. Scabby wheat grain is shriveled and chalky white to pink in color (arrows).

Wheat heads are most susceptible to infection by airborne spores during anthesis (flowering); however, infection can occur up to the soft dough stage. Infection is favored by continuous wetness and extended moderately warm (68-86°F, 20-30°C) weather. The longer the wheat plants stay wet during flowering, the greater the chance of infection and increased severity. Infected heads are partially (Figure 6) or entirely bleached.

Corn, wheat, and sorghum residue play an important role in the survival and buildup of inoculum in areas where these crops overlap. Spores produced on these residues during wet weather at flowering are blown to the heads.

Infection during the soft dough stage does not significantly shrivel kernels. However, these kernels may contain mycotoxins and may not be suitable for use as seed due to the potential for seedling blight.

Seed Quality and Testing

The importance of using good quality seed cannot be overemphasized. Effective risk management dictates that the grower controls as many as possible of the inputs in his/her cropping system. Seed quality is one of the factors that influence yield. The grower influences the chances for a higher yield during seed selection. Using healthy, high-quality seed optimizes the chances of obtaining high yields. The phrase “high-quality seed” means different things to different people. High-quality seed is not perfect, but it is reasonably pure genetically and mechanically, and has met minimum quality standards for germination, purity, and weed seed. In addition, it has been tested for disease-causing pathogens. Because it is genetically pure and is a known cultivar, the area of adaptability is also known, so it can be produced where the growing conditions are best for that cultivar. The higher genetic purity also ensures that the plant characteristics that are best suited for specific farming practices are present (i.e., maturity range, straw height, protein characteristics, and disease and insect resistance).

Planting “bin-run” wheat seed that has not been tested for quality factors, is of questionable genetic purity, is several generations from breeder seed,

or has not been properly conditioned through air screening will lessen the likelihood of obtaining a good stand and high yields. It may also be a means of planting undesirable weeds back into the farm.

The use of “certified” seed that has been quality checked in the field and in the laboratory is the best assurance of planting healthy, high-quality seed. All certified seed has been checked for genetic purity, mechanical purity, and viability. Seed contaminating noxious or undesirable weeds, such as jointed goatgrass or rye seed, cannot be marketed as certified seed.

Seed is a very low proportion of the total production costs. High-quality seed usually does not cost as much in the long run as bargain seed or low-priced seed lots. In the end, low quality seed can be expensive in terms of poor stand establishment and future problems with weeds and diseases.



Figure 6. Premature blighting of individual spikelets or portions of heads caused by the *Fusarium* head blight fungus.

Symptoms

- Premature blighting of individual spikelets or portions of heads after the soft dough stage (Figure 6).
- Glumes are more open and dull in appearance.
- Brown discoloration of the peduncle (neck) that kills the entire head.
- During warm humid weather, pink to orange spore masses are produced at the base of spikelets or on glumes.
- Infected grain is lightweight, shriveled, and chalky white to pink in color (Figure 5).

Management

- Plant resistant/tolerant cultivars.
- Use crop rotations in which wheat does not follow wheat, corn, or sorghum.
- Do not overirrigate after full heading and especially during flowering.
- Apply a fungicide at early flowering if wet weather prevails before and during flowering.
- Increase airflow in the combine to remove as many as possible of the shriveled, scabby kernels.
- Treat seed with a systemic fungicide before planting.

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