Stored Grain Fungi

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There are a number of fungi which can invade and cause damage to grains and seeds. In general terms we can divide these fungi into two groups- field fungi and storage fungi.

Field fungi invade the seeds before harvest while the crop is still in the field. Field fungi may affect the appearance and quality of seed or grain. Usually damage caused by field fungi occurs before harvest, can be detected by routine inspection and does not continue to increase in storage if grain is stored at the proper moisture content and temperature. Most field fungi are more prevalent when rainfall is above normal during grain fill and harvest. Invasion by field fungi may be more severe is the crop has been damaged by insects, birds or hail. With corn, ears well covered by husks and maturing in a downwards position usually have less rot than ears with open husks or ears maturing in an upright position.

Field fungi common on corn in Missouri include species of *Alternaria, Cladosporium, Aspergillus, Penicillium, Diplodia, Fusarium* and *Gibberella.* Descriptions of the ear and kernel rots caused by these fungi on corn are given in Table 1 . Field fungi may also occur on soybean seed in the field with species of *Phomopsis* and *Cercospora* being the most common problems (Table 2).

Storage fungi (also called storage molds) are fungi which invade grains or seeds during storage. Storage fungi are usually not present to any serious extent before harvest. Small quantities of spores of storage fungi may be present on grain going into storage or may be present on spilled grain present in harvest, handling and storage equipment or structures. Under improper storage conditions this small amount of inoculum can increase rapidly leading to significant problems. The development of storage fungi in stored grain is influenced by the moisture content of the stored grain, the temperature of the stored grain, the condition of the grain going into storage, the length of time the is grain stored and the amount of insect and mite activity in the grain. The most common storage fungi are species of *Aspergillus* and *Penicillium.* These fungi are widely distributed and almost always present.

Conditions Under Which Storage Fungi are Likely to Damage Stored Grains

The major factors that determine when stored grains will be damaged by storage fungi are:

1. Moisture content- A moisture content below 13.5 percent in starchy cereal seeds such as wheat, barley, rice, corn and sorghum and below 12.5 percent in soybean prevents invasion by storage fungi regardless of how long the grains are stored. As the moisture content rises above these levels, invasion by storage fungi increases with temperature and time. It is also important to be aware that there is variation in moisture content through a grain mass. Storage fungi will grow where moisture is suitable and not according to the average moisture content of the grain mass. These moisture content limits for safe storage imply that nowhere in the bulk of grain is the moisture content higher than

that specified.
2. Temperature- In the range of temperature between 40 to 50 degrees F, storage fungi grow very slowly. At 80 to 90 degrees F, they grow much more rapidly.
3. Cracked and broken kernels and foreign material - Broken or cracked kernels are more likely to be contaminated with storage fungi going into storage and more likely to be invaded once they are in storage than sound kernels. Foreign material may restrict air movement through the grain mass leading to temperature and moisture problems which may favor storage mold development.
4. The extent to which grain in already invaded by storage fungi when it arrives at a given storage site- Grain invaded by storage fungi, even if not detected in ordinary inspection, is partly deteriorated and is a much poorer storage risk than grain free of storage fungi and otherwise sound. Grain moderately invaded by storage fungi develops damage at a lower moisture content, at a lower temperature and in a shorter time than does grain free or almost free of storage fungi.
5. Length of time the grain is to be stored- Grain that is to be stored for only a few weeks before it is processed can be stored safely with a higher moisture content and more extensive invasion by storage fungi and can be kept at a higher temperature than grain that is to be stored for months or years.
6. Amount of insect and mite activity in grain- Insects and mites may carry fungal spores on their bodies thus introducing storage fungi into the grain mass. Insect and mite activity in a grain mass tends to lead to an increase in both temperature and moisture content of the grain surrounding the insect infestation. In these 'hot spots' conditions may be favorable for mold growth.

Management Practices to Minimize Damage from Stored Grain Fungi

Little can be done to prevent or reduce the invasion of crops in the field by field fungi. However, the following recommendations should help prevent storage fungi problems or minimize damage from storage fungi in stored grains.

1. Harvest as soon as the moisture content allows for minimum grain damage.
2. Adjust the harvesting equipment for minimum kernel or seed damage and maximum cleaning.
3. Clean all grain harvesting and handling equipment thoroughly before beginning to harvest. Clean bins or storage facilities thoroughly to remove dirt, dust and other foreign material, crop debris, chaff and grain debris.
4. Clean grain going into storage to remove light weight and broken kernels or seeds as well as foreign material and fines.
5. Moisture content is by far the most important factor affecting the growth of fungi in stored grain. After harvest grain should be dried to safe moisture contents as quickly as possible.
6. Aerate grain to safe and equalized temperatures through the grain mass.
7. Protect grain from insect and mite damage.
8. Check stored grain on a regular basis and aerate as needed to maintain low moisture and proper temperature.
9. High moisture corn can be protected from storage molds with propionic acid or other organic acids sold under various trade names. It is important to follow label directions on rate and application methods. Grain treated with propionic acid can only be used for animal feed and it is not permitted in commercial grain channels.

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Table 1. Ear and Kernel Rots of Field Corn in Missouri

Disease: **Black corn**
Pathogen: *Alternaria* and *Cladosporium* species
Symptoms: Black, blue-black or olive green to olive brown mold growth develops on husks, kernels and cobs (Fig. 1). Individual kernels may have dark blotches or streaks. Pericarps may have split to reveal clumps or tufts of dark mold growth. Both fungi have common invaders of dead plant tissues so may be found on husks, leaves and stalks as well as on ears and kernels (Fig. 2).

Disease: **Diplodia ear rot**
Pathogen: *Diplodia maydis* and *Diplodia macrospora*
Symptoms: Dense white to grayish white mold growth matted between kernels and between the ear and the husks is common (Fig. 3). Small black fungal fruiting bodies may be scattered on husks, cob tissues and sides of kernels (Fig. 4). The husks of early infected ears appear bleached or straw colored. The entire ear may be grayish brown, shrunken, very lightweight and completely rotted.

Disease: **Fusarium ear rot**
Pathogen: *Fusarium moniliforme*
Symptoms: Damage tends to occur as a salmon-pink to reddish brown discoloration on caps of individual kernels scattered over the ear (Fig. 5). A powdery or cottony kernel or pink mold growth may develop on infected kernels. Frequently Fusarium kernel rot becomes established around tunnels made by corn earworms or cornborers.

Disease: **Gibb ear rot**
Pathogen: *Gibberella zeae*
Symptoms: Usually begins as a reddish mold at the tip of the ear (Fig. 6). Early infected ears may rot completely with husks adhering tightly to the ear and a pinkish to reddish mold growing between husks and ears. Although mold growth usually has pinkish to reddish color, it can appear yellow to yellow-orange or yellow-red. Gibb ear rot typically begins at the tip of the ear but under favorable conditions it can move down the ear causing extensive damage. It may also develop around injuries from hail, birds or insects (Fig. 7). *Gibberella zeae* is the perfect or sexual stage name for *Fusarium roseum* f. sp. *cerealis.*

Disease: **Penicillium rot**
Pathogen: *Penicillium* species
Symptoms: Evident as discrete tufts or clumps or a blue-green or gray-green mold erupting through the pericarp of individual kernels or on broken kernels (Fig. 8, Fig. 9). Colonies of *Penicillium* tend to be small, discrete colonies with a dusty or powdery appearance.

Disease: **Aspergillus**

Pathogen: *Aspergillus flavus*
Symptoms: Evident as a greenish-yellow to mustard yellow, felt-like mold growth on or between kernels, especially adjacent to or in insect damaged kernels (Fig. 10).

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Table 2. Field Fungi on Soybean Seed

Disease: **Pod and stem blight and Phomopsis seed decay**
Pathogen: *Phomopsis sojae* or *Phomopsis longicolla*
Symptoms: Pod and stem blight infected plants may be stunted and stems discolored. Black pycnidia or fruiting bodies of the causal fungi develop on the lower portion of the main stem, branches and pods as plants reach maturity (Fig. 1). The pycnidia may be limited to small patches of usually near the nodes or may cover dead stems and pods. On stems, the pycnidia are usually arranged in linear rows while on pods they are randomly scattered. Prolonged periods of warm, wet weather during flowering and pod fill favor the development of pod and stem blight. When conditions are wet late in the season the fungus may grow through the pod and infect the seed as well. Infected seed tends to be misshapen and moldy.

Disease: **Purple seed stain**
Pathogen: *Cercospora kikuchii*
Symptoms: *Cercospora kikuchii* can infect soybean seeds, pods, stems and leaves but is most commonly found on the seed. Infected seeds show a conspicuous discoloration varying in color from pink to pale purple to dark purple (Fig. 2). The discoloration may range from small specks to large blotches which cover the entire surface of the seed coat. Warm, humid weather favors disease development. Yields are usually not reduced but a high percent of seed stain may be evident at harvest.

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