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DISEASES OF CORN

Stalk Rots

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Stalk rots of corn are a common problem in Indiana and appear each year with varying degrees of severity. They are caused primarily by plant pathogenic organisms (such as fungi and bacteria), but they can also result from abiotic stresses (such as drought and flooding). Stalk rots leave stalks weak and unable to support the weight of the ear.

Yield losses occur when stalk and pith tissue degrade below the main ear, which leaves the stalk brittle and prone to lodging close to harvest (Figure 1). When these diseases weaken or destroy vascular tissue in the stalk, the plant cannot transport water or carbohydrates effectively, which ultimately results in premature plant death and reduced grain fill.

Figure 1. Stalk rot can cause lodged corn

This publication describes:

1. The signs and symptoms of stalk rots
2. The key causes of the seven most common stalk rots
3. Favorable conditions for each stalk rot
4. How to manage the diseases and minimize yield losses

Table 1 compares the various stalk rots for easy reference and identification.

Signs and Symptoms

Stalk rot signs and symptoms do not appear until late in the season. Many of the organisms that cause stalk rots are opportunistic pathogens that infect plants that are already weak because of nutrient or water imbalances, hail or insect damage, or foliar disease damage.

It is not uncommon for more than one stalk rot organism to colonize the same plant. Furthermore, when plants die prematurely, a wide array of secondary organisms that are not involved in stalk rot diseases often colonize the dead plant material. This makes accurate field diagnosis of stalk rots very difficult, especially close to or after harvest when natural senescence has already occurred. However, since management strategies differ based on the disease/disorder, it is important to accurately diagnose the cause of stalk rot.

Anthracnose Stalk Rot

Anthracnose stalk rot, caused by the fungus *Colletotrichum graminicola*, has increased in economic importance, and is now one of the most common stalk rots in Indiana. Anthracnose stalk rot is caused by the same fungus that causes anthracnose leaf blight. However, anthracnose leaf blight does not contribute to anthracnose stalk rot or vice versa.

Sometimes, stalk rot symptoms first occur in the upper canopy. When this happens, it is referred to as anthracnose top dieback. These top dieback symptoms are actually a phase of the stalk rot disease.

Anthracnose can infect corn at any point in the growing season, but infection is favored by cloudy, warm, and humid weather after silking. The fungus can infect roots, or rain and wind can disperse fungal spores from plant residues to corn stalks.

Infection occurs primarily through wounds caused by insect feeding, hail, mechanical damage, or other mechanisms. Symptoms appear just before natural senescence. The most obvious symptom of the stalk rot phase is shiny, black blotches on the lower internodes of the stalk (Figure 2). When pinched, the stalk collapses easily and one can see that the discoloration extends into the pith. Tiny, whisker-like, dark fungal appendages (called setae) may be seen on infected tissue with a hand lens.

In the top dieback phase, the upper part of the plant appears bleached, while the lower plant tissue remains green (Figure 3). Black lesions may be present on the stalks in the top internodes when the leaf sheaths are removed. When lodging occurs because of anthracnose stalk rot, the stalk may break higher up on the stalk compared to other stalk rots where the stalk breaks closer to the ground.

Figure 2. (A) Dark blotchy symptoms of anthracnose stalk rot. (B) Dark, rotting pith caused by anthracnose stalk rot.

Figure 3. Bleached upper stalks, typical of Anthracnose top dieback.

Bacterial Stalk Rot

Bacterial stalk rot, caused by the bacterium *Erwinia chrysanthemi* pv. *zeae*, is typically only a problem in irrigated fields (particularly seed corn fields). Unlike many of the fungal stalk rots, bacterial stalk rot can occur very early in the season.

Symptoms appear during warm, wet weather when the plant's whorl or leaf tissue traps bacteria-contaminated water. Plants growing in areas that are prone to flooding or ponding have a higher risk of infection than those growing in well-drained soil. Using overhead irrigation with contaminated surface water is a common source of infection.

Bacterial stalk rot symptoms include rotting of the plant internodes accompanied by a foul odor, which helps distinguish it from the fungal stalk rots. The rotting stalk material often appears dark brown, mushy, and slimy (Figure 4). Lodging often occurs in a twisting, rather than cracking, manner. Since the bacteria do not degrade the vascular tissue, the plant will likely remain bright green.

To decrease the risk of yield losses from bacterial stalk rot, avoid excessive irrigation using surface water (such as ponds, lakes, or slow-moving streams) that can potentially harbor the pathogen.

Figure 4. Bacterial stalk rot can cause a mushy rot early in the growing season.

Charcoal Rot

Charcoal rot of corn is caused by the same fungus that causes charcoal rot of soybean, *Macrophomina phaseolina*. The fungus can also infect alfalfa, sorghum, and a variety of weed species. This disease is typically a problem in hot, dry seasons when there is low soil moisture, particularly during the grain-fill period.

The fungus invades the stalk through roots and lower stems. It then progresses into the stalk and disintegrates the pith tissue. In the stalk, *M. phaseolina* creates many tiny structures (called microsclerotia) that give the inside of the stalk a speckled appearance, similar to a silvery black charcoal dust (Figure 5). Microsclerotia are the fungus' long-term, thick-walled survival structures, and they may also be visible on the roots and just below the stalk surface.

Figure 5. Charcoal rot causes shredded, gray stalk tissue.

Diplodia Stalk Rot

Diplodia stalk rot, caused by the fungus *Stenocarpella maydis* (previously known as *Diplodia maydis*), has become one of the more important stalk rots in recent years, and it is the same fungus that causes Diplodia ear rot.

Infection is favored by dry weather before silking, followed by warm, wet weather after silking. Corn is most susceptible during the post-silking period. The fungus primarily invades through the lower stalk tissue, crown, and roots.

Plant leaves may turn a dull green as the fungus destroys the pith. The stalk pith tissue of Diplodia-infected corn disintegrates similarly to both Gibberella and Fusarium stalk rots, but Diplodia-infected pith will not have any red or pink discoloration.

This fungus also produces diagnostic signs on the stalk's surface: small, black, flask-shaped, spore-producing structures called pycnidia (Figure 6). Unlike the blue-black fungal structures (perithecia) of Gibberella stalk rot that can easily be scraped off the stalk's surface, the pycnidia associated with Diplodia stalk rot are embedded in the stalk tissue and cannot be easily removed by scraping the tissue. The pycnidia can give the stalk a sandpaper-like texture.

Figure 6. Diplodia stalk rot lesions.

Fusarium Stalk Rot

Fusarium stalk rot, primarily caused by the fungus *Fusarium verticilliodes*, is a common disease in the Midwest. This fungus also causes Fusarium ear rot and can infect roots, stalks, and leaf nodes. It is most common in hot, dry years.

Symptoms often are observed near dent (stage R5) and include yellowing of the lower portions of the stalk and dull green leaves. (Figure 7). Stalk tissue will easily deteriorate and the stalks may collapse when pinched. In severe cases, plants can break off at the lower nodes.

The fungus is very common and can be found even in healthy stalks. The infection will result in stalk rot disease only under favorable conditions.

Figure 7. Close-up of discolored stalk tissue caused by Fusarium stalk rot.

Gibberella Stalk Rot

Gibberella stalk rot is caused by the same fungus that is responsible for Gibberella ear rot on corn and Fusarium head blight of wheat and barley: *Fusarium graminearum* (also called *Gibberella zeae*). For this reason, disease tends to be more severe in wheat-corn rotations. Gibberella is a very common stalk rot in Indiana, and is favored by warm, wet conditions.

Usually, infection closely follows pollination. Signs to look for when scouting for Gibberella stalk rot are tiny, round, blue-black fungal structures (called perithecia) on the surface of the stalk near the first internode. One can easily remove the perithecia with a fingernail.

Inside the stalk, the pith will be disintegrated, leaving only the stringy vascular bundles. The pith also will have a pink-red coloration (Figure 8). Infection can occur through roots, stalk sheaths, or leaf sheaths and progress to infect the stalk.

Figure 8. Gibberella stalk rot causes a pink discoloration of stalk tissue.

Pythium Stalk Rot

Pythium stalk rot, caused by the fungus-like organism *Pythium aphanidermatum*, is rarely a significant problem in Indiana. Infection is favored by extended periods of hot (above 90°F), wet, humid weather, and disease occurrence is worse in fields with poor soil drainage.

Unlike the fungal stalk rot pathogens, Pythium is able to infect corn anytime between V2 and R6. Infection is typically confined to the first internode directly above the soil surface and results in a brown, mushy stalk. Like bacterial stalk rot, lodging occurs in a twisting fashion instead of cracking (Figure 9). Lodged corn plants infected with *P. aphanidermatum* will remain green for some time because vascular bundles are left intact.

Figure 9. Distorted stalk tissue resulting from Pythium stalk rot.

Abiotic and Insect Factors

Although pathogenic (infectious) organisms cause the majority of stalk rots, a variety of abiotic (noninfectious) factors and insect feeding damage can also cause corn stalks to become weak and lodge. It is very important to consider these factors when attempting to diagnose problems in the field.

Lodging can be much worse when stalks are already compromised because of drought stress, foliar diseases, nutrient imbalances, or herbicide damage. These abiotic stresses reduce the plant's total green leaf area, which reduces the plant's ability to photosynthesize and produce necessary carbohydrates. As a result, a stressed plant diverts carbohydrates from the lower stalk tissue up to the developing grain head, which serves as the plant's carbohydrate sink. The physiological remobilization of these carbohydrates physically weakens the stalk.

Because abiotic stressors often occur or develop in distinct spatial patterns within fields, weakened or lodged plants will also often occur in spatial patterns, especially during the early stages of the plant deterioration. For example, drought-prone areas of fields will often deteriorate and exhibit stalk lodging earlier than areas with adequate soil moisture. Another common abiotic cause of lodging in the Midwest is heavy storms that have high winds and driving rains.

General Management

There is no single management practice that will reduce the risk of stalk rots in a cornfield. However, minimizing overall stress in corn plants will help reduce the risk of stalk rots.

Reduce plant stress by maintaining proper soil drainage and adequate soil nutrient levels, and plant at recommended populations. These practices can contribute to full, healthy foliage, which reduces the chance a plant will reallocate resources and lodge prematurely. Planting hybrids with some level of foliar disease resistance can also help alleviate plant stress and ensure healthy, strong stalk development.

Insect damage can also predispose a plant to infection; so planting hybrids with insect-resistance traits may reduce the effects of stalk rots.

Many management techniques depend on the specific disease, so it is important to correctly diagnose the cause of the stalk rot before making management decisions. Most genetic resistance in hybrids is specific to a given stalk rot, although resistance to Diplodia stalk rot, Gibberella stalk rot, and Fusarium stalk rot may overlap.

Crop rotation can reduce most stalk rots, but the fungi that cause charcoal rot and Gibberella stalk rot can also infect other crops, so check for genetic resistance to these diseases in rotation crops to reduce the risk of infection. Tillage also may be an option to bury infected crop debris, which can reduce the risk of infection by fungi that overwinter in residue.

Foliar fungicides may reduce the impact of foliar diseases in years when conditions favor foliar disease development. Preventing foliar diseases can reduce plant stress and maintain leaf photosynthetic area during grain fill. However, applying fungicides in the absence of foliar disease risk does not consistently reduce the incidence of stalk rots or improve standability.

Scouting to Minimize Yield Losses

The best way to determine which stalk rots are present in a field and assess the risk of lodging is to scout fields before harvest. Unless you notice lodging while the leaves are still green (which may indicate bacterial or Pythium stalk rot), begin scouting within a few weeks of physiological maturity (kernel black layer). To scout for stalk rots, walk the field in a *W* pattern, and randomly check a total of 100 stalks with either the pinch or push test (see Pinch and Push Tests).

Another scouting method is to use late-season aerial imagery. Identify areas in the field that are dying prematurely, and then navigate directly to those areas to scout for and identify stalk rots and/or stress-killed plants. Access to late-season aerial imagery that is also geo-referenced allows you to better quantify the affected areas within fields.

Pinch and Push Tests

There are two basic tests to check for stalk rots: the pinch test and the push test.

For a **pinch test**, pinch the stalk somewhere between the lowest two internodes and check whether the stalk is strong enough to withstand the pressure of the pinch. If the stalk collapses, it fails the pinch test.

For a **push test**, push the corn stalk to a 30-degree angle from vertical (approximately 8 inches) at eye level. If the stalk does not spring back to upright when released, it fails the push test.

If 10 percent of the stalks tested in a field fail the pinch or push tests, consider harvesting at a higher moisture content and then drying the grain further after harvest to avoid yield losses due to late-season lodging.

It is difficult to diagnose the cause of a particular stalk rot in the field. If you are unsure what is causing the stalk rot in your field, send samples to a plant diagnostic lab to determine the cause before making management decisions.

More information about submitting samples is available from the Purdue Plant and Pest Diagnostic Laboratory, ppdl.purdue.edu.

Find Out More

Stalk Lodging in Corn: Guidelines for Preventive Management (Purdue Extension publication AY-262-W) provides more information about the causes and management of stalk lodging. This publication, and others in the *Diseases of Corn* series are available from the Purdue Extension Education Store, www.edustore.purdue.edu.

Reference to products in this publication is not intended to be an endorsement to the exclusion of others that may be similar. Individuals using such products assume responsibility for their use in accordance with current directions of the manufacturer.

Table 1. Identification and Management of Stalk Rots Diseases of Corn.

Disease (pathogen)	**Signs and Symptoms**	**When to Scout**	**Favorable Weather for Infection**	**Management Strategies**
Anthracnose (*C. graminicola*)	**Stalk:** black, shiny lesions, often blotchy in appearance. **Pith:** disintegrated.	R5-R6	Cloudy days with high humidity.	• Plant hybrids with some resistance • Reduce plant stress and wounding • Rotate crops (avoid rotating to sorghum)
Bacterial stalk rot (*E. chrysanthemi* pv. *zeae*)	**Stalk and Rind:** dark-brown, water-soaked lesions; soft, slimy tissue; foul odor; twists during lodging. **Plant Tips:** Slimy and rotten; may die prematurely.	V2-R6	Hot, humid periods.	• Avoid overhead irrigation using pond or surface water • Provide adequate field drainage • Avoid common plant stressors, including insect damage
Charcoal rot (*M. phaseolina*)	**Pith:** disintegrated and covered in silver-black fungal structures ("dust"). **Stalk and Roots:** May be covered in black fungal structures.	R5-R6	Hot and dry conditions (soil temperatures >90°F), especially near plant maturity.	• Irrigate during hot, dry seasons • Avoid common plant stressors (heavy foliar disease, nutrient imbalances, etc.)
Diplodia stalk rot (*S. maydis*)	**Pith:** disintegrated. **Stalks:** brown/black fungal structures embedded in the rind (not easily scraped off).	R5-R6	Warm, moist conditions.	• Rotate crops • Plant hybrids with some resistance • Till infected residue into soil • Avoid plant stress and wounding
Fusarium stalk rot (*F. verticilliodes, F. proliferatum,* & *F. subglutinans*)	**Pith:** disintegrated with salmon-pink discoloration. **Leaves:** dull green.	R5-R6	Dry conditions before silking followed by warm, wet conditions after silking. 80-100°F	•Reduce plant stresses: ◦ Control foliar diseases ◦ Provide adequate field drainage ◦ Avoid high-nitrogen, low-potassium soils
Gibberella stalk rot (*G. zeae*)	**Pith:** disintegrated with pink-red discoloration. **Stalk:** small, black fungal structures (easily scraped off).	R5-R6	Warm, moist conditions.	• Avoid wheat-corn rotations • Avoid plant stress and wounding
Pythium stalk rot (*P. aphanidermatum*)	**Pith and Rind:** soft, brown, and water–soaked. **Leaves:** green even after lodging. **Stalk:** twists during lodging.	V2-R6	Hot, wet, and humid conditions.	• Avoid overhead irrigation using pond or other stagnant water •Provide adequate field drainage • Avoid common plant stressors

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