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Common Stalk Rot Diseases of Corn

Tamra A. Jackson-Ziems
University of Nebraska-Lincoln, tjackson3@unl.edu

Jennifer M. Rees
University of Nebraska, Southeast Research and Extension Center, jrees2@unl.edu

Robert M. Harveson
University of Nebraska-Lincoln, rharveson2@unl.edu

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Tamra A. Jackson-Ziems, Extension Plant Pathologist

Jennifer M. Rees, Extension Educator

Robert M. Harveson, Extension Plant Pathologist

IANR

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Stalk rot diseases of corn are common, occurring in every field to some extent. Each year stalk rot diseases cause about 5 percent yield loss. Under some conditions losses can exceed 10-20 percent and in isolated areas, losses have been as high as 100 percent. Stalk rot diseases reduce yield both directly and indirectly. Plants with prematurely rotted stalks produce lightweight, poorly filled ears because of the plant's limited access to carbohydrates during grain fill. Infected stalks are converted from sturdy, solid rods to hollow tubes as the stalk pith pulls away from the outer rind, compromising stalk strength. Rotted, weakened stalks are prone to lodging, particularly if decay occurs below the ear *(Figure 1)*.

Stalk rot diseases tend to be more common in higher yielding hybrids that produce large, heavy ears. During times of stress, such as when foliar diseases cause substantial loss of leaf area, these large ears may cannibalize carbohydrates from the stalk and weaken it. Large, heavy ears also can predispose the stalk to lodging with the added weight supported above weakened lower stalk tissue. Lodging indirectly reduces yield through harvest complications and ear loss.

Stalk rot diseases can be caused by many fungi and bacteria. Most of these pathogens occur commonly in the field and behave opportunistically by primarily infecting senescing, injured, or stressed plants. A single plant often may be infected by multiple stalk rot pathogens which cause other diseases of corn and other crops. Each pathogen is favored by particular environmental conditions.

Figure 1. Lodging caused by stalk rot diseases.

General Symptoms of Stalk Rot

While specific symptoms vary with individual stalk rot diseases, a few general symptoms can be expected with most stalk rots. Plant wilting is often the first indication of a stalk rot problem. Leaves of affected plants may become discolored, turning gray or brown. Inside the stalk, decay causes discoloration of the inner pith tissue which pulls away from the stalk rind leaving a weakened hollow tube filled with detached strands of vascular bundles. Lower internodes turn from green to tan or dark brown which is sometimes visible from the exterior. Root decay often accompanies stalk rot diseases and in severe cases, premature death may occur in as little as two days.

This publication contains information on stalk rot diseases found in Nebraska corn, including causal agents, symptoms, favorable conditions, and management.

Anthracnose Stalk Rot

Colletotrichum graminicola causes several anthracnose diseases of corn including stalk rot, top dieback, and foliar and seedling diseases. This fungus is an aggressive pathogen of corn and is one of the few stalk rot pathogens that frequently causes disease prior to senescence. It is also the only corn stalk rot disease with a foliar phase. Since 1970, anthracnose stalk rot has emerged as one of the two most important stalk rot diseases of corn in the country.

Infected stalks often have shiny, black lesions on the stalk's outer rind *(Figure 2)*, indicative of the black fungal material just beneath the surface. The fungus produces reproductive structures, called *acervuli*, that contain tiny, dark, whisker-like appendages, called *setae (Figure 3)*. These may be visible with a high quality hand lens or stereomicroscope and can aid in making a definitive diagnosis. Setae

Figure 2. Black lesions visible on the outside of stalks are indicative of anthracnose stalk rot.

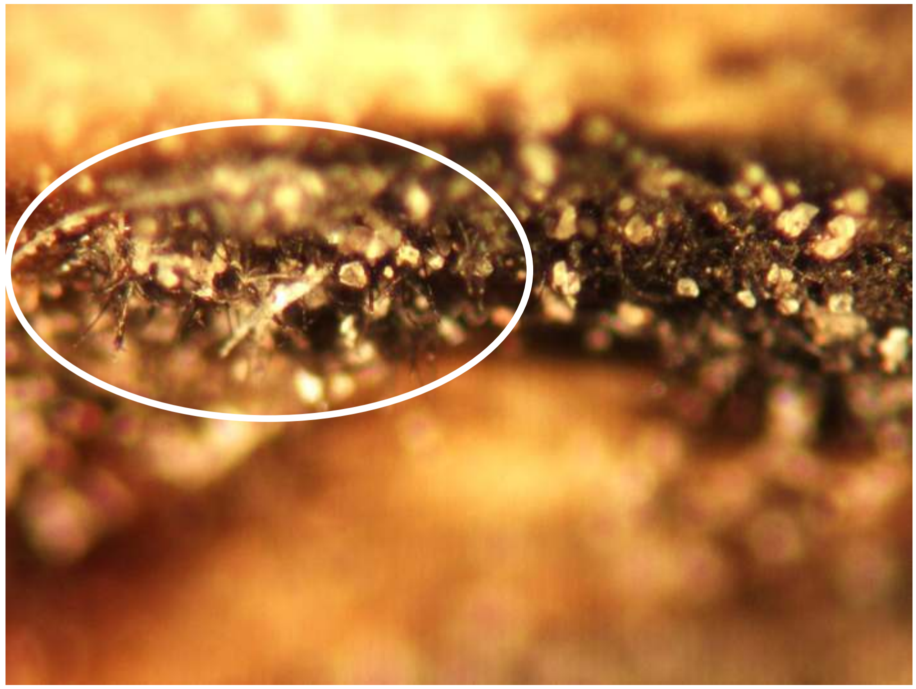

Figure 3. Black whisker-like setae (circled) are produced by the causal agent of anthracnose, *Colletotrichum graminicola* (magnified 40x).

can be observed most easily on foliar lesions and at stalk nodes. Fungal reproductive spores, called *conidia*, are produced in large quantities in the acervuli and infect new plants. Spore production and subsequent plant infection require high relative humidity and warm temperatures. Extended periods of cloudy weather in the summer are particularly favorable to the development and spread of anthracnose. Plants become increasingly susceptible after flowering and most are infected within two to three weeks after silking.

Effective resistance is available in corn to manage anthracnose. Disease severity of other stalk rots may be minimized through measures that reduce plant stress and wounding, such as ensuring balanced fertility, planting appropriate populations, and controlling corn borers. Tilling crop residue, when practical, can reduce fungal survival. Research results have found reduced fungal sporulation on residue buried as little as 1 inch below the soil surface compared to surface residue in no-till systems. However, tilling residue will not eliminate disease in areas where the pathogen is widespread or present in neighboring fields.

Fusarium Stalk Rot

Fusarium stalk rot historically has been the most common stalk rot disease in Nebraska. It is caused by one of at least three *Fusarium* species, including *F. verticillioides* (formerly named *F. moniliforme*), *F. proliferatum*, and *F. subglutinans*. Research has proven that *F. verticillioides* can infect kernels and overwinter in the seed until the following season. Infected kernels may lead to systemic infection of the plant. Spores and mycelia surviving in crop residue or soil also can infect plants directly or through wounds in the roots, leaves, and base of the leaf sheath. Fusarium stalk rot is favored by dry weather prior to silking and warm, wet weather after silking. It can be difficult to distinguish from some other stalk rot diseases. Sometimes the pathogen can cause white fungal growth on the outside of the stalk *(Figure 4)* and a pink or salmon discoloration inside rotted stalks *(Figure 5)*. Another diagnostic key is the lack of visible reproductive structures as compared with those produced by the causal agents of Gibberella and Diplodia stalk rots.

There is conflicting evidence on how tillage affects survival of the *Fusarium* species. In some cases the interpretation of this research may have been complicated by the influence of moisture stress on stalk rots in non-irrigated environments. In an Ohio experiment, fall tillage did not reduce the incidence of Fusarium stalk rot when compared to other stalk rot diseases. Fusarium stalk rot incidence was reduced in no-till treatments more than in tilled treatments, which could be due to reduced moisture stress in the non-irrigated, no-till environment. Other research results found that crop rotation did not reduce the incidence of Fusarium stalk rot, probably because the fungus can survive in the soil for long periods during inclement conditions or in the absence of a host. *Fusarium verticillioides* also causes stalk rot in sorghum and seedling and ear rot diseases in corn. Often, hybrids resistant to other fungal stalk rots may carry some resistance to Fusarium stalk rot.

Figure 4. White fungal growth visible at the node can occur with Fusarium stalk rot.

Gibberella Stalk Rot

The similarities between Gibberella and Fusarium stalk rots make the diseases especially difficult to differentiate. Gibberella stalk rot is distributed worldwide and is one of the most common stalk rots in the Corn Belt. The causal agent is *Gibberella zeae* whose asexual stage is *Fusarium graminearum*, a common seedling pathogen of corn and the causal agent of Fusarium head blight or scab of wheat, barley, oat, and rye. Gibberella stalk rot often causes a pinkish-red discoloration inside the stalk that may be accompanied by reproductive structures called *perithecia*. These small, round, blackish specks on the surface of the stalk rind *(Figure 6)*, often are near a node and can easily be scratched off. Spores inside the perithecium on crop residue can act as primary inoculum to infect plants the next season.

Figure 5. Pink to salmon discoloration inside the stalk may be associated with Fusarium stalk rot.

Like the *Fusarium* species causing Fusarium stalk rot, the causal agent of Gibberella stalk rot can survive in crop residue or in overwintering structures in the soil for many years in the absence of a crop host. This pathogen also causes an important ear rot disease of corn and both the ear and stalk rot diseases can be exacerbated in corn-wheat rotations. Disease development is favored by warm, wet conditions. Resistance to Gibberella stalk rot is not common in commercial hybrids, but planting hybrids with corn borer resistance may secondarily reduce disease by minimizing wounds caused by insects. Please see the section on risk management for additional management strategies.

Figure 6. Tiny black *Gibberella zeae* perithecia may develop on stalks. (Photo courtesy of Erick DeWolf, Kansas State University)

Figure 7. Tiny black *Diplodia maydis* pycnidia may develop on stalks, husks, or on infected kernels (pictured) at the base of an ear.

Diplodia Stalk Rot

The fungus *Diplodia maydis* (also known as *Stenocarpella maydis*) can cause both stalk and ear rot diseases of corn. Diplodia is indicated by minute dark brown/black reproductive structures called *pycnidia* which are embedded in husks, the rind of stalks, or on kernel surfaces *(Figure 7).* The pycnidia may be viewed with a hand lens, feel rough like sandpaper, and cannot be easily removed, in contrast to the perithecia produced by the causal agent of Gibberella stalk rot.

Two-celled pigmented spores (conidia) *(Figure 8)*, produced inside the pycnidia, can be splashed onto other areas of the plant. Infection at the nodes below the ear will cause stalk rot and infection of the silks and husk will cause ear and kernel rot. The fungus is known to infect the stalk through the roots, crown, and lower stem. Injury by birds and insects also favors fungal infection. At one time, Diplodia stalk rot was the most widespread and damaging stalk rot disease of corn. Now anthracnose and Fusarium stalk rots have increased in incidence and surpassed Diplodia in most of the Midwest.

The fungus overwinters in crop residue and has no other known host. Plant resistance to Diplodia is believed to be closely related to that for Gibberella stalk rot and similar control measures apply to both diseases.

Charcoal Rot

Charcoal rot is caused by the fungus *Macrophomina phaseolina*, which also causes stalk and stem rot of sorghum, alfalfa, and especially soybean. This fungus produces tiny, black, round, survival structures called *sclerotia* that are composed of a thick, protective, pigmented rind around the fungus. When many sclerotia are produced on the inside of the stalk, it gives the appearance of charcoal dust for which the disease was named (*Figures 9, 10,* and *11*).

Charcoal rot most commonly affects prematurely senescing plants that are grown under drought stress conditions. Disease development is optimal when soil temperature is 90°F or higher and soil is dry, particularly during grain fill. Management practices such as irrigation or adjusting planting date to avoid seasonably dry weather will

Figure 8. Two-celled *Diplodia maydis* spores are produced inside pycnidia (magnified 400x).

minimize plant stress and help avoid early senescence. During the recent Nebraska drought, charcoal rot was often observed in rainfed fields or dryland pivot corners. Resistance to other stalk rot diseases, especially Gibberella and Diplodia, has been effective against charcoal rot, too. Crop rotation has had little effect on its control due to the wide host range of this pathogen and the longevity of its survival structures.

Bacterial Stalk Rot

Bacterial stalk rot is the only major stalk rot disease in Nebraska caused by bacteria instead of a fungus. The disease is caused by *Erwinia chrysanthemi* pv. *zeae*, a different pathogen than those causing Stewart's wilt or Goss's bacterial wilt and leaf blight. It is associated with warm temperatures and high humidity in midseason.

Initial symptoms consist of lodging and dark brown, water-soaked lesions that progress to soft or slimy stalk tissues that appear at one to several internodes at or above the ground. The disease may initially develop from either the top or the bottom of the plant. A top rot may occur during periods of rapid vegetative growth in fields that are sprinkler-irrigated with surface water (*Figures 12* and *13*). The tops of infected plants may die prematurely and often can be easily removed (*Figure 14*).

A slimy rot occurs at the base of the whorl and moves rapidly downward until plants collapse. Rarely, this disease has also been reported after irrigation with groundwater. Plants also may be infected at or near the soil line (*Figure 15*). This often occurs

Figures 9 and 10. Symptoms of charcoal rot. When many tiny, black sclerotia form on the stalk interior wall, it looks like charcoal dust.

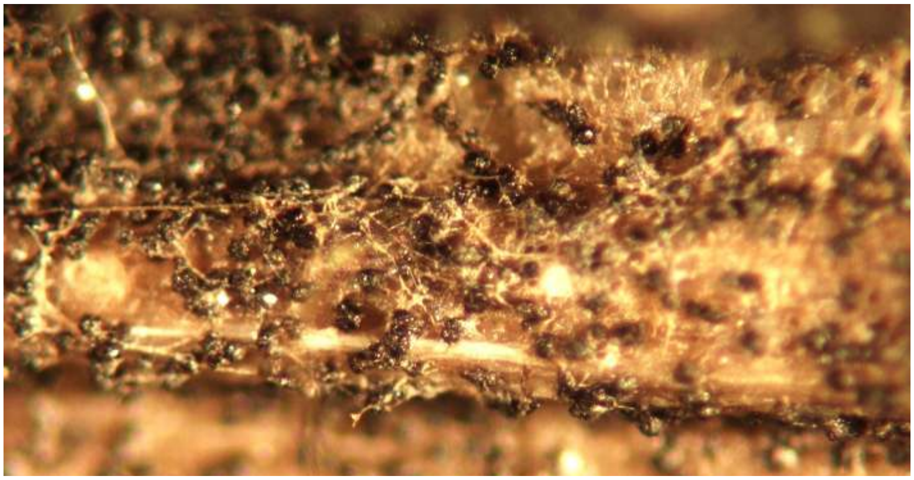

Figure 11. Sclerotia of *Macrophomina phaseolina* (magnified 60x), causal agent of charcoal rot, growing on a single vascular bundle inside the stalk.

Figure 14. The tops of plants may be prematurely killed by bacterial top rot and often can be easily removed from the plant.

Figures 12 and 13. Symptoms of bacterial stalk rot, which may be accompanied by a foul odor.

Figure 15. Infection by the bacteria also can occur on the lower stalk near the soil line (left) which can lead to eventual collapse of the plant (right).

when plants stand in water for a few days after heavy rains, especially at higher temperatures. As with the bacterial top rot phase described earlier, the infection spreads rapidly in the plant, which may lead to collapse of the entire plant in a few days.

The pathogen overwinters only in stalk tissue above the soil surface, and is most prevalent and destructive in areas with high rainfall and/or irrigation from canals or ponds via sprinkler irrigation, or from fields prone to flooding. The disease is additionally favored by high temperatures (90-100°F) and high humidity. In contrast to most other stalk rot diseases, bacterial stalk rot tends to develop midseason rather than at the onset of senescence.

Historically, bacterial stalk rot has appeared in south central Nebraska corn fields sporadically — every 5 to 10 years. A particularly severe epidemic in 2001 affected 13 pivot-irrigated fields, several of which experienced up to 15 percent mortality. During 2007, the same problem was observed in the

Nebraska Panhandle in 12-15 fields. Little economic damage was noted; however, it was an unusual problem and source of anxiety for many producers. This outbreak in Scottsbluff and Morrill counties was consistent with other outbreaks because the fields had overhead-irrigation with water from canals or other ditch source.

Fall discing of infested crop residue can promote decay and reduce disease incidence during the following season(s). Draining areas that tend to flood also may help reduce incidence since the disease is favored by flooded conditions. Some research also has indicated that the incidence of bacterial stalk rot is reduced in transgenic insect-resistant hybrids that have fewer wounds from stalk-boring insects.

Risk Factors and Stress Conditions Favoring Stalk Rots

- Hybrid susceptibility
- Moisture stress, either excessively wet or dry weather
- Plant injury (such as that caused by weather events or insects)
- Reduced photosynthetic leaf area, often due to foliar diseases
- Unbalanced soil fertility, especially too much or too little nitrogen and too little potassium
- High plant populations that lead to thinner stalks
- Cloudy weather that favors the pathogen and reduces photosynthetic activity
- Extreme temperatures favor some stalk rot pathogens
- Infected residue in the field. If practical, consider burying debris, rotating crops, or planting resistant hybrids
- Continuous cropping. Crop rotation often reduces the incidence of stalk rots, but be aware that some stalk rot pathogens can affect other crops.

Risk Factors and Management

Many factors can lead to the development of stalk rot diseases. In general, pathologists agree that plant stress from a number of sources can increase the incidence and severity of stalk rot.

A balance exists between the plant's priority to fill grain with carbohydrates and its ability to produce carbohydrates. Loss of leaf area caused by extensive foliar disease(s) reduces the plant's photosynthetic machinery that produces carbohydrates. Maintaining optimal soil fertility, particularly the balance between the macronutrients, nitrogen and potassium, is important to this process.

Managing the risk factors for stalk rot diseases can help reduce their incidence. Remember that fungicides are not labeled for management of stalk rot diseases. They may combat fungal leaf diseases which reduce photosynthetic area, predisposing the stalk to rot. They also may cause the plant to stay green longer.

Scouting

If conditions are favorable for stalk rot development, field scouting is critical for determining which fields should be harvested first to avoid or minimize plant lodging and ear drop. The most common method to scout for stalk rots is to use the Push or Pinch Test.

Push or Pinch Test

Walk through a field and randomly select a minimum of 100 plants representing a large portion of the field. To test for stalk rot:

- Push the plant tops approximately 30° from vertical. If plants fail to snap back to vertical, the stalk has been compromised by stalk rot.
- Pinch or squeeze the plants at one of the lowest internodes above the brace roots (pinching the same internode on each plant). If the stalks crush easily by hand, their integrity has been reduced by stalk rot.

If more than 10 percent of plants exhibit stalk rot symptoms, harvest that field first to reduce the potential for plant lodging and yield loss. Under severe stalk rot conditions, it may be more economical to harvest early at higher moisture and dry grain than to experience severe harvest losses.

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