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Common Stalk Rot Diseases of Corn

Corn stalk rot diseases occur every year in every field to some extent. This NebGuide discusses the symptoms, impacts and management of these diseases.

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Corn is grown throughout Nebraska on over 8 million acres of land; approximately 5 million acres are irrigated. Seed corn, field corn and specialty corns (e.g., high oil, high amylose and white corn) comprise the three main corn production systems. Field corn is grown on the most acreage. Whether grown in an irrigated or dryland production system, all corn hybrids are susceptible to a variety of stalk rot diseases. These diseases occur every year in every field to some extent. The level of impact is determined by a number of factors, including the weather during the growing season, the amount of stress on the plants, hybrid genetics and the populations of the stalk rot pathogens in the field.

Stalk Rot Diseases in Nebraska

Corn stalk rot is a family of diseases caused by several species of fungi and bacteria. The geographic distribution of plant diseases and the incidence and severity of those diseases changes over time due to changes in climatic conditions, agricultural practices and hybrid genetics. Periodically, a survey is needed to determine the prevalent pathogens causing disease in a specific geographic region. Such is the case with corn stalk rot in Nebraska. Although stalk rot has been prevalent in the state for decades and locally severe in the last few years, there is not a clear picture of the distribution of the various pathogens and the associated risk factors. Consequently, developing an effective and practical stalk rot management plan is difficult at best.

Stalk rot diseases cause internal decay and discoloration of stalk tissues, directly reduce yields by impairing translocation of water and nutrients, and can result in death and lodging of the plants any time during the season *(Figure 1)*. Individual stalk rot diseases differ greatly in their frequency of occurrence, the symptoms they induce, the severity of damage they cause and their geographic distribution. Some stalk rot pathogens attack the plant early in the season while others attack late. Some attack the plant from the seedling stage through senescence.

Figure 1. Stalk rot of corn can result in lodging at any node of the plant, depending on which disease is present and the hybrid affected.

The most prevalent mid to late season stalk rot pathogens in Nebraska are *Fusarium, Gibberella, Diplodia* and *Colletotrichum*. These fungi, alone or in combination, are commonly found in corn stalk tissue. Yield losses as a result of lodging or poor kernel fill can be compounded by other severe stresses on the plant, including foliar diseases (e.g., gray leaf spot, corn lethal necrosis).

Fusarium stalk rot: Fusarium stalk rot has been the most common stalk rot disease in Nebraska. It is caused by the pathogen *Fusarium moniliforme* (and the subspecies, *F. moniliforme* var. *subglutinans*). This pathogen is seed-borne; however, the role of seed-borne inoculum to the development of stalk rot is uncertain. Although over 75 percent of field corn plants can be infected with the *Fusarium* stalk rot pathogen, stalk damage may occur late enough in the season that yield loss is minimal. *Fusarium* stalk rot can be distinguished by a reddish-pink discoloration of the internal stalk tissues *(Figure 2)*. Symptoms of *Fusarium* stalk rot can be easily confused with *Gibberella* stalk rot, which produces a reddish discoloration of the internal stalk tissues.

The *Fusarium* stalk rot pathogen survives in corn residue on or in the soil. It can infect the plant directly through the roots, causing decay of the roots and lower stalk. *F. moniliforme* produces two types of conidia that can be splash-dispersed onto leaves, wash down the sheath, and infect at the nodes. (The microconidia are most important.) Wounds from hail or insect feeding (e.g., European corn borer) can provide additional sites of entry. *F. moniliforme* also infects ears and kernels.

Figure 2. Fusarium stalk rot (*Fusarium moniliforme*) is characterized by a pinkish discoloration in the internal pith tissues. It can be easily confused with the reddish discoloration associated with Gibberella stalk rot (*Gibberella zeae*).

Figure 3. Diplodia stalk rot (*Diplodia maydis*) is characterized by brown discoloration in the lower two internodal regions of the stalk and by the appearance of small black reproductive structures (pycnidia) on the stalk surface.

Figure 4. The top die-back phase of anthracnose stalk rot (*Colletotrichum graminicola*) can be confused with early dry-down. The plant is killed from top down as the fungus progressively colonizes the stalk.

Gibberella stalk rot: Gibberella stalk rot is caused by the fungus *Gibberella zeae;* the asexual stage of this pathogen is *F. graminearum*. Unlike *F. moniliforme*, *F. graminearum* is rarely seed-borne. As mentioned, Gibberella stalk rot causes a reddish discoloration of the internal stalk tissues and can be easily confused with *Fusarium* stalk rot.

The Gibberella stalk rot pathogen survives in corn residue on or in the soil. Spores of *Gibberella* are produced on the surface of infected stalks and air dispersed to stalks where they infect by direct penetration. *F. graminearum* produces macroconidia that can be splash-dispersed onto leaves, wash down the sheath, and infect the plants at the nodes. The spores of *G. zeae* and the conidia of *F. graminearum* also infect ears and kernels. The prevalence of Gibberella stalk rot in Nebraska is uncertain.

Diplodia stalk rot: Diplodia stalk rot is a common late-season stalk rot throughout the Corn Belt, usually occurring three to six weeks after silking. It is caused by the pathogen *Diplodia maydis.* The pathogen can be seed-borne and lead to seedling disease. *Diplodia* stalk rot is less common than *Fusarium* stalk rot in Nebraska. It is distinguished by internal brown stalk discoloration and dry rot in the lower two internodes of the plant *(Figure 3)*;

the pith tissue is usually shredded. Black spore-forming structures (pycnidia) are commonly found embedded in the surface of the lower stalk.

Diplodia survives as conidia inside pycnidia within corn residue on or in the soil. Spores are dispersed by wind, rain and insects and can infect the roots, mesocotyl and the nodes above the soil. Although infection can occur earlier, symptoms usually appear several weeks after silking. As the disease progresses, small brown to black reproductive structures appear on the stalk surface near the nodes.

Figure 5. In fields damaged by top die-back anthracnose, the middle of the plants appear to have a green band; leaves at the bottom of the plants are dying from senescence while the top leaves are dying from anthracnose.

Anthracnose stalk rot: Corn anthracnose has three components: leaf blight, stalk rot and top die-back. Anthracnose stalk rot was less common in central Nebraska than the other stalk rot diseases until 1998, when the prolonged periods of high temperature and high relative humidity provided an ideal climate for the disease. Several localized areas in the state had severe anthracnose stalk rot, but the top die-back phase of the disease was extremely widespread across the eastern half of the state. Many fields were severely damaged.

The top die-back phase occurs mid to late season and may be confused with early dry-down *(Figure 4)*. Affected fields commonly appear to have a green band across the middle of the plants because the bottom leaves are dying from senescence and the top leaves are dying from anthracnose *(Figure 5)*. Anthracnose can be distinguished by black discoloration on the inside of the stalk as well as on the surface *(Figure 6)*.

General Symptoms and Impacts of Stalk Rot Disease

The most striking external symptom of stalk rot is premature plant death. Leaves may suddenly turn dull and grayish green while stalks may show brown or black internal and/or external discoloration depending on which stalk rot is developing. The disease ultimately destroys a major portion of the pith tissue. The remaining strands of vascular bundles within the intact stalk are usually light brown or bleached. In advanced stages of deterioration, the stalks become spongy and soft. A wind velocity of less than 20 mph will cause the infected stalk to break or lodge. Stalk lodging can occur at any node *(Figure 7)* and depends on which disease is present. Although the most obvious symptoms are collapsed stems and fallen plants, stalk rot can significantly reduce yield even if plants remain standing due to impaired translocation of water and nutrients throughout the plant and specifically to the developing grain.

A variety of stresses can result in early onset of stalk rot symptoms and increased severity of disease. These stresses include environmental factors such as inadequate or excess moisture and biotic factors such as foliar disease. Many foliar diseases reduce the amount of photosynthetically active leaf area available

Figure 6. Anthracnose can be distinguished by black discoloration on the surface of the stalk; black internal discoloration also is common in advanced stages of stalk rot.

for providing carbohydrate to the grains, putting severe stress on the corn plant as the grain fills. As leaf area is reduced from foliar disease, the plant draws on nutrients stored in the stalk to fill the grain. This provides favorable conditions for the predominant stalk rot pathogens. Severe stalk rot has been correlated with high gray leaf spot disease pressure in Nebraska and in other Corn Belt states. The corn plant is essentially competing with the foliar and stalk rot pathogens for available energy. Any stress at the dough-to-dent stage predisposes the plants to stalk rots and can directly and significantly impact yield (e.g., smaller ears, lower test weights, harvest losses because of lodging). Affected plants commonly yield lower kernel weights.

Disease Management

Table I. Risk factors for stalk rot.

1.	**Cropping Sequence and Plant Density:** Corn following corn increases the risk of stalk rot when a susceptible hybrid is grown and stress during the season cannot be minimized or prevented. High plant populations (e.g., greater than or equal to 32,000 plants/acre planted) can predispose a field to severe stalk rot.
2.	**Foliar Disease Epidemic:** Foliar disease (e.g., gray leaf spot) can place severe stress on the plant, predisposing it to stalk rot. If the risk of gray leaf spot is high and a susceptible hybrid is planted, managing to reduce foliar disease will help reduce the risk of severe stalk rot.
3.	**Tillage:** There is conflicting evidence regarding the effects of tillage on the severity of stalk rot. In general, the effects tend to be indirect through the effects on soil moisture retention; no-till fields retain more moisture, resulting in less stress on plants in dry years.
4.	**Hybrid Susceptibility:** Hybrids vary greatly in their standability. However, stalk rot can impair yields even if plants remain standing. No true stalk rot resistant hybrids are available in Nebraska. Anthracnose-resistant hybrids are grown in the eastern Corn Belt.
5.	**Weather Pattern:** The effects of weather depend on which stalk rot pathogen is prevalent. For Fusarium and Diplodia, dry conditions early in the season followed by above-average rainfall in mid season can predispose the plants to stalk rot. For anthracnose, high temperatures and high relative humidity in mid season can predispose a field to stalk rot.

Figure 7. Stalk breakage and lodging.

Table II. Stalk rot management.	
1.	**Cropping Sequence and Plant Density:** Rotation to crops other than corn for at least one year can reduce the severity of stalk rot by reducing the amount of primary inoculum when corn is again planted in that field. In fields with a history of severe stalk rot, rotation to other crops for longer than one year may be necessary; plant populations should not exceed 28,000 to 32,000 plants/acre in these fields.
2.	**Tolerant Hybrids:** Hybrids with improved standability should be planted in fields with a history of severe stalk rot or with multiple risk factors. There are no true stalk rot-resistant hybrids available for planting in Nebraska.
3.	**Fungicide Application:** There are no fungicides currently labeled for use in Nebraska specifically for the management of stalk rots caused by Fusarium, Gibberella, Diplodia and Colletotrichum.
4.	**Tillage:** Tillage as a management option for stalk rots has had mixed results, depending on the field risk factors and the pathogens present. In general, tillage alone is not an effective management practice.

Strategy: The overall strategy for stalk rot management is to minimize stress on the plant. Common stresses include: high nitrogen and low potassium fertility, high moisture in mid to late season after a dry early season, moisture stress early in the season and during grain fill, high leaf disease pressure and insect damage. While there are no preventative measures for stalk rot, the impact can be lessened by selecting hybrids that are tolerant of the stress factors prevalent in the managed fields and by selecting hybrids with stalk rot tolerance (e.g., hybrids with good standability). It's also beneficial to provide balanced soil fertility, avoiding high nitrogen and low potassium conditions. Farm managers should base fertilizer applications on soil test results and projected yields. The best management plan for stalk rot depends on the level of risk in the field. Risk can be separated into five factors for each production system *(Table I)*. Management practices will depend upon which factors and how many risk factors apply. It is extremely important to scout production fields to monitor the incidence and severity of stalk rot.

Scouting: Be vigilant and scout fields every seven to 14 days from mid to late August until harvest to assess the degree of stalk rot. Randomly select 20-50 plants in each field and squeeze the lower two to four internodes. If the stalk can be crushed, examine the plant more carefully to try to determine the extent of damage and the type of stalk rot. A hollow shell of a stalk that collapses easily indicates advanced stalk rot. If 25 percent of the plants have stalk rot, consider harvesting the field as soon as possible after maturity. Stalk rot will continue developing throughout the field until harvest so it's important to harvest before lodging occurs. The choice may be to harvest early and dry higher-moisture corn or to pick the corn off the ground after the plants lodge.

Cropping sequence and plant density: Corn following corn increases the risk of stalk rot when a hybrid susceptible to the disease is grown and stress during the season cannot be minimized or prevented. Stalk rot has been reported to be more severe in fields with high plant populations (e.g., greater than or equal to 32,000 plants/acre planted); this has been observed in several states, including Nebraska in 1998. The importance of plant population and row spacing is dependent on other risk factors and the specific stalk rot present.

Foliar disease epidemic: Foliar disease (e.g., gray leaf spot, anthracnose) can place severe stress on the plant, predisposing it to stalk rot. If the risk of foliar disease is high because the hybrid is susceptible and the weather is favorable, managing the field to reduce disease development will help reduce the severity of stalk rot. This can be accomplished by planting disease-tolerant hybrids when an epidemic is anticipated (e.g., continuous corn minimum tillage production system, history of disease in field, long-range weather forecast is favorable to disease development) prior to planting or by the strategic application of fungicides as an epidemic is developing.

Tillage: There is conflicting evidence on the effects of tillage on the severity of stalk rot. In general, the effects tend to be indirect through the effects on soil moisture retention; no-till fields retain more moisture, resulting in less stress on plants in dry years. Some stalk rot pathogens are natural soil inhabitants (e.g., *Fusarium*); hence, tillage to reduce surface residue coverage may have minimal impact on the incidence and severity of these diseases.

Hybrid susceptibility: No true stalk rot resistant hybrids are available in Nebraska. Hybrids vary greatly in tolerance to stalk rot (i.e., their standability). However, stalk rot can impair yields even if plants remain standing. Anthracnose-resistant hybrids are grown in the eastern Corn Belt; however, anthracnose leaf blight resistance is not well correlated to anthracnose stalk rot resistance. Most seed companies are actively pursuing stalk rot tolerance/ resistance and include stalk rot screening in their evaluations. Gray leaf spot-tolerant hybrids are commercially available and yield well under moderate gray leaf spot disease pressure; their use may indirectly reduce the potential for losses due to stalk rot.

Weather pattern: The effects of weather depend on which stalk rot pathogen is prevalent. For *Fusarium* and *Diplodia*, dry conditions early in the season followed by above average rainfall in mid to late season can predispose the plants to stalk rot. For anthracnose, high temperature and high relative humidity in mid to late season are very favorable to stalk rot development. At present there are no weather-based models for use as decision aids in managing these diseases.

Fungicides: There are no fungicides currently labeled for use in Nebraska specifically for the management of stalk rots caused by *Fusarium*, *Gibberella*, *Diplodia* and *Colletotrichum*. Fungicides help manage stalk rot indirectly through their use to treat foliar diseases.

Unresolved Issues for Stalk Rot

Among the unresolved issues for managing stalk rot are the following:

1. the effectiveness of tillage and residue management for a specific field,
2. the importance of plant density and row spacing to the incidence and severity of stalk rot,
3. the identification of true stalk rot resistance in hybrids, and
4. the impact of manure amendments to soil on the severity of stalk rot.

Web Sites

Several Web sites provide additional information on corn stalk rot and images of symptoms associated with the various stalk rot diseases.

Stalk rot sites:	http://www.ipm.iastate.edu/ipm/icm/1996/9-3-1996/srotscout.html
	http://www.ipm.iastate.edu/ipm/icm/1997/11-17-1997/tilstalk.html
	http://www.ipm.iastate.edu/ipm/icm/1998/1-19-1998/btdiscon.html

	http://www.agcom.purdue.edu/AgCom/Pubs/AY/AY-262.html
	http://www.pioneer.com/USA/crop_management/national/hybrid.htm
	http://www.btny.purdue.edu/Extension/Pathology/CropDiseases/Corn/corn2.html#stalk
	http://www.ext.missouri.edu/agebb/pdmgt/pdfield/pdcorn/pdmg6.l
	http://www.scisoc.org/feature/grayleaf/top.html
Weather sites:	http://hpccsun.unl.edu/
	http://www.crh.noaa.gov/

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