Disease Management

Paul Vincelli

Diseases of crops can occur whenever a *disease-causing agent* is in contact with a *susceptible host plant* in an *environment that is favorable for disease development*. These three fundamental ingredients are necessary for a disease to develop and are often referred to as the *disease triangle* (Figure 1).

Understanding this fundamental relationship helps us understand disease management since all disease management practices presented in this publication affect one or more sides of the disease triangle. For example, planting a hybrid with some resistance to gray leaf spot targets the *host* side of the disease triangle. Crop rotation helps to starve a *pathogen* (disease-causing agent) by depriving it of its food source; this affects the pathogen side of the disease triangle. Delaying planting until soil temperatures exceed 50°F reduces the amount of seedling damping off by targeting the *environment* side of the disease triangle.

Preplant Decisions That Affect Disease Development

Most of the agronomic decisions corn producers make have some impact on disease development. In fact, once a corn field is planted, a producer's disease management program is essentially in place, for better or worse. Thus, consider your preplant decisions as disease-management decisions also.

Crop Rotation

Many corn pathogens survive between crops in the corn residue, and some do not attack other field crops commonly grown in rotation with corn. Consequently, rotating to wheat, soybean, or other crops helps to starve certain corn pathogens that survive in the field by depriving them of a food source as the crop residue decomposes. Crop rotation is thus one of the most important disease control practices for corn production worldwide.

Pathogens that are not as effectively controlled by crop rotation include those that do not survive in the production field itself. For example, rust fungi that attack corn overwinter south of Kentucky and are blown into our corn fields each season on wind currents. Pathogens that attack a wide range of field crops are also less effectively controlled through rotation. For example, the charcoal rot pathogen can attack corn, soybean, and grain sorghum and is not controlled through a corn/soybean rotation. Likewise, pathogens that persist indefinitely in agricultural soils are not effectively controlled through crop rotation. An example is the fungus *Pythium ultimum*, the most common cause of damping off of corn.

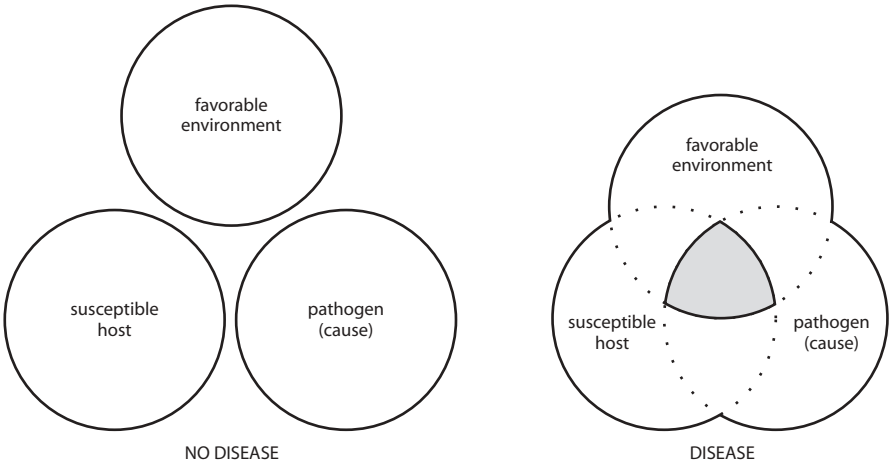
Resistant Hybrids

One of the most practical and economical means of disease control is to select agronomically suitable hybrids with adequate resistance to diseases of concern on your farm. Unfortunately, resistance is not available for some diseases. However, when available, disease resistance should be the foundation for economical disease control.

No single corn hybrid is resistant to all diseases present in Kentucky. Furthermore, the importance and prevalence of corn diseases vary from one farm to the next and from one year to the next. These facts can complicate the hybrid selection process. Nevertheless, an informed decision can be made by selecting hybrids with resistance to the diseases most likely to be a problem. Resistance to other diseases should be considered on a secondary basis.

When selecting a hybrid, the producer should recognize that there are different levels of disease resistance. If available, agronomically acceptable hybrids with high levels of resistance usually provide the best protection against a serious disease outbreak. Hybrids may also exhibit moderate or even low levels of resistance to particular diseases. This means that, while the disease still can develop on these hybrids, lower incidence of disease can be expected in most circumstances than on a fully susceptible hybrid. For some diseases, low to moderate resistance is all that is available

Figure 1. Disease triangle. Disease only develops when three conditions are met: a pathogen infects a susceptible host under disease-favorable conditions.



among current commercial hybrids, even though higher levels of resistance would be desirable. In these cases, use of a hybrid with even a low level of resistance is usually superior to planting a susceptible hybrid. Sometimes a moderate level of resistance is acceptable for fields where reduced disease pressure is expected. However, under high disease pressure, low to moderate levels of disease resistance will not provide adequate disease control. Such hybrids may require you to pay greater attention to other disease management strategies in order to achieve good results.

Hybrids can also be selected for tolerance—the ability to yield well even though symptoms develop. Information on disease-tolerant hybrids is limited, but tolerant hybrids can be useful when available.

It is important to plant more than one corn hybrid on your farm. Planting one hybrid is like "putting all your eggs in one basket." Should a disease problem develop on that hybrid, your whole crop is at risk. Planting several hybrids helps to spread the risk of losses from disease.

Tillage

Conservation tillage systems provide for less soil erosion, less fuel consumption, savings of time and labor, moisture conservation, and easier double-cropping. Conservation tillage systems can, however, increase pressure from certain diseases, especially under continuous corn production. Prime examples are gray leaf spot and Diplodia ear rot. Spore levels of the fungi that cause these diseases are higher in fields where previously infected corn residue is left on the soil surface. When residue is tilled into the soil, spores are trapped underground and cannot easily spread to aboveground plant parts. Furthermore, buried crop residues decompose faster, which reduces pathogen survival. Activity of seedling diseases can also be increased in no-till systems because soils remain cooler and wetter during spring under conservation tillage.

While conservation tillage systems may favor certain diseases, they can also reduce pressure from certain others. For example, charcoal rot, which is favored by high soil temperatures and low soil moisture early in the growing season, would be expected to be worse in a conventional system than a no-till system.

The possibility of enhancing pressure from certain diseases under conservation tillage is not necessarily an argument to return to conventional tillage. However, producers should recognize situations when their production system may enhance disease activity so they can employ other disease management practices in order to maintain adequate levels of disease control.

Other Cultural Practices

Other preplant decisions can also influence disease activity. For example, early planting tends to enhance activity of Pythium seedling diseases, which are favored by cool, wet soils. Conversely, late planting can enhance pressure from gray leaf spot, a late-season disease that is more damaging on younger crops than more mature ones.

Plant populations are usually selected on the basis of hybrid characteristics and yield potential of the field. Some diseases can be more severe at high plant populations; several of the stalk rot diseases are examples. A fertility program that is inadequate or excessive, or in which major nutrients are not in proper balance, may also enhance disease activity.

Fungicides

Essentially all corn seed is treated before purchase with fungicides to help control seed rots and seedling diseases. This provides inexpensive protection against stand loss, should conditions favor these diseases after planting. Untreated seed should be treated with fungicides before planting.

Foliar sprays of fungicides may be economical in seed corn fields to protect against a variety of leaf diseases. They may also occasionally be justified for production of certain specialty corns. However, fungicide sprays typically do not show justifiable economic returns for commercial production of dent corn.

Scouting for Diseases

While it is not possible to know with complete certainty which diseases will develop in a given season, the disease history of the farm and area will indicate the diseases most likely to occur. A disease history for a farm is established by scouting fields and identifying disease outbreaks when they occur. Your county Extension agent, farm supply dealer, and crop consultant can also be good sources of information. However, farm-specific information obtained through field scouting is the most reliable basis for developing a farm disease history. Unless you are absolutely certain as to the cause of a particular problem, have the condition diagnosed by a reputable field specialist, or submit the sample to the University of Kentucky Plant Diagnostic Lab.

Mycotoxins

Several mycotoxins—toxins produced by fungi—can occasionally be found in shelled corn. Aflatoxins occur very infrequently in Kentucky, but when they occur, they are often associated with hot, dry weather during grain fill or with improper storage conditions. Fumonisins can also sometimes be found in Kentucky corn, as can vomitoxin (also called deoxynivalenol, or DON), and zearalenone. More information on mycotoxins in corn can be found in the Extension publications *Aflatoxins in Corn* (ID-59) and *Mycotoxins in Corn Produced by Fusarium Fungi* (ID-121).

Diseases of Corn

Anthracnose

Cause: Colletotrichum graminicola

Symptoms: Tan to brown leaf spots surrounded by a yellow halo, usually more abundant toward leaf tip. Lesions may coalesce, blighting entire leaves. Early in season, anthracnose symptoms are most common on lower leaves. Late in season, symptoms of anthracnose include blighting of upper leaves and possibly breakage of plant tops (see Top Dieback). Anthracnose also causes a late-season lower stalk rot. Black spines may be visible in dead leaf spots with a hand lens.

Damage: Early-season leaf symptoms usually are not damaging but indicate the need to scout later for stalk rot. Yields can be reduced from leaf blighting, although this is uncommon. The stalk rot phase can cause stalk lodging.

Key Features of Disease Cycle: The fungus survives in undecomposed corn residue. Spores are spread by wind-blown rain and rainsplash.

Management: Use resistant hybrids, especially where corn is grown without rotation under reduced tillage. Rotate away from corn for one to two years.

Ear and Kernel Rots

Cause: Stenocarpella, Gibberella, Fusarium, Aspergillus, Penicillium

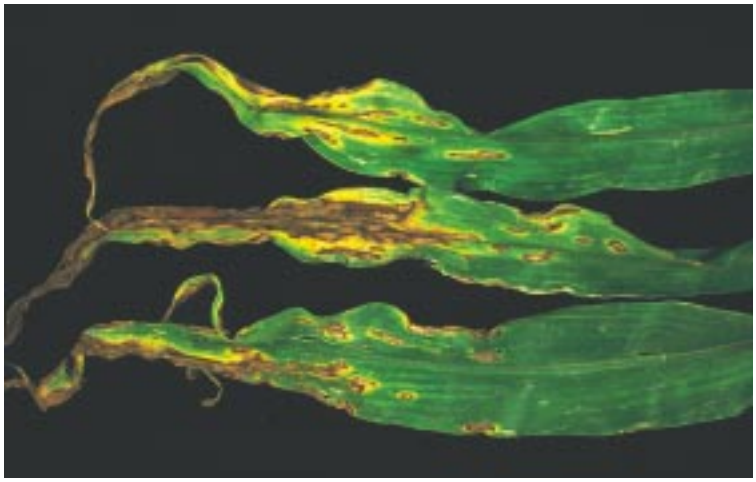
Symptoms: Moldy growth on ears and kernels. Helpful distinguishing features:

- Diplodia ear rot, caused by *Stenocarpella*—white mold growth between kernels, usually progressing from base of ear.
- *Gibberella*—pink to reddish mold growth, often progressing from ear tip.
- *Penicillium*—green or blue-green powdery mold on and between kernels, often at the ear tip.
- *Aspergillus*—greenish-yellow mold on and between kernels.
- *Fusarium*—whitish pink to lavender mold growing on individual kernels or small clusters of kernels.

Damage: Ear and kernel rots reduce feed value and marketability. Yield and test weight may also be reduced. When severe, *Diplodia* ear rot can affect 50 percent or more of the ears in a field. Contamination of grain by mycotoxins from certain ear molds can also reduce nutritional value and marketability of the corn. *Aspergillus* can contaminate grain with aflatoxins, although this toxin is very uncommon in Kentucky. *Fusarium verticillioides (=Fusarium moniliforme)* and related fungi can produce fumonisins in the grain, and *Gibberella* can contaminate the grain with vomitoxin (=DON or deoxynivalenol), zearalenone, or both.

Key Features of Disease Cycle: Wounds made by birds and insects provide infection sites for these fungi, although infection may occur in unwounded tissues. Other factors that can aggravate ear and kernel rots include lodging of stalks that brings ears in contact with soil, incomplete coverage of ears by husks, and maturation of ears in upright position.

Management: For *Diplodia* ear rot, rotate away from corn when 2 to 3 percent of ears have the disease; break up corn residue if practical to enhance decomposition; and avoid highly susceptible hybrids. For all ear and kernel rots, choose hybrids in which ears are well covered by husks and in which ears point downward at maturity. Control insects that feed on ears in the field. Harvest at about 25 percent moisture for shelled corn to minimize kernel damage and field losses. Adjust harvesting equipment for minimum kernel damage and maximum cleaning. Avoid harvesting faster than drying facilities can operate effectively. Dry shelled grain to below 15.5 percent moisture within 24 to 48 hours after harvest. Clean bins before storage and maintain dry storage conditions. Control insect infestations in storage. Periodically aerate and check for heating, crusting, or musty odors. Maintain stored corn uniformly as indicated in Table 1.



Anthracnose leaf symptoms. *(R. Stuckey)*

Table 1. Recommended temperatures for stored corn.

Average monthly temperature	Minimum grain temperature	Maximum grain temperature
Below 40° F	35° F	45° F
40° - 60° F	Within 5° F of average monthly temperature	Within 5° F of average monthly temperature
Above 60° F	55° F	65° F

Diplodia ear rot. *(P. Vincelli)*

Gibberella ear rot. *(D. G. White)*

Sources of Additional Information: Principles of Grain Storage (AEN-20), *Aeration, Inspection, and Sampling of Grain in Storage Bins* (AEN-45), *Aflatoxins in Corn* (ID-59), *Mycotoxins in Corn Produced by* Fusarium *Fungi* (ID-121).

Gray Leaf Spot

Cause: Cercospora zeae-maydis

Symptoms: Gray to tan, narrow, rectangular lesions $^{1}/_{4}$ to 2 inches long. Lesions on some hybrids exhibit a yellow border. Lesions are restricted by veins. Substantial numbers of leaf lesions usually do not appear until tasseling or later. Older leaves are affected first; severely affected leaves can be killed when lesions coalesce. Weakening and lodging of stalks may occur if a severe outbreak blights leaves during grain fill.

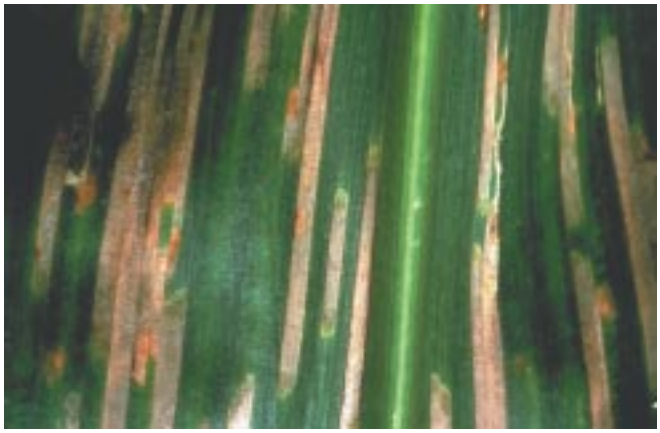
Damage: Yield is reduced through shorter ears and smaller kernels. Yield losses in the range of 10 to 20 percent are typical in susceptible hybrids grown in Kentucky, although losses of 50 percent or more may occur under very high disease pressure. Test weight may also be reduced. When leaf blighting is severe, stalks may weaken and lodge as the plant draws nutrients from the stalk to fill ears.

Key Features of Disease Cycle: The fungus survives for one to two years in undecomposed residue of infected leaf blades and sheaths. Spores are spread by air movement. Leaves become infected during prolonged periods (11 to 14 hours or more) of high relative humidity (>95 percent) and warm temperatures (72° to 86°F). The disease is most severe in fields with corn following corn under conservation tillage. Severe yield loss can occur when leaves become blighted during early grain fill.

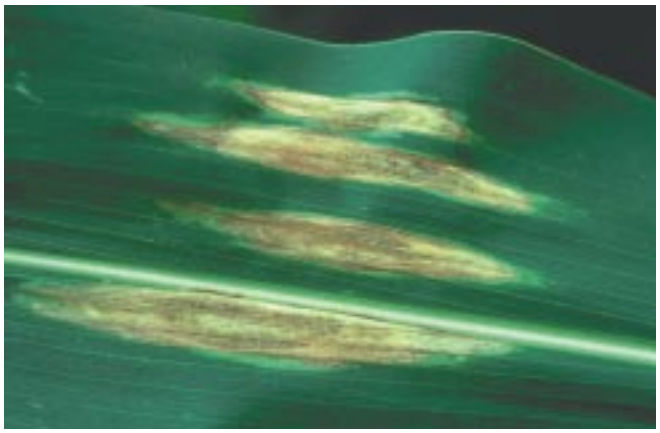
Management: Use resistant hybrids, especially when grown without rotation under conservation tillage. Recognize that there are no immune hybrids, although hybrids exist with a wide range of levels of partial resistance. Typically there is a greater choice of resistant hybrids among mid- and full-season hybrids than among early-maturing hybrids. Consider using a hybrid with high levels of resistance in fields where 1) last year's crop was corn, or 2) corn was grown two years ago and residue cover is at least 30 percent, or 3) there is untilled corn residue within 150 to

Fusarium ear rot. *(R. Stuckey)*

Aspergillus ear rot. *(R. Stuckey)*



Gray leaf spot on a susceptible hybrid. *(D. G. White)*



Northern leaf blight on a susceptible hybrid. *(D. G. White)*

500 feet of the field to be planted (the later the planting, the further it should be from untilled corn residue if it is a susceptible variety). Fungicidal control of gray leaf spot may occasionally be economically justified in certain fields of specialty corns. However, fungicide sprays usually do not show justifiable economic returns for commercial dent corn production.

Sources of Additional Information: Gray Leaf Spot of Corn (PPA-35).

Northern Leaf Blight

Cause: Setosphaeria turcica (= Exserohilum turcicum, = Helminthosporium turcicum)

Symptoms: Elliptical, grayish-green or tan lesions 1 to 6 inches long with smooth margins. During damp weather, greenish-black fungal sporulation is produced in lesions. Older leaves are affected first. Severely affected leaves can be killed when lesions coalesce. On hybrids carrying an Ht_2 resistance gene, long, yellow to tan lesions with wavy margins and no sporulation are observed on leaves infected with *S. turcica*. These resistance-reaction lesions can be easily confused with Stewart's wilt.

Damage: Yield and test weight can be substantially reduced in cool, wet summers, although most hybrids grown in Kentucky have adequate resistance.

Key Features of Disease Cycle: The fungus survives in undecomposed corn residue. Spores are spread by air currents. Spores germinate and infect leaves during wet weather with moderate (64° to 81°F) temperatures. Severe yield loss can occur when leaves become blighted during early grain fill. More severe in fields with corn following corn under reduced tillage. Also infects sorghum.

Management: Use resistant hybrids, especially when grown without rotation under conservation tillage. Hybrids with either single-gene (Ht) or multiple-gene resistance are available. Rotate away from corn and sorghum for one to two years.

Rusts

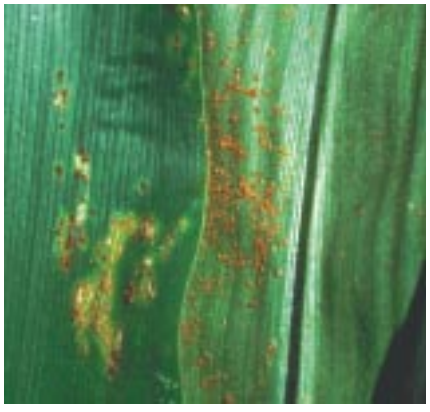
Cause: Puccinia sorghi, Puccinia polysora

Symptoms: Pustules that are circular to oval, golden-brown to cinnamon brown, up to 1/8 inch long. Pustules become brown to black at harvest. Leaves turn yellow and dry up when severely infected. Pustules of common rust (*P. sorghi*) are common on both leaf surfaces. Pustules of southern rust (*P. polysora*) are densely scattered on upper leaf surface with few on lower surface.

Damage: Common rust rarely causes economic loss in field corn in Kentucky. An aggressive outbreak of southern rust in late-planted crops may reduce stalk strength in a grain crop and quickly desiccate silage corn.

Key Features of Disease Cycle: Spores of both fungi are carried on springtime winds from southern areas of the United States. Common rust is active during cool (60° to 75°F), humid weather; southern rust is most active during warm (80°F), humid conditions. Both fungi infect leaves when spores are present and leaf surfaces are wet. Both are potentially more severe in late plantings. Greatest yield loss occurs in susceptible hybrids when outbreaks begin during early grain fill.

Management: Most hybrids in Kentucky have adequate resistance levels to common rust for our conditions. Resistance to southern rust is limited in hybrids commonly grown in Kentucky. Southern rust outbreaks, when they occur, develop in late summer. Therefore, minimize late plantings, which would be at a younger age and therefore more subject to yield loss should an outbreak occur.



Common rust (left) and southern rust (right). *(D. G. White)*

Seed Rot and Damping Off

Cause: Principally *Pythium ultimum*, but also *Stenocarpella*, *Fusarium*, *Penicillium*, *Rhizoctonia*

Symptoms: Rotting of seed before or after germination. Yellowing, wilting, and death of leaves of emerged plants. Soft rot of stem tissues. Rotting of roots, which may appear brown, watersoaked and grayish, faintly pink, or greenish-blue. May result in uneven stand height later in season.

Damage: Stand establishment and early-season vigor can be reduced, leading to lower yields.

Key Features of Disease Cycle: These pathogens are common fungi in Kentucky soils. They usually do not limit stands but can do so when seedlings are stressed. Common stresses include planting in cool, wet soils and chemical injury. Early planting dates preferred by many farmers tend to enhance these diseases.

Management: Use high-quality, vigorous seed treated with fungicide. Plant in warm (above 50°F), moist soils; measure soil temperature at a 2-inch depth after sunrise. Place herbicide, fertilizer, insecticide, and seed properly to avoid stress or injury to seedling.

Symptoms of Pythium root rot. The outer root cylinder appears watersoaked and easily is pulled away from vascular tissue. *(D. G. White)*

Smut, Common

Cause: Ustilago maydis

Symptoms: Greenish-white or silvery galls, or swellings, up to 6 inches in diameter. Galls can occur on any aboveground plant part. As galls age (except those on leaves), the interior darkens and turns into masses of powdery, dark olive to black spores. Galls on leaves usually remain small (0.5 inch or less) and become hard and dry without rupturing. Plants with galls on the lower stalks may be barren or produce small ears.

Damage: Hybrids of field corn grown in Kentucky typically have adequate resistance, and consequently, yield losses typically are minimal (2 percent or less) to nonsignificant.

Key Features of Disease Cycle: The fungus survives for several years as spores in corn residue and in soil. Spores can infect any actively growing aboveground plant part. Wounding (stinkbugs or other forms of injury) enhances infection substantially. Once infection occurs, galls develop, enlarge, turn powdery, and rupture to release spores.

Management: Use hybrids with adequate resistance.

Common smut. *(R. Stuckey)*

Southern Leaf Blight

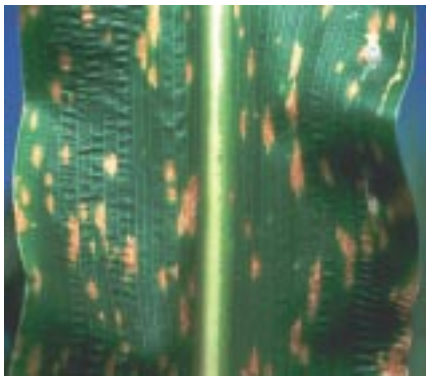
Cause: Cochliobolus heterostrophus (=Bipolaris maydis, =Helminthosporium maydis)

Symptoms: Elliptical, tan to light brown, small lesions ($^1/_8$ to $^1/_4$ inch by $^1/_4$ to $^3/_4$ inch), often with somewhat parallel sides, and sometimes with a brown border. Older leaves are affected first; severely affected leaves can be killed when lesions coalesce.

Damage: Yield and test weight can be reduced, although most hybrids have adequate resistance for our conditions.

Key Features of Disease Cycle: The fungus survives in corn residue. Spores are spread by air currents. Spores germinate and infect leaves during warm (68° to 90°F), wet weather. More severe in fields with corn following corn under reduced tillage. Greatest yield loss can occur when leaves become blighted during early grain fill.

Management: Plant resistant hybrids, especially when grown without rotation under reduced tillage. Rotate away from corn for one to two years.



Southern leaf blight. *(D. G. White)*

Stalk Rot

Cause: Stenocarpella maydis (= Diplodia maydis), Gibberella zeae (= Fusarium graminearum), Fusarium verticillioides (= Fusarium moniliforme), Macrophomina phaseolina, Colletotrichum graminicola

Symptoms: Lower stalk is spongy and internal tissue (pith) shredded and often discolored. Stalks weaken and lodge. Plants sometimes turn grayish-green and dry prematurely during grain fill. Helpful distinguishing features:

- Diplodia stalk rot, caused by *Stenocarpella*—Stalk and pith light brown. Small, dark-brown to black pimple-like fruiting structures develop just below epidermis near base of stalk.
- *Gibberella*—Pith pink to reddish. Small black pimple-like fruiting structures develop superficially on stalk near nodes and can be easily scraped off with fingernail.
- *Fusarium*—Pith whitish-pink to salmon-colored. Roots often rotted. Difficult to distinguish from *Gibberella*.
- Charcoal Rot (*Macrophomina*)—Pith contains many very tiny black fungal structures, giving charred appearance. Roots rotted and black.
- Anthracnose (*Colletotrichum*)—Dark brown to black discoloration on exterior of lower stalk. Dark spines may be visible with hand lens, especially near soil line. Pith light to dark brown.

Damage: Plants lodge and become difficult or impossible to harvest. In severe cases, grain yield may be reduced.

Key Features of Disease Cycle: These fungi survive on corn residues. All but charcoal rot are favored by warm, wet weather during grain fill. Charcoal rot is favored by hot, dry weather during grain fill. Other aggravating factors:

- High plant populations.
- Loss of leaves from disease, insects, or hail.
- Excessive nitrogen, especially when combined with low potash.

Early-season hybrids are often more susceptible than full-season hybrids. Several stalk-rot fungi also cause ear and kernel rots. *Colletotrichum* also causes anthracnose of leaves, as well as top dieback. *Macrophomina* also infects sorghum and soybean.

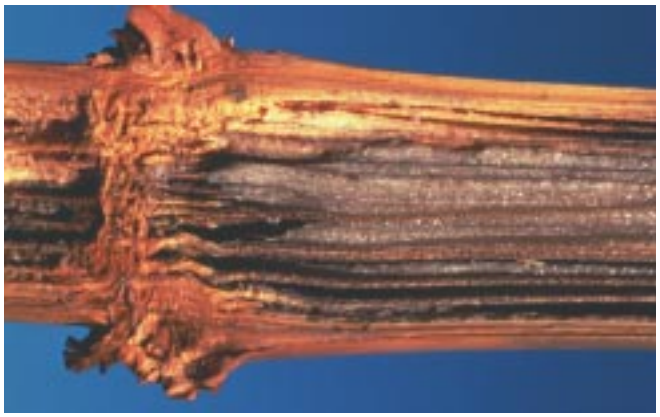
Management: Use hybrids resistant to stalk rots and important leaf diseases like gray leaf spot. Avoid excessive plant populations. Maintain balanced soil fertility and adequate but not excessive nitrogen. Control insects that feed on leaves, stalks, and roots. Scout for stalk rots by either pinching the lower two or three stalk internodes or by pushing stalks 8 to 12 inches from vertical to check for lodging. Harvest early if 10 to 15 percent show disease. Avoid growing continuous corn. Consider avoiding soybean and sorghum following severe outbreaks of charcoal rot.

Sources of Additional Information: *Corn Stalk Rots* (PPA-26).

Diplodia stalk rot. *(R. Stuckey)*

Gibberella stalk rot. Note pink to reddish discoloration in pith. *(D. G. White)*

Gibberella stalk rot. Note fruiting structures on thumbnail. *(D. G. White)*



Charcoal rot. *(D. G. White)*

Anthracnose stalk rot. *(D. G. White)*

Stewart's Wilt

Cause: Pantoea stewartii (=Erwinia stewartii)

Symptoms: Long (2 to 10 inches), linear (1/8 to 1 inch wide) leaf lesions with very wavy margins. At first, lesions are pale green to yellow, but they become light brown when they dry. Severely affected leaves are killed. Lesions of Stewart's wilt are easily confused with lesions on hybrids carrying an Ht_2 resistance gene to northern leaf blight. To aid field diagnosis, hold leaves to light and look in lesions for scratch-like feeding marks of flea beetle; if uncertain, submit samples to the University of Kentucky Plant Diagnostic Labs. Infection of seedlings causes rapid wilt and death.

Stewart's wilt. *(D. G. White)*

Damage: Yield and test weight can be reduced in susceptible hybrids, although most hybrids of dent corn have adequate resistance. In a highly susceptible variety, stands may be reduced if infected as seedlings.

Key Features of Disease Cycle: Overwinters in body of corn flea beetle, which also spreads the bacterium. Disease pressure is usually high in Kentucky but can be low following a very cold winter, which kills overwintering flea beetles.

Management: Plant resistant hybrids. Control of the disease in field corn through application of insecticides targeting the flea beetle is uneconomical.

Sources of Additional Information: Stewart's Wilt of Corn (PPA-33).

Top Dieback (Upper Stalk Rot)

Cause: Colletotrichum graminicola

Symptoms: Plants turn yellow or red from top downward during grain fill. Leaves at ear level remain green. Lodging and breakage of stalks occur when severe. Internal stalk tissue has brown discoloration. Be sure to rule out stalk injury from European corn borer.

Damage: Yield and test weight can be reduced, although serious outbreaks of this phase of anthracnose have not been commonly reported in Kentucky in recent years. Stalk lodging may occur.

Key Features of Disease Cycle: The fungus survives in corn residue. Spores are spread by windblown rain and rainsplash. Also causes early-season anthracnose on leaves, as well as anthracnose stalk rot.

Management: Use resistant hybrids, especially when grown without rotation under reduced tillage. Rotate away from corn for one to two years.

Top dieback. *(R. Stuckey)*

Virus Complex

Cause: Maize Dwarf Mosaic Virus (MDMV), Maize Chlorotic Dwarf Virus (MCDV)

Symptoms: Symptoms can be variable. MDMV typically causes stunting and irregular, light and dark green mosaic patterns in the leaves, especially the youngest leaves. MCDV typically causes stunting, yellowing, and sometimes reddening of the youngest leaves and sometimes causes leaf tattering. Usually most severe around areas of fields highly infested with johnsongrass rhizomes.

Damage: Yield and test weight can be reduced substantially in localized outbreaks in and around areas with rhizome johnsongrass.

Key Features of Disease Cycle: Both viruses overwinter in johnsongrass rhizomes. MDMV is spread by certain aphids; MCDV, by certain leafhoppers. Late-planted fields have greater risk of serious disease outbreaks. Compared to corn planted on time, late-planted corn is at an earlier stage of crop development when insect vectors become active. Earlier infection usually results in more severe symptoms. MDMV also causes a disease of sorghum.

Management: Use virus-tolerant hybrids in fields with heavy infestations of johnsongrass rhizomes. Eliminate johnsongrass rhizomes to reduce disease pressure. Avoid late planting since the younger a crop is when an outbreak occurs, the more yield loss is possible.

Sources of Additional Information: Virus Diseases of Corn in Kentucky (PPA-40).

Virus complex. *(P. Vincelli)*

Acknowledgment

Thanks to Donald Hershman for reviewing a previous draft of this chapter and to Donald G. White and Richard Stuckey for providing photos.