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G99-1384 Gray Leaf Spot of Corn

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Gray Leaf Spot of Corn

All corn hybrids and inbreds are susceptible to gray leaf spot in varying degrees. This NebGuide discusses the symptoms, impacts and management of this disease.

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Corn is grown throughout Nebraska on over 8 million acres of land; approximately 5 million acres are irrigated. The market is segmented into seed corn, field corn and specialty corns (e.g., high oil, high amylose and white corn). Field corn represents the largest portion of the acreage grown. To varying degrees, all corn hybrids and inbreds are susceptible to gray leaf spot disease.

Gray leaf spot is a significant disease worldwide. It has been present in the United States since 1925 and has been considered a problem in the mid-atlantic states and the eastern midwest region of the Corn Belt for decades. Gray leaf spot has been present in Nebraska since at least 1986. However, significant yield losses have occurred over a wide area only since 1994. Unique weather patterns since 1992 (cooler temperatures and prolonged periods of overcast days); changing crop residue management practices (increased acreage of reduced tillage management); and the cultivation of new high-yielding hybrids all may have contributed to the increased prevalence and severity of gray leaf spot in Nebraska.

Impact of Gray Leaf Spot

Many factors affect the degree of impact of gray leaf spot on corn production. The susceptibility of the hybrid is chief among them. Some hybrids yield 40 percent to 50 percent less under severe gray leaf spot disease pressure. In parts of Nebraska, affected fields may yield 40-50 bushels less. Equally important are the weather conditions at the critical times for reproduction, dispersal and infection by the pathogen.

Direct effects: Many foliar diseases put severe stress on the corn plant as the plant matures and grain fill is progressing. This stress can affect the plant in at least two ways: directly, by inhibiting yield fulfillment, and indirectly, by predisposing the plant to other diseases. Extreme disease pressure early can result in premature plant death, but this is rare in Nebraska. Disease lesions expand and coalesce, reducing the amount of photosynthetically active leaf area available for providing carbohydrate to the grains. The plant is competing with the pathogen for available energy. Any stress at the dough-to-dent stage can directly and significantly impact yield. Typically in Nebraska, the gray leaf spot epidemic is in logarithmic phase at this point in plant development, resulting in lower kernel weights in susceptible hybrids. In some years, the corn crop matures sooner than in an average year. This may result in severe gray leaf spot developing after the dough-to-dent stage, minimizing direct effect on yield.

Figure 1. Early lesions of gray leaf spot can be easily confused with lesions caused by other pathogens.

Indirect effects: High gray leaf spot pressure also can predispose corn plants to the family of late season stalk rots, including those caused by *Fusarium, Diplodia* and *Colletotrichum* (anthracnose). 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 to high gray leaf spot pressure in other states across the Corn Belt.

Symptoms

In minimum tillage fields with a history of gray leaf spot, early symptoms occur on the lower leaves prior to tasseling. Early gray leaf spot lesions can be easily confused with lesions caused by other leaf spot and blight pathogens. In Nebraska, early gray leaf spot lesions can be confused with eyespot (*Kabatiella*) or anthracnose (*Colletotrichum*) (*Figure 1*). Mature lesions on leaves are rectangular in shape and restricted by leaf veins (*Figure 2*); reverse lighting reveals a yellow halo on most hybrids (*Figure 3*). Mature lesions can be diagnosed and are easily distinguishable from other diseases. As lesions expand, they coalesce, resulting in a blighting of large portions of the leaf (*Figure 4*). When the source of primary inoculum is within the field, symptoms originate on the lower leaves and progress up the plant as infection cycles occur. When severe, the entire plant may be blighted (*Figure 5*). Stalk infections have been reported and can result in lodging, if severe. Lesions on sheath or husk tissues may be oval to ellipsoidal in shape and are not usually diagnostic. On a field scale, severely

Figure 2. Mature gray leaf spot lesions on leaves are rectangular in shape and restricted by leaf veins. Mature gray leaf spot lesions are diagnostic and easily distinguishable from other diseases.

Figure 3. Reverse lighting (hold leaf up to the sun) of mature gray leaf spot lesions reveals a yellow halo on most hybrids.

affected areas appear to be experiencing early dry-down.

Figure 4. As disease progresses, lesions expand and coalesce, resulting in blighting of large portions of the leaf.

Figure 5. When gray leaf spot is severe, the entire plant may be blighted.

Pathogen

Gray leaf spot is caused by the fungus *Cercospora zeae-maydis*. It is a different species than the pathogen that causes gray leaf spot of sorghum, *Cercospora sorghi*. Although a perfect stage association to *Mycosphaerella* has been proposed, only the asexual stage is important to the epidemiology of gray leaf spot within a season. There are two populations of *C. zeae-maydis* distinguishable by growth rate on laboratory media, geographic distribution and production of the toxin cercosporin. Molecular analyses readily distinguish the two populations from each other, as well as from *C. sorghi*. One population occurs only in the eastern Corn Belt and mid-atlantic states, while the other is found throughout the corn production area of the United States. No differences in virulence between the two populations have been reported. The potential for genetic variation leading to altered virulence is uncertain at present. Variation (genetic, cultural and virulence) between U.S. populations of *C. zeae-maydis* and populations from other continents should be determined.

Epidemiology

Survival: No specific survival structures such as sclerotia or chlamydospores exist for this pathogen, which survives in infected corn tissues on the soil surface. The pathogen does not compete well in the soil environment; the population quickly declines if residue is buried in the soil. No known alternate hosts are involved in the life cycle of *C. zeae-maydis.* Consequently, the longevity of this pathogen is a function of the decomposition of colonized residues.

Infection cycle: The two potential sources of inoculum for plants within a field are infested surface residue from a previous corn crop that had gray leaf spot and air-borne conidia dispersed from nearby or distant fields with the disease. Seed transmission of the pathogen is not believed to be important to disease development. From infected residue on the soil surface, conidia of *C. zeae-maydis* can be rain-splashed or wind-blown onto the lower leaves of the corn plant. On the leaf, they can germinate in 12-24 hours, grow across the leaf surface and penetrate through natural plant openings such as stomates within four to seven days. Approximately nine days after infection, chlorosis becomes evident, and over the next few days necrotic lesions typical of gray leaf spot develop. Conidia production may begin 14 days after infection and continue for several days. In a typical gray leaf spot lesion, up to 5,000 conidia per square millimeter of leaf blade tissue can be produced. Consequently, the more leaf area affected and the larger the lesions, the greater the number of conidia produced. Between 50 percent and 80 percent of the conidia produced are capable of germination.

The infection cycle (infection, penetration and production of conidia) may vary in duration depending upon hybrid genetics. The infection cycle on a susceptible hybrid may last 14-21 days, while on a tolerant/resistant hybrid the infection cycle may last 21-28 days. The potential benefit of the lengthened

infection cycle is fewer cycles per season and/or a delay in reaching the economic threshold for that hybrid.

Weather: The pathogen requires continuous periods of high relative humidity (greater than or equal to 12 hours at greater than 90 percent) and leaf wetness (greater than or equal to 12 hours of free moisture on the leaf surface) with moderate temperatures (70-90°F/25-32°C). Leaf wetness can result from dew, rain or irrigation. The infection cycle can be regulated by the prevailing weather conditions, primarily temperature and humidity. For example, conidia may remain on the leaf surface for several days before germinating if the environmental conditions are not favorable. Also, an epidemic can be slowed or stopped by a change in weather. This may have the effect of lengthening the infection cycle if weather conditions are less than optimal for disease development. The benefit of a lengthened infection cycle may be fewer cycles per season and a delay in reaching the economic threshold. During the 1997 cropping season, gray leaf spot was observed 10 days earlier than in 1996 (a severe gray leaf spot epidemic). However, the hot and dry weather during July and early August were less than ideal for gray leaf spot, resulting in fewer reports of significant yield loss.

Disease Management

Strategy: The overall strategy for gray leaf spot management is to delay the onset of the epidemic and/or to slow the rate of disease development. The ultimate objective is to minimize the number of disease cycles per season and to prevent significant leaf area damage until after the grain fills. If severe stalk rot is a problem in a field, minimizing leaf area damage even after the critical grain filling period may remain a management objective. Because hybrids vary greatly in susceptibility and subsequent yield loss, there is no general economic threshold to target.

The best management plan depends on the level of risk in the field. Risk can be separated into six specific factors for each production system *(Table I)*. The management practices will depend upon which and how many risk factors apply. At present, gray leaf spot management has three components: residue management, hybrid tolerance and fungicide applications.

Table I. Risk factors for gray leaf spot.	
1.	**Cropping Sequence:** Corn following corn increases the risk of gray leaf spot if a susceptible hybrid is grown in a field that had Gray Leaf Spot the previous year and the weather is favorable.
2.	**Prior gray leaf spot Epidemic:** If gray leaf spot occurred last year in the same field, the risk is high; gray leaf spot in adjacent fields also may increase risk for mid-to-late season infections.
3.	**Tillage:** Minimum tillage increases the risk if gray leaf spot occurred in the previous year and there is approximately 30 percent residue cover at planting; less residue cover can still pose a risk.
4.	**Hybrid Susceptibility:** Hybrids vary greatly in their susceptibility to gray leaf spot. Some hybrids have high tolerance to Gray Leaf Spot and still yield under moderate to high disease pressure.
5.	**Weather Pattern:** Weather events increase the risk of gray leaf spot if there are leaf wetness periods of 12 hours or more, temperatures between 70° and 90°F and relative humidity above 90 percent for 12 hours or more.
6.	**Irrigation:** There are reports of increased gray leaf spot in pivot irrigated fields in south central Nebraska. This may be due to 12 continuous hours of leaf wetness as a result of the irrigation

cycle.

Residue: NebGuide G93-1133, *Estimating Percent Residue Cover Using the Line-Transect Method*, tells how to estimate residue cover. Generally, if residue coverage is 30 percent or greater in a field that had gray leaf spot the previous season, damaging levels of gray leaf spot are likely to occur if weather conditions are favorable. However, as little as 10 percent residue coverage can lead to significant yield loss, depending on the hybrid's tolerance to gray leaf spot and the disease pressure that year. Crop rotation and residue incorporation can be effective in minimizing risk. Leaf tissue decomposes in about one year while sheath and husk tissue may take longer. Rotation allows infected tissues to decompose, which decreases the amount of initial inoculum when corn is again planted in the field. The gray leaf spot pathogen does not survive well in soil. Consequently, its population rapidly declines when infected residue is incorporated into the soil and the amount of initial inoculum is decreased when corn is again planted. Once gray leaf spot is endemic in a region, abundant aerial conidia may be present during the season. Under these circumstances, the effectiveness of residue management may be reduced.

Hybrid tolerance: Resistant or tolerant hybrids are the first and best option for managing gray leaf spot. Hybrids vary greatly in susceptibility to the pathogen. Hybrids with high levels of tolerance to gray leaf spot have performed well in Nebraska over the last few years *(Figure 6)*, even in areas with high levels of the disease. Tolerant hybrids yielded well in 1998 in low to moderate disease pressure situations. Hybrid tolerance is a practical method for gray leaf spot management. Careful selection of gray leaf spot tolerant hybrids is recommended if the disease was present at or near that site the previous year and corn is being planted into corn stubble in a minimum tillage system with 30 percent or more residue coverage.

Figure 6. Hybrids vary greatly in susceptibility to gray leaf spot. Tolerant hybrids are available and have performed well in Nebraska.

Fungicides: In late-planted corn with high gray leaf spot pressure, a fungicide treatment may be necessary to prevent significant impacts on yield. Fungicides can be very effective in preventing the development of the disease on the upper leaves of the plant that contribute most to grain fill. The decision to incorporate a fungicide application into a gray leaf spot management plan should include consideration of the potential for disease development (weather and cropping history), the potential for yield loss if disease does occur (hybrid tolerance), and the potential for economic benefit from an application (cost of fungicide and application costs versus the projected yield return). For seed corn production, economic benefit can be realized under high disease pressure. For hybrid field corn, this is an extremely difficult decision. Generally, when a fungicide application decision must be made, it is too early to predict the disease's severity. Hybrids vary in their response to gray leaf spot and the leaf area affected may not be indicative of eventual yield loss. Experience with a specific hybrid or recommendations from the seed company on hybrid performance under varying levels of disease pressure can be helpful. Also, early in symptom development when lesions are small, it is difficult to be sure the lesion is gray leaf spot. Lesions caused by other, usually less damaging, pathogens (e.g., eyespot, *Alternaria*), easily can be confused with gray leaf spot. A correct diagnosis is critical. If gray leaf spot lesions are present on the ear leaf or leaves above the ear leaf at or prior to tasseling, economic benefit may result from a fungicide application. There are two basic options for fungicide management of gray leaf spot: application of a locally systemic fungicide (e.g., Tilt®) or application of a contact fungicide (e.g., Manzate®). These fungicides differ greatly in how they protect and when they can be applied; **READ AND FOLLOW ALL LABEL DIRECTIONS**. A new class of fungicides based on

biologically derived compounds (strobilurins) is being developed and tested. These products are presumed to be of low toxicity and low environmental risk. The preliminary tests of efficacy for gray leaf spot management using these new products are very encouraging.

Integrated management: Some combination of the above practices may be necessary to effectively manage gray leaf spot over a wide area within a season and within a field over several seasons. It is important to assess the risk associated with each field and to develop a short-term and long-term management plan (*Table II*). Weather-based decision tools are under development to help within-season management decisions for the use of fungicides.

Table II. Gray leaf spot management.	
1.	**Cropping Sequence:** Rotation to crops other than corn for at least one year in low-risk fields (two years in high-risk fields) can greatly minimize the severity of gray leaf spot.
2.	**Tolerant Hybrids:** Hybrid tolerance/resistance is the best option for management of gray leaf spot. Hybrids with high tolerance to gray leaf spot yield well under moderate to high disease pressure and should be the first consideration in high-risk fields.
3.	**Fungicide Application:** Under high disease pressure, timely fungicide applications can greatly minimize impact on yield. These applications are costly and usually only practical when disease pressure is high.
4.	**Tillage:** Tillage can reduce the risk of gray leaf spot when the residue is incorporated into the soil and decomposition results. However, the benefits from reduced tillage (e.g., increased water retention, reduced erosion) outweigh the negative impacts of gray leaf spot (see NebGuide G81-544, *Residue Management for Soil Erosion Control)*. This is especially true if other gray leaf spot management measures are employed; e.g., crop rotation, the use of tolerant hybrids and the application of fungicides when necessary.

Unresolved Issues for gray leaf spot

Unresolved issues for managing Gray Leaf Spot include:

1. the effectiveness of residue management for a specific field in regions with high gray leaf spot incidence and severity;
2. the decision point for implementing a fungicide application (when and how much to apply) ;
3. the importance of plant population density and spacing to the incidence and severity of gray leaf spot; and
4. the usefulness of hybrid ratings in seed catalogs.

Web Sites

Several Web sites provide additional information about gray leaf spot of corn, including additional images of symptoms. Several sites also monitor the weather in any Nebraska county. Some of these are:

Weather sites:
http://hpccsun.unl.edu/
http://www.crh.noaa.gov/

Gray leaf spot sites:

http://www.scisoc.org/resource/top.html
http://www.btny.purdue.edu/Extension/Pathology/Alerts/GrayLeafSpot/GrayLeafSpot.html
http://www.ag.iastate.edu/departments/plantpath/extension/leaf1.html
(good site for comparison of gray leaf spot symptoms to symptoms of other diseases)
http://www.scisoc.org/feature/grayleaf/gallery.htm

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