Diseases of Grain Sorghum

Dr. Terry Spurlock, Dr. Travis Faske and Dr. Jason Kelley

Introduction

A number of diseases affect grain sorghum grown in Arkansas. The diseases with the greatest potential to become economically important are primarily caused by fungi, and tend to be problematic just prior to or during the reproductive stages of development. Production practices in Arkansas are variable with respect to inputs and fungicide applications are not always necessary when disease is present. Proper disease diagnosis and understanding of the yield loss potential of diseases commonly found in Arkansas will aid farmers in decision making. The following chapter provides general descriptions and describes management options for many of the most common diseases of grain sorghum found in the state.

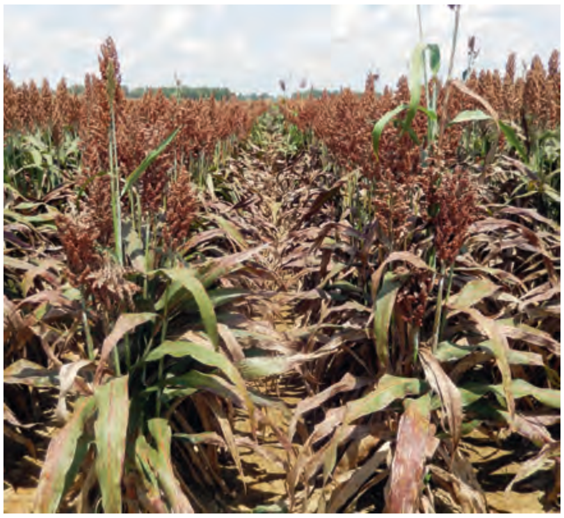

Fig 1. Severe symptoms of Anthracnose on a susceptible hybrid. (Image, left, by Jason Kelley; right by Travis Faske.)

Foliar Diseases

Anthracnose

Anthracnose is caused by the fungus *Colletotrichum sublineolum*. It can occur in Arkansas wherever grain sorghum is grown. It is most often observed when the weather is hot and humid and on susceptible hybrids can be severe and cause tremendous yield losses. Anthracnose has multiple phases; the foliar phase, the panicle and grain phase, and the stalk rot phase.

The foliar phase of anthracnose describes disease of the leaf and leaf midrib (Fig. 1). Lesions begin as small purple to reddish dots and expand to lesions with straw-colored centers and wide red, orange, or purple margins. As the disease progresses, the lesions can grow together, or coalesce, and expand to cover most of the leaf surface. After prolonged disease development, the leaf can die. In the tissue that has been killed (mostly within the lesions), small reproductive structures called acervuli can be seen with the aid of a 10x hand lens. The acervuli are dark colored, mostly black, and have spiny structures protruding called setae. These acervuli are diagnostic for foliar anthracnose. The midrib infections will have similar lesions and may occur independently of foliar symptoms. However, when occurring simultaneously, disease can be severe and likely more severe where disease onset was earlier in the season.

The panicle and grain phase may or may not be correlated in severity with the foliar or stalk rot phase of anthracnose but foliar anthracnose likely contributes to it. As foliar lesions sporulate, conidia are moved behind the leaf sheath into the area adjacent or onto the panicle by wind or water, where

Fig 2. The images above demonstrate the progression of target spot on grain sorghum. Severity increases moving left to right and top to bottom. Lesions begin on the lower leaves and are sporatic. Sporulation from within the lesions spread the disease across the leaf surface and to neighboring leaves and plants. The severity of the disease is determined by the susceptibility of the variety, time when disease occurs (earlier or later in the season), and the weather. (images by Jason Kelley)

they germinate and infect. Lesions first appear on the panicle as small, oval-shaped, and dark water-soaked pockets. They become purple with age. If the panicle is split internally, tissue may appear dark and somewhat marbled. This is considered the stalk rot phase. The panicles from severely diseased plants are typically smaller, and the grain ripens prematurely. Dark streaks appear on grain when it is infected. Acervuli can be found on many parts of the panicle and head during this phase. The panicle and grain phase of disease can cause serious losses on moderately susceptible to susceptible hybrids by decreasing both grain quantity and quality.

The best management of anthracnose is by resistant hybrids. However, evidence suggests the pathogen that causes anthracnose can be genetically variable. Different genotypes cause disease on some hybrids but not others. Because of this difference, the fungal isolates are referred to as pathotypes. A number of different pathotypes have been observed in Arkansas and while some hybrids are or have demonstrated resistance to all or most of these pathotypes in the past, resistance may not be consistent across all fields in all years. When a hybrid appears to be susceptible, a fungicide application may be necessary. Typical timing coincides with heading, but application should be made when disease is actively spreading in a field. Disease is spreading when new infections (lesions) are appearing on heathy plants every couple of days. Fungicides with activity against anthracnose can be found in the current version of *MP154 Arkansas Plant Disease Control Products Guide*. Because the fungus overwinters in dead plant tissue or soil, crop rotation and tillage may reduce initial inoculum in a field. The fungus may also colonize other grasses such as johnsongrass indicating weed control around fields reduce disease incidence.

Target leaf spot

Target leaf spot is caused by the fungus *Bipolaris sorgicola*. It is a common disease in Arkansas grain sorghum and can be severe on susceptible hybrids (Fig. 2). The fungus can infect the plant in all growth stages. It typically survives in soil or residue from the previous year but can also be present on grassy weed hosts. Symptoms begin as small purple spots and progress to reddish-purple oval or elliptical shaped lesions. The lesions can have a tan center with a purple border but this is rare. The lesions range in size from 1 to 10 cm and coalesce when conditions favor continued disease development. Unlike gray leaf spot, lesions are not confined by the leaf veins. Profuse sporulation can occur within the lesions and spores can be spread by wind or water splashing to neighboring plants in the field. Leaves with numerous lesions eventually become blighted, brown, and die.

Control of target spot is best achieved by resistant hybrids or fungicides on susceptible hybrids. Both triazole and strobilurin fungicides have demonstrated good control when fields are at treatment level. To reduce residual inoculum, avoid growing grain sorghum in the same field year after year. Spring tillage may also be effective in reducing residual inoculum levels.

Sooty stripe

Sooty stripe is caused by the fungus *Ramulispora sorghi*. The disease can occur at any time during the growing season and be severe on susceptible hybrids. Sooty stripe first appears as nondescript lesions on the lower leaves of the plant (Fig. 3). During warm, humid weather, conidia form in the lesions and spread to healthy tissue. As lesions

Fig 3. Sooty stripe of grain sorghum. (image by Travis Faske)

mature, they become elongated, with a yellow or reddish border and sclerotia form in the insides of the lesions. The sclerotia are dark colored and easily wipe away having a sooty appearance.

Sooty stripe is best controlled with resistant hybrids. Fungicides labeled for control of foliar diseases of grain sorghum may offer some control when applied prior to significant disease development. In instances of no-till or reduced tillage, the disease may be more severe. Continuously cropping sorghum in the same fields may maintain soil inoculum levels as sclerotia, a dense mass of hyphae that serve as a survival structure. Sclerotia may also survive on sorghum residue, so residue destruction could reduce disease in the following crop.

Fig 4. Zonate leaf spot. (image by Jason Kelley)

Zonate leaf spot

Zonate leaf spot is caused by *Gloeocercospora sorghi*. The fungus causes a relatively large alternating purple and tan banded concentric lesion, thus the "zonate" name (Fig. 4). The lesions are often large, 1-7 cm in diameter, and can encompass the entire leaf width. Lesions can also be found on the leaf sheath. In Arkansas, the disease has been prevalent in certain years but has not caused yield loss. During the season, the fungus spreads, producing pink or salmon colored spores (conidia) that are either blown or splashed to neighboring plants from within the lesion. Sclerotia are formed in dead sorghum tissue and can germinate and infect new growth or plants in the next season. Some evidence suggests the fungus may be carried on seed.

While losses from zonate leaf spot would be unusual, the fungus can be controlled through rotation of fields growing sorghum each year and burying or destruction of sorghum residue. Control of grassy weeds like johnsongrass would most likely reduce inoculum and aid in control. Fungicides are likely not economical unless disease is severe on an apparently susceptible hybrid.

Fig 5. Rough leaf spot. (image by Terry Spurlock)

Rough leaf spot

Rough leaf spot is caused by the fungus *Ascochyta sorghina*. It is readily identified by purple lesions with raised black pycnidia, appearing as black globe-like grains that are rough to the touch in the entirety of the lesion, sometimes a well-defined dark margin is present around the lesion (Fig. 5). The lesions begin as small purple specks on the leaf as disease progresses can encompass the entirety of the leaf. While very common in Arkansas sorghum it is of little economic importance and causes no detectible yield loss. In some instances the leaf can be killed but this is rarely due to rough leaf spot alone as it is often found occurring with other foliar diseases. The fungus spreads by airborne conidia produced in sporulating lesions. Warm, wet weather favors sporulation and disease spread.

Rough leaf spot will be limited by crop rotation and control of grassy weeds. Application of fungicides for control is not recommended due to the limited potential for yield loss

Leaf blight

Fig 6. Leaf blight of grain sorghum. (image by Travis Faske)

Leaf blight is caused by the fungus *Excerohilum turcicum*. This fungus also causes Northern corn leaf blight. The disease is most readily identified by large cigar-shaped lesions on the leaf with reddish or purple margins (Fig. 6) . Within the lesion, there are often noticeable black conidia formed by sporulation of the fungus giving the lesion an ashy gray to dark olive appearance. Like many foliar pathogens, the conidia are blown or splashed to neighboring leaves or other plants and will infect when free moisture is available on the leaf. Some hybrids are resistant to the fungus. Resistant reactions have lesions that are smaller, often no larger than a purple fleck, with little to no sporulation. The fungus survives as mycelia on plant residue, buried in the soil, or on the surface.

Control of the disease is best achieved through resistance but fungicides are effective. Crop rotation and tillage may also offer some control, but the proximity of corn may provide enough inoculum blowing from the corn field to the sorghum field to cause disease. Yield losses can occur if disease is present early in the season, and prior to reproductive stages of development (panicle emergence).

Crazy top

Crazy top is caused by the microorganism *Sclerophthora macrospora*. It is an oomycete which is different than a fungus. In young plants the disease produces mottled yellow plant tissue similar to that of a mosaic symptom caused by some viruses. As the plant matures, the heads often do not emerge or are malformed. Leaves of the plant are thick, with many leaves twisted and appearing to emerge from a similar location on the stem and the plant appears to have “too many” leaves (Fig. 7). The fungus survives by producing a resting spore called an oospore. When free water is available on the soil surface or in soil pores, the oospore germinates and produces motile zoospores (spores that swim) that infect the sorghum plant. Mycelia form in the meristematic tissue of the plant and sporangiophores are produced in the stomata of the leaves. The sporangiophores form zoospores that can infect the plant in a secondary cycle. The disease develops in young plants growing in wet soil and is generally more prevalent in the wetter parts of a field. If the soil is saturated for 1 to 2 days, zoospores can infect grain sorghum across many different temperatures.

Fig 7. Crazy top in grain sorghum. (image by Terry Spurlock)

Metalaxyl or mefanoxam as a seed treatment has demonstrated good control of the disease. Avoiding fields or improving drainage in fields with a history of this disease should decrease symptoms.

Fig 8. Black necrotic roots on a young grain sorghum plant. (image by Jason Kelley)

Seedling diseases

The establishment of grain sorghum in Arkansas can sometimes be problematic due to the variable temperatures and frequent rains that often occur during or just after planting. While cold wet soil can be responsible for reducing seedling emergence and vigor, associated soilborne or seedborne pathogens can reduce stands or stunt plants. Seedling diseases are often caused by fungi in the genus *Rhizoctonia* and *Fusarium* or oomycetes in the genus *Pythium* (and likely combined effects of these referred to as a seedling disease complex). These microorganisms can destroy roots and reduce yields if conditions favorable for disease persist. Typically, cool wet soil favors disease development but wet poorly drained soil alone can also be problematic. Acidic soils with a pH below 5.2 have been reported to favor disease caused by Fusarium. Symptoms of seedling disease include stunted plants with reduced vigor, often in clusters in the field, with black, malformed roots that do not function efficiently (Figs. 8 and 9).

Fig 9. Uneven stand caused by seedling disease. (Image by Terry Spurlock)

Seedling diseases can be managed by seed treatment fungicides. Products with mefanoxam or metalaxyl are effective against *Pythium* spp. However, planting strategies where timing based on soil temperatures above 65°F in fields that are well drained could be enough to manage seedling disease in most years. It is important to note that a seed treatment fungicide should not be expected to provide adequate protection if cool wet soil conditions persist past a few weeks after emergence.

Bacterial Diseases

These diseases are caused by bacteria, which are different microorganisms than fungi and oomycetes. As such, fungicides which control fungal diseases will have little to no effect on bacterial diseases. Therefore, applications are not recommended.

Bacterial leaf spot

Bacterial leaf spot is caused by P*seudomonas syringae pv. syringae*. It produces small cylindrical lesions that occur in clusters on the leaf. The bacterium can also cause the leaf to remain in the whorl. The lesions can have a tan center as they age and can be confused with pesticide injury or another fungal disease. The bacterium infects and causes disease during periods of cool wet weather, during seedling emergence or much later in the growing season. Movement of the pathogen can occur over long distances by wind and water but can also be transported on the seed.

Bacterial leaf spot is unlikely to be of economic importance in Arkansas and therefore, control measures are probably not warranted.

Fig 10. Bacterial streak on a susceptible grain sorghum hybrid. (Image by Terry Spurlock)

Bacterial leaf streak

Bacterial leaf streak is caused by *Xanthomonas campestric* var. *holcicola*. This disease is common in Arkansas. Lesions appear first as purple spots and elongate. They are often confined to the leaf veins and appear to "streak" across the leaf (Fig. 10). When the disease persists, due to warm and wet environmental conditions, or if a cultivar is particularly susceptible, the leaf will become blighted, tan, and die. Leaves often will be shredded or tattered on the ends. Like many bacterial diseases, it is spread by wind and water to neighboring plants. Once in contact with a leaf, the bacterium infects through leaf openings called stomata or through wounds. Although bacterial leaf streak is common, it is likely of little economic importance and control measures are not needed.

Bacterial top and stalk rot

Bacterial top and stalk rot is caused by the bacterium *Erwinia chrysanthemi*. The disease occurs throughout the state but is typically sporatic in fields. The most recognizable symptom of the disease is the upper four to five leaves dead in the whorl (Fig. 11). When the plant is removed from the soil and split longitudinally, the interior of the stalk is reddish, water-soaked, and a putrid odor emanates from the diseased tissue. (Fig. 12)

There are no reported control measures for bacterial top and stalk rot. If a field has considerable amounts of the disease, it should not be planted to grain sorghum the next season.

Fig 11. The upper most leaves have died in the whorl due to bacterial top and stalk rot. (Image by Jason Kelley)

Nematodes

Grain sorghum serves as a host for a number of plant-parasitic nematodes, although there is little evidence at this time that nematodes pose an economic threat to the crop in Arkansas. Nematodes often found in association with grain sorghum in the state include certain species of the lesion nematode (*Pratylenchus*), the spiral nematode (*Helocotylenchus*), the stubby-root nematode (*Paratrichodorus*), and stunt nematodes (*Tylenchorhynchus* and *Quinisulcius*), and the southern root-knot nematode (*Meloidogyne incognita*). It is important to note that lesion nematodes may be found in grain sorghum roots in high numbers, and could be responsible for crop damage under some conditions.

Grain sorghum is not a host for reniform nematode (*Rotylenchulus reniformis*) or soybean cyst

Fig 12. Bacterial top and stalk rot. The stem is split longitudinally to reveal the internal tissue necrosis. (Image by Terry Spurlock)

nematode (*Heterodera glycines*), but is susceptible to the southern root knot nematode (*Meloidogyne incognita*), although hybrids vary in their ability to support root-knot populations. Consequently, grain sorghum may or may not be useful in rotation with soybean, corn, or cotton where one or more of these nematodes are resident and problematic.

Head Blight and Head Molds

Head molds

These diseases are caused by a variety of fungal pathogens. Fungi in the genus *Fusarium*, *Curvularia*, *Phoma*, *Helminthosporium*, and *Alternaria* have all been described as causing head molds. Head molds often cause the head and grain to appear pink, orange, or dark gray-black (Fig. 13). The heads can be malformed or smaller than other non-moldy heads in the field (Fig. 14). In severe cases of disease, the head can split longitudinally, and red tissue will be observed in the interior. Seed can also be smaller or there may be less seed in the head.

Head blight

Head blight is caused by many of the same fungi responsible for head mold. The disease is described differently due to different symptoms. Symptoms of the disease include blighting (tissue necrosis) of the panicle or rachis branches that can cause the panicle to die. Sometimes, there are small black reproductive structures (acervuli) with spines (setae) on the panicle indicating infection and disease caused by *Colletotrichum,* the same fungus responsible for anthracnose.

Fig 13. Moldy and absent grain caused by head mold. (Image by Terry Spurlock).

Fig 14. Malformed and split heads caused by head mold. (Image by Terry Spurlock)

Chemical control of both head blights and head molds are probably not feasible due to timing of the infection and disease. Genetic resistance is most likely the best option since resistance to many of the causal organisms has been observed. In many years, the maturing of grain sorghum will coincide with hot dry weather (typical of Arkansas in the summer). These conditions offer the best opportunity to avoid serious problems with these two diseases along with timely harvest.

Stalk rots

A number of fungi can cause stalk rots that negatively affect grain sorghum in Arkansas. Fungi such as *Fusarium sp., Colletotrichum sublineolum* (anthracnose stalk rot), and *Macrophomina phaeseolina* (charcoal rot) are likely the most commonly observed. While symptoms of stalk rots are similar, causal pathogens may differ. The stalks appear weakened by deterioration of the internal tissue, such that the thin outer stalk may become detached and the plant eventually lodges. Stalk rots can be differentiated in some cases by differing signs of the causal pathogens. For example, charcoal rot will have black microsclerotia present on or within stalk tissue (Fig. 15), anthracnose may be observed with spiny black acervuli, while stalk rot caused by *Fusarium* sp. may appear to be pink or red where the fungus has secreted a pigment.

Fig 15. Microsclerotia (small dark specks) and stalk rot caused by charcoal rot. (Image by Jason Kelley).

Charcoal Rot

Charcoal rot is caused by the fungus *Macrophomina phaeseolina*. It is an important disease in a number of dry regions growing grain sorghum around the world. The sclerotia survive in the soil or on residue left after harvest and germinate when sorghum is planted the next season. The fungus can infect soybean and corn so the residue left in the field by these crops can serve as a source for survival of the sclerotia. Subsequently, crops can have charcoal rot maintaining the fungus in non-sorghum planting years. Charcoal rot is often made more severe by a number of common stresses on sorghum. These can be singular or are more often a combination of high plant population, drought, foliar disease, insect damage, high nitrogen, low potassium, and the hot humid weather typical for summer. The disease becomes more evident as the sorghum approaches maturity. High soil temperature and low soil moisture during the post-flowering stages of development favor disease. The fungus survives by producing sclerotia. Symptoms of the disease include brown or black water-soaked roots with dark grey sclerotia forming on the dead tissue. The plant tissue is weakened by the attack of the fungus and causes the plants to collapse and lodge. Lodged plants do not produce full heads of grain or fully formed heads and are difficult to harvest.

Control of charcoal rot can best be achieved through maintaining adequate soil moisture and only applying recommended amounts of nitrogen and potassium. Because the fungus also causes disease in corn and soybean, these rotations will not reduce the chances for disease. Little data is available on resistance for charcoal rot in grain sorghum hybrids. Due to the ability of the fungus to infect and cause disease late in the year, chemical control through seed treatments or otherwise is likely not effective.

Management of stalk rots are aligned with fundamental practices that would likely increase the opportunity for a successful crop. Control of weeds that could compete for plant available nutrition and insects and foliar diseases that could reduce leaf surface area will reduce overall plant stresses in a growing season. Balanced fertility and proper plant populations will also reduce stress. Any practice that reduces plant stress should reduce the likelihood of losses due to stalk rots.

Fig 16. Lodging of grain sorghum as a result of severe stalk rot. (Image by Jason Kelley).