6 - Common and Important Diseases of Grain Sorghum

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Introduction

Grain sorghum continues to be an economically important crop in Arkansas, fitting into production schedules and helping to control nematodes of both cotton and soybeans. However, numerous diseases of grain sorghum can be found wherever the crop is grown, including Arkansas. Some of these diseases have been investigated in the past and we have listed several below which are either continuing to be important pathogens that affect yields or are very common and provoke interest from producers. In addition, one new disease of grain sorghum was recently found in the United States and it is listed below as an uncommon disease for information purposes. It was discovered in one field in Arkansas in 2001 but with assistance of the producer has not reappeared in the field. It has not been found in Arkansas since that initial report.

Anthracnose

Since 1985, sorghum anthracnose, caused by a fungus, *Colletotrichum sublineolum*, has increased dramatically throughout Arkansas. It is especially common in the eastern, southeastern and southwestern grain sorghum areas. Although outbreaks have been sporadic, the disease has been a significant economic factor for grain sorghum producers in these regions.

Symptoms of leaf anthracnose usually become clearly visible about the time of boot formation. On susceptible hybrids, small circular spots develop on leaves and leaf midribs (Figure 6-1). These spots have wide margins that are red, orange, purple, or tan with straw-colored centers. As the disease progresses, the spots may increase in number and coalesce to cover most of the leaf surface. In the centers of the spots, small black fruiting bodies (acervuli) develop. These acervuli, with setae (small, black, hairlike structures protruding from the acervuli), are diagnostic characteristics of anthracnose. Use of a hand lens or a dissecting scope helps identify these structures. These symptoms are sometimes easier to recognize on the mid-vein of older leaves (Figure 6-2). The disease can also infect the stalk of grain sorghum hybrids (Figure 6-3).

Although leaf lesions are the first symptoms of infection in the field, there are four separate phases of anthracnose: seedling root rot, leaf (foliar), stalk rot and seed mold. All four phases may occur on sorghum within a single growing season. All phases can reduce yields severely. Seed rot is caused by planting infected seed or by infection of the seeds as they germinate in infested soil. The leaf phase occurs from the first true leaf through the emergence of the panicle from the boot. Generally, the leaf phase of anthracnose begins to develop very quickly near the end of the vegetative stage of the plant and near the beginning of the heading stage. If the foliar phase destroys leaf tissue prior to or during grain filling, yields may be reduced. Stalk anthracnose develops from spores produced in the foliar phase, and is spread throughout the field by splashing rain and wind.

The rate and severity of stalk and head infection are determined by the level of anthracnose resistance in the hybrid, the number of spores produced and the environment. Spores of *C. sublineolum* produced on leaves are washed into leaf sheaths by rain or dew. The spores germinate and infect the stalk above the uppermost leaf and rot the interior of the stalk. If the head and stalk are split lengthwise, a banded or marbled pattern of dark red to purple lesions interspersed with white pith tissue can be seen (Figure 6-4). This phase is most common when stem borers have been active in the plant because the borers create wounds for the fungus or carry the fungus with them into the stem. Under conducive

Figures 6-1 through 6-13 can be found on pages 45-46 at the end of this chapter..

conditions, the infections of the leaf and stems continues and leads to invasion of the panicle and seeds. Under severe conditions, infection of the panicles can prevent grain filling. Heads of infected plants generally mature earlier and are smaller and lighter in weight than uninfected heads. Because the destruction of stalk tissue limits movement of nutrients to the developing grain, the stalk phase of anthracnose can be an important factor in final determination of grain yield. Seed from infected heads may also be infected. Dark brown or black streaks encircling the seed are an indication of seed infection. Acervuli may also develop on the seed in the later stages of infection. The fungus can overwinter in the soil on refuse, on infected seed and as a small sclerotia.

Resistance to the leaf and stalk phases of anthracnose appears to be controlled by several different dominant and recessive genes, which means that sorghum can have resistance to the leaf phase, or to stalk phase or to both phases. Some hybrids can also have resistance on the leaf blade but still produce large lesions on the midveins of the same leaf. The fungus is known to be extremely variable and many of the current hybrids possess some degree of resistance to certain strains (called pathotypes) of the pathogen. Many of the inbred lines used in popular hybrids were developed for anthracnose resistance in areas of the southern U.S. where the disease was a significant problem. Some hybrids rated as resistant elsewhere are relatively susceptible to the pathotypes found in Arkansas.

Resistance of Selected Grain Sorghum Hybrids to Anthracnose in Arkansas

Anthracnose has been found on several of the University of Arkansas Experiment Stations since 1995. Because the availability and use of sorghum hybrids tends to change greatly from year to year two kinds of field tests were conducted at Rohwer, Marianna and Pine Tree to monitor the severity of the disease and to determine the levels of resistance in these grain sorghum hybrids to this disease. In the first of the field tests, disease ratings were made on all hybrids and selections in the Arkansas Variety Test Program. These tests were not artificially inoculated and results depended entirely upon the amount of the pathogen and the strains present in that test area. Individual entries in the variety test varied from year to year and often included experimental breeding lines that may or may not be released to the public under a hybrid name. Yield data on the hybrids and lines within this test are available from the Variety Test Performance Report.

In addition to the variety test, tests consisting of the highest yielding hybrids and hybrids that were the most popular among producers in Arkansas were also conducted at Rohwer, Marianna and Pine Tree. The 15 hybrids in these tests accounted for an estimated 90 to 95 percent of the grain sorghum acreage grown in the state.

Results from the 2003 entries in the Arkansas Variety Test Program are given in Table 6-1. These tests were conducted at the Cotton Branch Station, Marianna, Arkansas, and at the Pine Tree Station, Colt, Arkansas. At Marianna, none of the 41 entries in the test were rated as resistant to anthracnose, although 12 entries were rated as moderately resistant to this disease. Twenty-three (23) entries were rated as moderately susceptible and 6 entries (Dyna Gro 732B, Dyna Gro X173B, Dyna Gro X1754, Dyna Gro 715B, Terral TV97H17 and Triumph TR 461) were rated as susceptible to anthracnose. Disease severity ratings, indicating the estimated percentage of leaves infected by anthracnose, ranged from a low of 2.5 to a high of 9.5. Among the moderately resistant entries, disease severity ratings ranged from 2.5 (Garst 5515) to 7 (Terral TVX94S34, TVX95S25 and Triumph TR459). Disease severity ratings ranged from 7.5 to 9 for the hybrids rated as susceptible to anthracnose at that location.

Results from the Grain Sorghum Variety Test at Rohwer were significantly different from those at Marianna. At Rohwer, 28 of the entries were rated as resistant to anthracnose, 5 were rated as moderately resistant, 8 were rated as moderately susceptible and none were rated as susceptible to anthracnose. Disease severity ratings ranged from 1 to a high of 5.5. Among the entries rated as resistant, severity rating ranged from 1 to 2.5 indicating a relatively low level of disease on these entries. Among the entries rated as moderately resistant, the severity ratings were slightly higher ranging from 1.5 to 3. Among the 8 entries rated as moderately susceptible, severity ratings ranged from 2.5 to 5.5, indicating a slightly higher level of disease on these entries. All of the entries were examined for uniformity of the disease ratings between the two locations.

Table 6-1. Disease ratings for resistance and severity to anthracnose for 41 selections of hybrids and breeding lines entered in the Grain Sorghum Variety Test Program in 2003. Ratings were made at two locations at the hard dough stage of plant development.

	Marianna		Pine Tree	
Hybrid/Entry	**Rating**	**Severity**	**Rating**	**Severity**
Asgrow A571	MS	6.5	MR	1.5
CroplanGen514	MS	8.5	R	1.5
DeKalbDKS53-11	MR	4	R	1
DekalbDKS54-00	MR	3.5	R	1
Dyna Gro 732B	S	8	MS	3
DynaGroX1738	S	9.5	R	1
DynaGro X1754	S	7.5	R	1.5
DynaGroX17F90	MR	3	R	2.5
DynaGro715B	S	8.5	R	1.5
DynaGro762B	MS	8	R	1
DynaGro780B	MS	7.5	R	2
FFR 318	MR	6	MR	3
FFR 322	MS	6	MS	2.5
Garst 5440	MS	7.5	R	1.5
Garst 5515	MR	2.5	R	1.5
Golden Acres 3694	MS	5.5	R	1
Golden Acres 444E	MS	7.5	MS	2.5
Golden Acres X2027	MS	8	R	1.5
H-502	MS	7	R	1.5
H-512	MS	8.5	R	2
Monsanto X204	MS	7.5	R	1
Monsanto X234	MS	6	MR	2.5
Pioneer 83G15	MR	3	R	1.5
Pioneer 83G66	MS	5	R	1.5
Pioneer 84G62	MS	5	R	2
South States SS650	MS	5.5	R	1.5
South States SS800	MS	8	R	1
Terral TV1050	MR	6.5	R	1
Terral TV93S72	MS	8.5	R	1
Terral TV9421	MS	9	MS	3
Terral TV96H81	MR	6.5	R	1.5
Terral TV97H17	S	7.5	R	2
Terral TVX93S16	MS	9	MR	3
Terral TVX 94S34	MR	7	MS	2
Terral TVX95S201	MR	4.5	R	1
Terral TVX95S25	MS	7	MS	2.5
Terral TVX96H202	MR	3.5	R	1
Terral TVX96H23	MS	5.5	MR	1.5
Triumph TR459	MS	7	MS	3.5
Triumph TR461	S	9	MS	5.5
Triumph TR82G	MR	4	R	1.5
Average Rating		6.5		1.8

Table 6-1 shows that most entries were rated as either resistant or moderately resistant, moderately resistant or moderately susceptible or moderately susceptible or susceptible at the two locations. However, 18 entries including an entry from Croplan Genetics, five from Dyna Gro, one from Garst, one from Golden Acres, two from H, one from Monsanto, one from Pioneer, two from Southern States and two from Terral, were rated as susceptible or moderately susceptible at Marianna while they were rated resistant at Pine Tree. The remaining 23 entries were rated uniformly or more similarly across both locations. These large differences could have resulted from the significantly higher levels of disease pressure at Marianna or from the occurrence of different strains of the pathogen at these locations. Preliminary evidence from molecular studies and from previous tests indicates that we have different strains virulent to different hybrids within Arkansas.

Results of the survey of anthracnose resistance within the 15 highest yielding or most popular hybrids in Arkansas are presented in Table 6-2. These tests were conducted at the Pine Tree Experiment Station, Colt, Arkansas, at the Cotton Branch Station at Marianna, Arkansas, and at the Southeast Branch Station at Rohwer, Arkansas. All ratings were taken at the hard dough stage of plant maturity without regard to time of year. In this test, 14 of the 15 entries were rated as resistant to anthracnose at Pine Tree and one was rated as moderately resistant to disease. At Marianna, all 15 entries were rated as resistant to anthracnose. In this case, these entries were planted in a different field and location than was the variety test. At Rohwer, 10 of the 15 entries were rated as resistant while 5 were rated as moderately resistant to infection by anthracnose. Disease severity ratings ranged from 1 to 2 at Pine Tree and Marianna and from 1 to 4.5 on 14 of the 15 entries at Rohwer. The highest severity rating (7.5) was on TV 9421 which was rated as only moderately resistant at Rohwer.

The uniformity of the rating for disease severity across the locations in this test is low; nevertheless, most of the hybrids exhibited some resistance to anthracnose at all three locations. There were significant differences noted in the reaction of some entries and all of these differences were recorded at Marianna where the 10 entries were rated as susceptible or moderately susceptible in the variety test there while rated as moderately resistant or

Table 6-2. Ratings for disease resistance and severity for selected high-yielding and popular grain sorghum hybrids grown in Arkansas. The data listed were obtained from tests conducted in 2003 at three locations in eastern Arkansas.

Grain Sorghum Hybrids	Anthracnose Ratings Across Locations					
	Pine Tree		Marianna		Rohwer	
	Rating	Severity	Rating	Severity	Rating	Severity
TV1050	R	1	R	2	R	3.5
TR 82G	R	2	R	1.5	MR	2
TV 9421	R	1	R	1	MR	7.5
DG 780B	R	2	R	1	R	3
FFR 322	R	2	R	1	MR	4
DG 751B	R	2	R	1	R	3
Pioneer 8282	R	2	R	2	R	3
Asgrow A571	MR	2	R	1	R	2
Pioneer 84G62	R	2	R	1.5	MR	4.5
SS 650	R	2	R	2	R	2
Pioneer 83G66	R	2	R	2	MR	4
SS 800	R	2	R	1	R	2.5
DKS 54	R	2	R	1	R	1
Golden Acre 444E	R	2	R	2	R	5
DK 53S-11	R	1	R	1	R	3
Average Rating		1.8		1.4		3.3

resistant at all other locations and tests. As stated above, these differences in results between the variety test at Marianna and the variety test results at Pine Tree and all three of the hybrid tests at Pine Tree, Rohwer and Marianna may reflect significant differences in the strain(s) of the pathogen present at that one location at Marianna.

The results of the 2003 tests of the best hybrids closely reproduces the results of previous years in which this test was conducted at Pine Tree and Rohwer in which all these were rated as resistant or moderately resistant to infection.

Bacterial Diseases

Bacterial Leaf Spot

Bacterial leaf spot is caused by *Pseudomonas syringae pv. syringae*. The disease is found throughout Arkansas but is more common in the southern regions of the state. Symptoms of the disease consist of an initial water soaked lesion on the lower leaves. As lesions grow and mature, they become elliptical to circular and often develop red or brown margins (Figure 6-5). As lesions dry, the centers become light colored. At this stage, leaf spot can resemble pesticide injury, physiological spotting and one or more fungal diseases. This disease is most commonly found in the spring since it is dispersed by rain and wind. As the growing season approaches summer, the disease usually becomes insignificant in severity. The bacterium overwinters in debris and in infected grasses. Control measures include crop rotation, destruction of crop residue and planting of resistant cultivars and hybrids.

Bacterial Leaf Streak

Bacterial leaf streak is caused by *Xanthomonas campestric var holcicola*. The disease is common in the warm humid areas wherever sorghum is grown. It is found throughout Arkansas. The typical symptoms of the disease include small interveinal watersoaking areas that increase in size and that become several centimeters in length and purple in color in many varieties grown in Arkansas (Figure 6-6). The purple lesions often remain between the leaf veins and may appear as stripes. In very susceptible varieties, the stripes coalesce to become blotches and leaf shredding and death may occur at this stage.

The disease is most commonly found in the spring and is favored by warm wet conditions. Under normal conditions in Arkansas, the disease becomes progressively less severe as the hot dry summer months approach. Control measures include crop rotation, destruction of crop residue and planting resistant varieties and hybrids.

Other Important Fungal Diseases

Leaf Blights

Leaf blight is caused by several fungi, including *Exserhilum turcicum*, and is widespread in many parts of the world, including Arkansas. Disease development is favored by moderate temperatures (18° to 27°C) and heavy dews or rain during the growing season. The disease can make its appearance early in the season and continue to develop throughout the growing season unless retarded by dry weather. If disease becomes established on susceptible cultivars before panicle emergence, yield losses can approach 50 percent. Symptoms of the disease include small reddish or tan spots (the color is dependant on cultivar type) that can enlarge to long elliptical reddish purple or tan lesions (Figure 6-7). These lesions can be 12 mm wide and 2.5 to 15 cm long. Sporulation of the fungus on lesions often gives them a dark gray or olive appearance on the surface.

The fungus can survive on grasses, on residue and on seeds. The disease is controlled by the use of resistant cultivars and by rotation. However, rotation is made less effective if infected grasses persist in fields or in field margins. High yielding and resistant cultivars and hybrids have been identified and are available to growers.

Charcoal Rot

Charcoal rot is caused by a soil-borne fungus, *Macrophomina phaseolina*. This can be a major disease in the drier regions of the world and has appeared in Arkansas during late summer. It appears to be especially destructive on high yielding cultivars that set and fill seed during hot, dry weather if plants are subjected to drought. Portions of fields can be affected with all plants completely lodged while other portions of the same field may appear to be healthy.

In general, the disease becomes conspicuous during the late season as plants near maturity. One symptom of the disease is lodging; however, diagnosis of infection by *Macrophomina phaseolina* is best characterized by a dried, stringy appearance of the stem near the soil line (at the fold in lodged plants) and the presence of black sclerotia in the affected areas (Figure 6-8). There is normally little if any reddening of the pith or cortex of the stems.

The pathogen is soil-borne and survives in the soil as sclerotia which provides the initial inoculum. High soil temperatures and low soil moisture are the predisposing factors for expression of the disease after flowering has occurred.

Incidence of charcoal rot can be minimized by maintaining soil moisture during the post-flowering stages. High levels of nitrogen and low levels of potassium are conditions that should be avoided. Host resistance is a complex of interacting characteristics and not generally well described.

Head Blight and Head Molds

Head blight and molds are caused by a variety of fungal pathogens. Head molds generally refer to fungi that mold the grains as they mature on the seed head. *Fusarium moniliforme*, *Fusarium semitectum*, *Curvularia lunata*, *Phoma sorghina*, *Helminthosporium* spp. and *Alternaria* spp. are generally considered to be head molds. In addition, anthracnose can also infect peduncles, pedicles and seeds on severely infected plants. The most obvious symptoms of head molds are the pink, orange or white seeds found on heads infected by *Fusarium* and by the presence of black seeds on heads infected by *Curvularia*, *Alternaria* or *Helminthosporium* (Figure 6-9). The presence of small black dots may indicate *Phoma* pycnidia or the acervuli of *Colletotrichum*. Head blight is usually reference to the infection of panicle or rachis branches that result in premature death of all or parts of a panicle. Head blights can be caused by *Fusarium* but also can be caused by *Colletotrichum*.

Head blights and molds can be partially avoided by adjusting planting dates so that plants mature during a period without frequent rains. Some sorghum genotypes are more resistant than others but none are considered to be completely resistant. Although the fungi infect seeds, there is no clear evidence that seed-borne infections greatly influence the occurrence of these fungi on seeds in subsequent crops.

Target Spot

Target spot is caused by *Bipolaris sorghicola*. The disease was found in plots at the Pine Tree station in 2001 in epidemic levels. It had not been found at these levels prior to 2001. It is a disease that should be watched carefully because it is potentially severe.

The symptoms of the disease first appear as reddish or grayish spots which later develop into elliptical, oval or more commonly cylindrical shapes (Figure 6-10). The lesions vary in size from 1 to 10 cm in length. On rare occasions the purple lesions may have a tan-colored center. Under wet conditions, numerous spores can be produced on lesions. Spores are brownish to gray in color.

The fungus attacks plants of all ages and stages. The disease can appear in early spring and can continue to develop throughout the entire year into heading. On susceptible cultivars or hybrids, lesions can coalesce to kill the entire leaf. The fungus can survive as mycelium or as spores in infected debris or on weed hosts such as johnsongrass.

Resistant hybrids or cultivars are recommended. However, very few hybrids are considered to be highly resistant. Rotations are partially effective if weedy hosts are kept to a minimum. The disease is easily dispersed from infected plants by the airborne spores.

Zonate Leaf Spot

Zonate leaf spot is caused by *Gloeocercospora sorghi*. This is a very common disease throughout Arkansas and is easily recognized but generally of little or moderate importance. Symptoms of the disease are often described as very large (3 to 8 cm) circular lesions that have alternating straw-colored and purple rings (Figure 6-11). However, many of the initial lesions are purple blotches that may have light irregularly shaped spots in the centers. The fungus overwinters in sclerotia in soil and in infected plant debris. During warm wet periods, pink to salmon colored spores may be visible on the lesions. It is known that lesions can appear within 12 hours

after infection with 1 cm purple blotches developing within 24 hours of infection. The fungus is dispersed by rain and water and the disease can be severe in wet periods.

The disease is reduced by crop rotation and cultivation to control susceptible weed hosts such as johnsongrass and other grassy weeds. Cultivars and hybrids that are somewhat resistant to the disease are also available to growers.

An Uncommon Fungal Disease of Potential Significance to Arkansas

Sorghum Ergot

Sorghum ergot is caused by a fungus called *Claviceps africanae*. The disease was introduced into the U.S. a few years ago and has caused significant losses in Texas, Kansas and Nebraska. Although still present in these states, the disease has not become a significant problem throughout the region. Ergot was found in Arkansas in 2000 in White County on Pioneer Hybrid 8313. It is widely held that this variety is among the most easily infected by this fungus. The disease was not found or reported in Arkansas in 2001.

Symptoms of the disease begin shortly after flowering (Figure 6-12). The fungus usually only infects unfertilized flowers and infection results in the production of a sugary exudate on the infected flowers (Figure 6-13). The exudate contains spores that can produce still another spore which is, in turn, disseminated to infect additional flowers. After maturity, the infected seed produces an elongated black horn resembling ergot of rye but which are much larger. Control of the disease is made possible by rotation and by planting cultivars and hybrids that are resistant to infection.

Summary

Sorghum anthracnose continues to be an economic consideration in grain sorghum production in southwestern Arkansas and in other areas of the state. From 1989 through the present, significant yield losses due to this disease were found in susceptible hybrids throughout the state. Empirical information suggests that hybrid selection, planting date and environmental conditions that favor disease development and dissemination at crop maturity appear to influence anthracnose severity.

The occurrence of anthracnose and other diseases indicates that inoculum for future epidemics is present in soils or plant refuse and suggests that producers should plant resistant hybrids whenever possible. The more recent information on these diseases, especially anthracnose, suggests that a high degree of variability exists within these fungi in the world and probably within Arkansas.

Commercial hybrids are available to producers that carry a significant level of resistance to the anthracnose. Sorghum producers are strongly encouraged to consider the anthracnose resistance or susceptibility of any hybrid that may be offered for sale.

Nematodes

Plant-parasitic nematodes are not currently considered to be of economic significance on grain sorghum in Arkansas. Although, several nematode species can be found in association with grain sorghum roots in the state, there is very little reliable information available on their impact on crop performance. Grain sorghum is not a host for the soybean cyst nematode (*Heterodera glycines*) or the reniform nematode (*Rotylenchulus reniformis*), and it is a relatively poor host for the southern root-knot nematode (*Meloidogyne incognita*). Consequently, crop rotation sequences that include grain sorghum may be effective in lowering populations of these nematodes for these and other crops.

Management Recommendations for Grain Sorghum Diseases

Anthracnose has been a serious yield limiting factor for grain sorghum production in Arkansas under some conditions although the disease may not be severe in any location or field each year. It is difficult to predict at planting if the environmental conditions that will prevail near the blooming, or anthesis stage, when hybrids are most susceptible, will be favorable for anthracnose development.

Producers can have an impact on the severity of this disease and on other diseases by choosing from a number of management strategies including resistance, planting date, rotation and seed bed preparation.

Resistance

Although some of the grain sorghum hybrids that are popular in Arkansas appear to be susceptible to the local and endemic strains of a pathogen, there are also several hybrids that are resistant to diseases in each production area. New information collected from several locations shows that many lineages and strains of this fungus are found in the world and some of these occur in Arkansas. Further, the use of resistant hybrids may be the most cost-effective means of managing diseases. The tabular data in this report may aid in selection of resistant hybrids to anthracnose. It is important to remember that from experience, hybrids that were rated as resistant to anthracnose in other areas of the U.S. may not be highly resistant to the pathotype(s) found in Arkansas.

Planting Dates

Grain sorghum producers in areas where anthracnose has been a problem have found that early planting of resistant hybrids may further decrease yield losses due to this disease because flowering and grain maturation occur in an environment not conducive to disease. Care should be taken so that planting does not occur so early as to risk seed and root rot problems and not so late as to cause sorghum to head out in the cooler and wetter conditions of early fall that may favor diseases such as anthracnose.

Crop Rotation

In 2003, an anthracnose epidemic occurred in one field in which sorghum was planted for several years. Since, this pathogen and many others can survive in crop refuse, an aggressive crop rotation program is another aid to disease management, especially when coupled with use of resistant sorghum hybrids.

Seed Bed Preparation

Moldboard plowing to bury sorghum residues and eliminate grasses (e.g., johnsongrass) also may be helpful in disease management. Similarly, cutting down stalks that remain after harvest may help eliminate further build-up of the pathogens on crop residue. The residue provides the fungus with a place to survive and grow and a mechanism to spread to seedlings in the new crop.

The following photographs were referenced throughout Chapter 6 – Common and Important Diseases of Grain Sorghum.

Figure 6-1. Symptoms of anthracnose on an infected sorghum leaf.

Figure 6-2. Anthracnose symptoms on a mid-vein of a sorghum leaf.

Figure 6-3. Symptoms of sorghum anthracnose on a sorghum leaf.

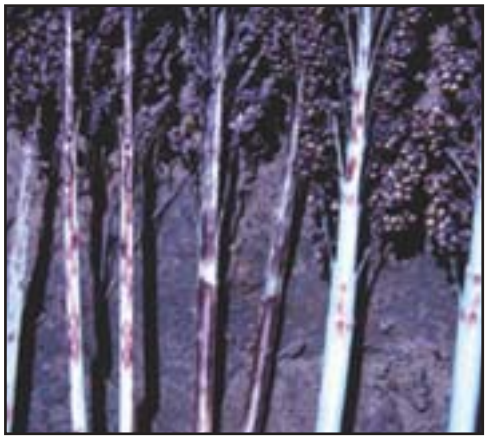

Figure 6-4. Stalk rot of grain sorghum caused by anthracnose.

Figure 6-5. Bacterial spot of grain sorghum.

Figure 6-6. Bacterial leaf streak of grain sorghum.

Figure 6-7. Leaf blight of grain sorghum caused by *Helminthosporium*.

Figure 6-8. Charcoal rot of grain sorghum showing a rotted and degraded stem bent at the soil line.

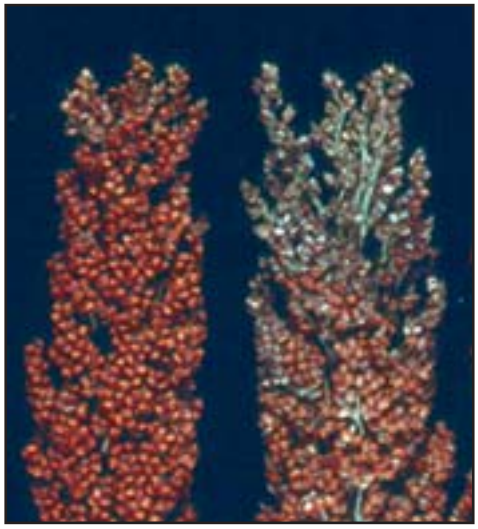

Figure 6-9. Head blight of grain sorghum caused by a *Fusarium*.

Figure 6-10. Target spot of grain sorghum caused by *Bipolaris sorghicola*.

Figure 6-11. Zonate leaf spot of grain sorghum caused by *Gloeocercospora sorghi*.

Figure 6-12. Sorghum Ergot caused by *Claviceps africanae*.

Figure 6-13. Honeydew of sorghum ergot caused by *Claviceps africanae*.