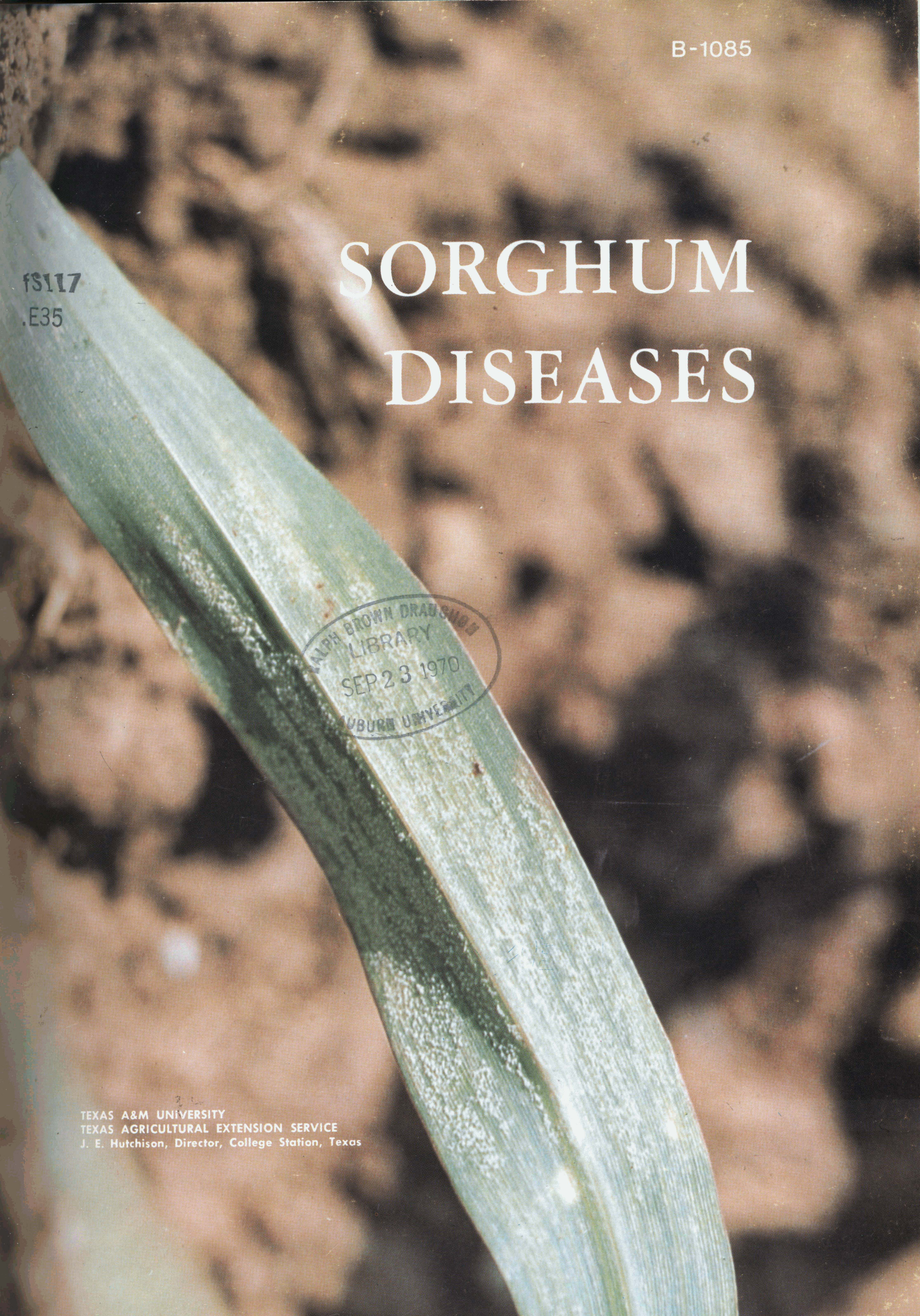

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SORGHUM DISEASES

TEXAS A&M UNIVERSITY
TEXAS AGRICULTURAL EXTENSION SERVICE
J. E. Hutchison, Director, College Station, Texas

AUTHORS

JOSE AMADOR, Area Extension Plant Pathologist, Weslaco

ROBERT W. BERRY, Area Extension Plant Pathologist, Lubbock

RICHARD A. FREDERIKSEN, Assistant Professor, Department of Plant Sciences

C. WENDELL HORNE, Extension Plant Pathologist, College Station

WALTER H. THAMES, Professor, Department of Plant Sciences

ROBERT W. TOLER, Associate Professor, Department of Plant Sciences

Texas A&M University

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SORGHUM DISEASES

GRAIN SORGHUM ACREAGE has increased rapidly since introduction of hybrids, and disease has increased almost proportionately. National disease losses in grain sorghum are estimated at 9 percent, representing a net profit loss to growers, since production costs remain constant with or without disease damage.[1] Most suggested control techniques require only changes in cultural practices or tolerant variety selection and little or no extra production cost. Therefore, reducing disease losses represents direct increase in net profit for the grower.

Introduction of new hybrids has changed the picture of disease occurrence, but these later introductions are susceptible sometimes to old familiar diseases as well as to new diseases appearing in recent years. The older diseases have been controlled through wise cultural practices and resistant varieties or hybrids. More recently described diseases, such as downy mildew and virus diseases, are currently more damaging to production. Their control is under intensive study, and recommendations in this publication are based on the more recent research.

Disease symptoms result from pathogen interaction with susceptible host plants. Pathogenic organisms are classified as fungi, bacteria, viruses, nematodes and mycoplasma. Abnormal plant responses not resulting from damage by these pathogens are referred to as non-pathogenic diseases.

Practices to control pathogenic diseases must be chosen to match the most vulnerable point in the organism's life cycle. Crop rotation controls some diseases while other practices, such as seed treatment, stop others. Other problems may be solved by proper fertilization or by planting a resistant hybrid. No single practice will solve all sorghum disease problems.

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[1] "Losses in Agriculture", Agricultural Research Service, USDA, Agricultural Handbook No. 291, 1965.

A logical first step in sorghum disease control is recognition of the problem. This publication identifies disease problems and offers information on control through cultural means, chemical methods or varietal resistance to specific diseases. New hybrids are being developed continuously. For this reason, their disease reactions are not given in this publication. Growers should contact their county agricultural agent for the latest recommendation.

SEED ROTS AND SEEDLING DISEASES

When seeds are placed in the soil, they are immediately exposed to numerous organisms that may attack and destroy them before or after they germinate. Organisms may be in the soil or they may be introduced with seed.

With use of high-quality seed treated with fungicides, damage caused by seed rot and seedling disease can be reduced. Seedling diseases can become serious enough during some years to cause considerable stand reduction.

Seed rot

When seed decay occurs before germination, the term "seed rot" is used. Numerous fungi cause sorghum seed rot. Certain of these fungi are seedborne, while others persist from year to year in the soil. Either type can destroy seed before it germinates.

Seed rot is more severe when non-treated seed are planted very early, when the soil is cold and damp. Under these conditions, seed germination is delayed and seed is exposed to attack for a longer time. Conditions unfavorable for fast seed germination are favorable for development of organisms attacking seeds.

Seedling disease

When infection occurs after germination and the seedling has begun to grow, the term "seedling disease" is used. Infection of the young seedling may occur before or after emergence. The terms "pre-emergence and post-emergence damping off" are sometimes used to more accurately define the growth stage affected.

Environmental conditions that encourage seed rot development also will increase the amount of damage caused by seedling disease. Vigorous seedlings produced from high-quality seed can withstand attack much better than low-vigor seedlings developing from low-quality seed.

Plant high-quality seed in a well-prepared seedbed when soil moisture and temperatures favor rapid germination and seedling growth. More uniform stands will result when sound undamaged seed are treated with a fungicide to protect the germination zone from attack by seed-rotting organisms.

DOWNY MILDEWS

Three kinds of downy mildews occur on grain sorghum. These mildews, caused by three different fungi, vary in nature of occurrence and severity of damage. A downy mildew commonly called "crazy top", *Sclerophthora macrospora* (Sacc.) Thirum, Shaw, and Naras, was reported by Texas in 1958. This later was determined to be the same disorder previously reported by Texas in 1936. This fungus can cause considerable sorghum damage, although it usually is confined to individual fields or areas within fields that are occasionally flooded.

Sorghum downy mildew, *Sclerospora sorghi* (Kulk) Weston & Uppal, was found first in Texas in 1961, and became epidemic in 1967. It has since been severe along the Texas Gulf Coast and is a potential threat to other sorghum-growing areas of the United States. The disease reportedly has occurred in Mississippi, Oklahoma and Kansas. Most Sudangrass, sorghum-sudan hybrids and broomcorns are susceptible to sorghum downy mildew. Grain sorghums are less susceptible, although some hybrids are highly susceptible to the foliar phase of this disease.

A third type of downy mildew, commonly known as "green ear," *Sclerospora graminicola* (Saac.) (Schr.), has occurred sporadically but has been of little economic importance on grain sorghum.

There are three symptoms typical of plants attacked by sorghum downy mildew:

Systemically diseased seedlings (infection occurring on roots in soil) are yellowed, stunted and frequently have a white downy growth on the underside of the yellowed leaves, figure 1. This downy growth, formed by the conidia or fungus spores, can best be observed during periods of relatively high humidity and low temperatures. As the plant grows, newly formed leaves become striped but have little downy fungus growth.

Another symbtom appears when conidia (seed-like fungus structures) produced on systemically diseased seedlings infect other plant foilage, producing stippled or speckled areas from which more down is produced with in 4 to 7 days. Extent of foliar damage is proportional to persistence of favorable weather conditions, plant susceptibility and the host's stage of development. See cover photo.

The third phase of the disease is represented by systemically diseased plants which develop late in the season. These plants have green and white-striped or mottled leaves. They may fail to head, figure 2, produce sterile heads, or form partially affected heads. Leaf shredding, figure 3, occurs on these plants as fungus destroys cells between the veins, releasing thick-walled overwintering spores (oospores).

Downy mildew symptoms known as "crazy top" differ from previously described downy mildews. In plants infected with "crazy top," overwintering spores develop within and adjacent to veins rather than between veins. Leaves infected with "crazy top" are mottled, thickened, stiffened, twisted or curled, figure 4. The leaf surface appears to be covered with warts. Any heads produced have numerous leafy shoots. Downy growth, as found in downy mildew, is not apparent; nor do leaves stripe or shred.

Fig. 1. Downy mildew symptoms on young sorghum plant. Leaves are striped and downy growth is present on lower leaf surfaces.

Fig. 2. Downy mildew infected plants showing green and white stripe symptom. These plants are sterile and will not produce grain.

Fig. 3. Downy mildew infected sorghum plant showing the advanced leaf shredding symptom.

Fig. 4. Symptoms produced on sorghum by the "crazy top" type of downy mildew.

The disease cycle of sorghum downy mildew, as presently understood, is illustrated in figure 5. Sorghum seedlings can be infected by germinating oospores in the soil. When conditions are right, spores are produced on the leaf surface and released from infected plants. They become airborne, and after landing on a healthy leaf, germinate and result in foliar infection. This foliar cycle of spores from diseased to healthy leaves may be repeated many times during the growing season. Plants infected in the foliar cycle may become systemically diseased. Leaves of systemically infected plants will become striped with white bands sometimes running the whole length of the leaf. At this stage, the disease possibly may be confused with virus diseases or minor element deficiencies. When numerous oospores are produced within the striped leaves, tissue between veins is destroyed, leaving only vein tissue. Oospores are released from these shredded leaves, fall to the ground and remain there until the next crop season. Oospores reportedly survive as long as 6 to 8 years in the soil.

The disease cycle of "crazy top" mildew is somewhat different since oospores germinate and produce swimming spores. These swimming spores require flowing water for movement from where they are produced. Newly infected plants will produce additional fruiting bodies which germinate and produce swimming spores. Because moisture is necessary to complete the disease life cycle, damage is observed most often on plants growing on land where overflows have occurred.

To effectively control sorghum downy mildew, use combined practices designed to avoid infection and reduce the amount of disease-causing inoculum in the soil. The best and most practical means of avoiding infection is the use of resistant hybrids. Hybrids currently available differ greatly in their reaction to sorghum downy mildew. Growers may obtain information on disease reactions by hybrids from county agricultural agents.

Many forage-type sorghums used for silage and green-manure purposes are highly susceptible to sorghum downy mildew. Growers should avoid planting these in fields where this disease is present and if grain sorghum is to be planted in the immediate future.

Several cultural practices can be utilized to reduce the carryover of disease organisms in the soil. Rotation with non-related crops is the most important cultural practice. Sorghum stubble should be destroyed as soon after harvest as possible to reduce organism buildup.

Table 1. Host range of downy mildew diseases

Downy mildew	Crazy top		Green ear
Broomcorn	Barley	Mannagrass	Corn
Corn	Bluestem	Millet	Millet
Johnsongrass	Bromegrass	Oat	Panicgrass
Sorghum	Broomcorn	Red top	Sorghum
Sudangrass	Canarygrass	Rice	Sudangrass
Sweet sorghum	Corn	Rye	Sugarcane
Teosinte	Crabgrass	Sorghum	Sweet sorghum
	Foxtail	Sudangrass	Teosinte
	Johnsongrass	Sugarcane	
	Lovegrass	Wheat	

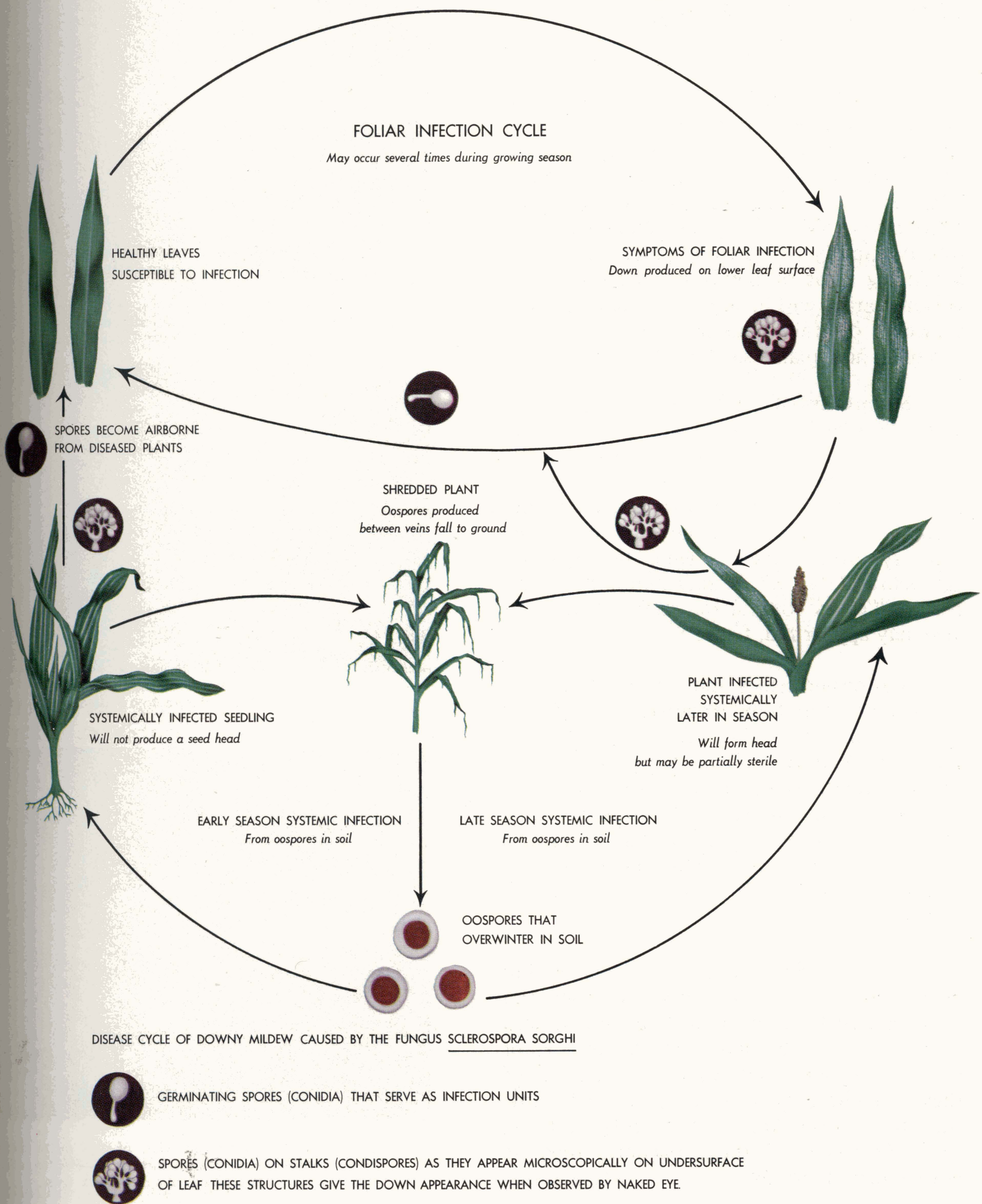

Fig. 5. Life cycle of downy mildew caused by the fungus (Sclerospora sorghi.)

MAIZE DWARF MOSAIC (MDM)

Maize dwarf mosaic is a severe sorghum disease occurring throughout the midwestern and souther states, with losses ranging up to 45 percent. This disease was observed first in 1962 on a few corn plants growing along the Ohio River. Since then, the causal virus has spread rapidly throughout most sorghum-producing areas of the United States. Distribution varies within areas, depending upon presence of the virus and availability of perennial host plants such as Johnsongrass.

Symptoms of MDM appear on leaves as chlorotic mottle of light and dark green areas, figures 6 and 7. Intensity of this mottle depends on the genetic makeup of a particular hybrid, stage of infection and certain environmental conditions. On some varieties, a "red leaf" symptom develops when temperatures are below 75 to 85 degrees Fahrenheit for a period. Leaves contain red streaks and heads also may appear red, figure 8.

Malformed heads and varying degrees of sterility are symptoms associated with disease development. Severely infected plants may fail to head. Extent of this symptom depends on the growth stage at the time of infection and reaction of the variety to virus infection. Stunting is another symptom that varies with variety reaction. Extreme stunting of sorghum is not as common as it is with certain varieties of corn.

Virus particles which multiply within plant cells and produce visible symptoms can be separated from diseased tissue and viewed under the electron microscope, figure 9. Plant virologists have investigated the nature of these unbelievably small particles and know that they form from constituents of living cells. Presence of these particles disrupts normal cell functions.

Several grass-type plants are susceptible to the virus. These include Johnsongrass and

Fig. 6. Mottling in leaf caused by the maize dwarf mosaic virus.

Fig. 7. Mottling in the top of plant caused by the maize dwarf mosaic virus.

Fig. 8. Red leaf symptom caused by the maize dwarf mosaic virus.

Fig. 9. Virus particles of the maize dwarf mosaic virus as seen through an electron microscope. Magnified about 40,000 times.

Fig. 10. Maize dwarf mosaic virus symptoms on Johnsongrass along with corn leaf aphids which transmit the virus.

quackgrass, which are perennial and persist through the winter by rhizomes. Virus particles are distributed throughout all plant parts except seed. Shoots produced from infected rhizomes are infected and serve as an overwintering virus source for aphids capable of transmitting the disease, figure 10.

Virus particles are carried on the aphid's mouthparts as it moves from infected to non-infected host plants. Virus particles are injected into plant cells where their multiplication begins. Symptoms begin to develop in 8 to 12 days on most sorghum varieties. Amount of infection that develops within a given sorghum field depends upon the number of overwintering host plants in or around the field and population level of aphids, figure 11.

Aphids with demonstrated ability to transmit the virus include:

1. Corn leaf aphid, *Rhopalosiphum maidis*
2. Green peach aphid, *Myzus persicae*
3. Melon aphid, *Aphis gossypii*
4. Apple grain aphid, *Rhopalosiphum fitchii*
5. Goldenglow aphid, *Dactynotus rudbeciae*
6. Cowpea aphid, *Aphis craccivora*
7. Pea aphid, *Acyrthosiphon pisum*
8. Spotted alfalfa aphid, *Therioaphis maculata*
9. Bluegrass aphid, *Rhopalomysuz poae*
10. Cabbage aphid, *Brevicoryne brassicae* L.
11. Oat bird-cherry aphid, *Rhopalosiphum padi*
12. Corn root aphid, *Anuraphis maidiradicis*
13. Green bug aphid, *Schizaphis graminum*[1]

Maize dwarf mosaic attacks a wide variety of grasses. Those grasses found to be susceptible to MDMV in Texas include:

TEXAS ANNUALS[2]

1. Carolina foxtail, *Alopecurus carolinianus*
2. Japanese chess, *Bromis japonicus*
3. Soft chess, *Bromis mollis*
4. Foxtail brome, *Brome rubens*
5. Downy brome or cheatgrass, *Bromis tectorum*
6. Hairy crabgrass, *Digitaria sanguinalis*
7. Barnyard grass, *Echniochloa crusgalli*
8. Japanese millet, *Echnichola*

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[1] R. W. Toler and Norris E. Daniels, personal communication.

[2] Leisy, Ralph L., Masters Thesis, Texas A&M University, Host Range of Maize Dwarf Mosiac Virus, 1968.

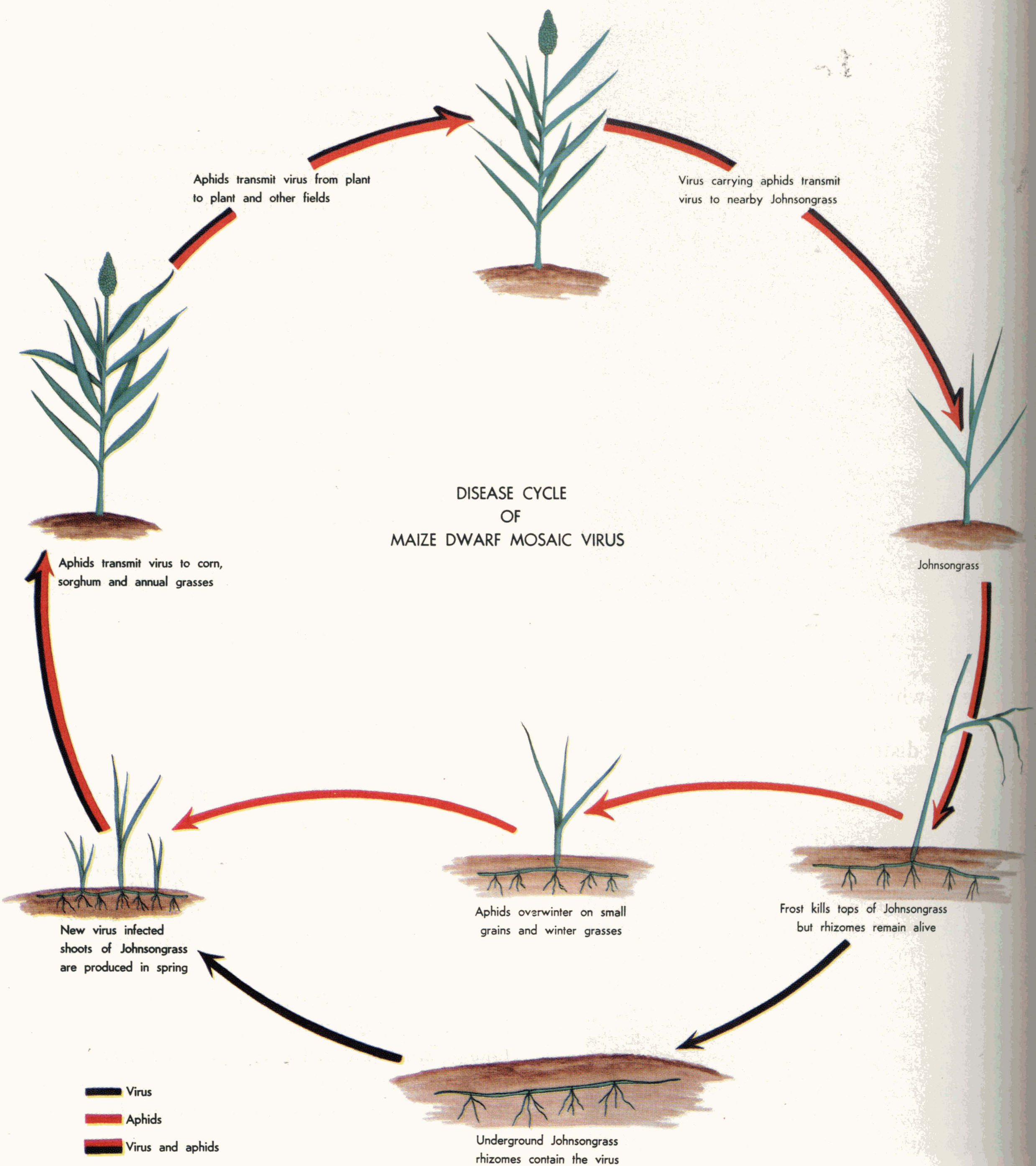

Fig. 11. Disease cycle of maize dwarf mosaic.

crusgalli, var. *frumentarea*

9. Goosegrass, *Eluesine indica*
10. Lacegrass, *Eragrostis capillaris*
11. Southwestern cupgrass, *Erichloa gracilis*
12. Rice, *Oryza sativa*
13. Common witchgrass, *Panicum capillare*
14. Broomcorn millet, *Panicum miliaceum*
15. Foxtail millet, *Setaria italica*
16. Yellow bristlegrass, *Setaria lutescens*
17. Giant bristlegrass, *Setaria magna*
18. Hooked bristlegrass, *Setaria verticillata*
19. Green bristlegrass, *Setaria viridis*
20. Sorghum species, *Sorghum almum*
21. Sorghum, *Sorghum bicolor*
22. Sudangrass, *Sorghum bicolor*
23. Corn, *Zea mays*
24. Sorghum sudan hybrid
25. Showy chloris, *Chloris virgata*
26. Junglerice grass, *Echinochloa colonum*
27. Prairie cupgrass, *Eriochloa contracta*
28. Red sprangletop, *Leptochloa filiformis*
29. Browntop panicum, *Panicum fasiculatum*
30. Texas panicum, *Panicum texanum*

TEXAS PERENNIALS

1. Little bluestem, *Schizachyrium scopari,* cem var.
2. Gaintreed or Georgia cane, *Arundo donax*
3. Coast sandbur, *Cenchrus incertus*
4. Rhodesgrass, *Chloris gayana*
5. Bermudagrass, *Cynodon dactylon*
6. Tall fescue, *Festuca elatior*
7. Green sprangletop, *Leptochloa dubia*
8. Perennial rye, *Lolium perenne*
9. Kliengrass, *Panicum coloratum*
10. Switchgrass, *Panicum virgatum*
11. Dallisgrass, *Paspalum dilatatum*
12. Yellow Indiangrass, *Sorghastrum nutans*
13. Johnsongrass, *Sorghum halespense*
14. Sand lovegrass, *Eragrostis trichodes*
15. Winestem muhly, *Muhlenbergia frondosa*
16. Nimblewill, *Muhlenbergia schreberi*
17. Blue panicum, *Panicum antidotale*
18. Prairie cordgrass, *Spartina pectinata*
19. A dropseed, *Sporobolus asper*
20. St. Augustine grass, *Stenotaphrum secundatum*

GRASSES REPORTED SUSCEPTIBLE IN OTHER STATES

1. Meadow brome, *Bromus erectus*
2. Hackgrass, *Miscanthus sacchariflorus*
3. Plains muhly, *Muhlenbergia cuspidata*
4. *Panicum decompositum*
5. *Polyotoca macrophylla*
6. Sugarcane, *Saccharum officinarum*
7. Sefaria, *Setaria sphacelata*
8. Sorghum spp., *Sorghum arundinaceum*
9. Sorghum spp., *Sorghum versicolor*
10. Sorghum spp., *Sorghum verticilliflorum*
11. *Trichloaena monachne*
12. Florida gamagrass, *Tripsacum floridanum*
13. Field brome grass, *Bromus aruenus*
14. African millet, *Eleusine coracana*
15. Teosinte, *Euchlaena mexicana*
16. Browntop millet, *Panicum ramosum*
17. Pearl millet, *Pennisetum glaucum*
18. *Rottboellia exaltata*
19. Bristlegrass, *Setaria faberi*
20. Tunis grass, *Sorghum virgatum*
21. Veldtgrass, *Ehrharta calycina*

Infection caused by aphid transmission of the virus from perennial hosts is called primary infection. Infection caused by transmission from annuals to annuals within the season is called secondary. A high level of secondary infection often is observed where weather favors maintenance of high aphid population levels throughout the season. As crowding occurs on individual plants, winged forms are produced. These fly to other host plants in the direction of wind movement.

Best prevention of MDMV infections is eradication of perennial host grasses such as Johnsongrass in fields or near fields where sorghum is to be grown. Losses have appeared greater where infected Johnsongrass is present in the sorghum field, and islands of infection are often observed around spots of infected Johnsongrass.

Control Johnsongrass by cultural and chemical means. Control usually is more successful when different practices are used in combination well before growing the sorghum crop. Several chemicals are effective in controlling Johnsongrass, but take care to study label recommendations before using them where food or feed crops are to be grown.

Prevention of MDMV by aphid control has been considered but has not been investigated sufficiently to warrant recommendations. Conventional insecticide application cannot effectively control incoming aphids before they have an opportunity to transmit the virus.

SMUTS

There are three important smut diseases of sorghum and several minor ones also have been described. Smuts reduce yields and contaminate grain with black smut spores, thus reducing quality for food and feed purposes. Smut losses vary according to environmental conditions and the level of improved practice adoption by growers.

Smuts are caused by fungi which penetrate and develop within the sorghum plant. The black dust in the smutted head or kernel consists of thousands of spores which act like tiny seeds to spread the fungus and keep it alive during winter.

Covered kernel smut

Covered kernel smut, caused by a fungus, *Sphacelotheca sorghi* (Link) Clinton, has been reported as the single most destructive sorghum disease in the United States. With the advent of hybrid sorghums, however, seed production was taken from the farm and centralized by seed companies. Since then, essentially all sorghum seed have been treated with a fungicide which has pratically controlled the disease. It appears only in fields of sorghum from seed grown and planted without treatment, and occasionally on volunteer plants in a field.

Fig. 12. Covered kernel smut of sorghum.

The disease usually destroys all kernels in a head, but occasionally a few grains escape, figure 12. The kernel is replaced by the cone-shaped gall. These galls are first covered with a light gray or brown membrane that may later rupture to release dark brown spores. Spores may spread to healthy heads but most remain in place until threshing. At harvest, the galls are broken and spores contaminate the clean seed. When smut-contaminated seeds are planted, spores germinate along with the seed and infection occurs. The growing fungus invades the developing seedling and grows systemically inside the plant. At heading, the smut galls replace the kernels; otherwise the plant appears normal.

Covered kernel smut has been controlled effectively through seed treatment, planting smut-free seed and growing resistant varieties. It is never safe to assume that seed are smut-free and that all varieties or hybrids are resistant. Seed treatment is necessary to prevent the disease.

Loose kernel smut

Loose kernel smut, caused by the fungus, *Spacelotheca crucenta* (Kuehn) Potter, occurs about as frequently as covered kernel smut in commercial sorghum fields. All types of sorghum are affected by the disease. A strain of the fungus also causes the same disease on Johnsongrass.

Galls formed by loose kernel smut are long and pointed and the thin membrane covering them usually breaks soon after galls reach full size. Most of the dark brown spores are quickly blown away, leaving a long, dark, stem-like structure in the central part of what was formerly the gall. As in covered kernel smut, fungus spores are carried on the seed and germinate soon after seed are planted. Penetration occurs and fungus grows within the young sorghum plant. Here fungus continues to grow unobserved until after heading, when long, pointed smut galls appear in the heads in place of normal kernels. Unlike covered kernel smut, however, this disease stunts infected plants and frequently induces development of abundant side branches.

Loose kernel smut, in addition to being seed-borne and able to infect sorghum seedlings, may cause secondary infection; that is, spores from a smutted head may infect and cause smut to develop in late heads on otherwise healthy plants.

The same measures that control covered kernel smut are also effective against loose kernel smut. One should select a resistant hybrid and use smut-free treated seed.

Head smut

The fungus that causes head smut on sorghum, *Sphacelotheca reiliana* (Kuehn) Clint, is the most damaging of all smut fungi. Reports of disease occurrence since the early 1900's show that head smut developed only occasionally until the early 1960's. Heavy losses were first noticed in southern Texas and later the disease became widely distributed in the Central Plains states. A good source of genetic resistance was discovered in 1958 and the disease became less common because of the use of resistant hybrids. It usually occurs in fields planted to susceptible hybrids and new races have been identified which attack "resistant" hybrids.

Head smut is distinguishable from kernel smuts because it destroys the entire head, transforming it into a large mass of dark brown powdery spores, figure 13. The smut first becomes evident at heading time when the large gall bulges from the boot. At first the gall is covered with a whitish membrane, which soon breaks and allows spores to be scattered by wind and rain to soil where they overwinter. The following spring and summer the spores germinate and infect sorghum plants. After invading a sorghum plant, the

Fig. 13. Head smut of sorghum.

fungus grows systemically within it until the plant reaches the heading stage at which time the smut gall becomes evident.

Because this smut fungus persists in the soil, sorghum grown from clean seed and planted on infested soil may be attacked. Some smut spores from broken galls also may contaminate the seeds produced on nearby plants. When such infested seeds are sown, head smut may be introduced into the soil of previously non-infested fields. Only soil-borne spores produce plant infection and cause the heads to be smutted.

Head smut control is possible mainly through the use of resistant hybrids. Most commercial hybrids have resistance and should be grown. Sanitation and rotation, while desirable for control of many other diseases, cannot effectively prevent head smut. Spores may live many years in soil and it is virtually impossible to remove every infected plant. Seed treatment will prevent disease spread from field to field on planting seed, but will not prevent infection from spores already in the field.

Table 2. Summary of smut diseases of sorghum

Disease	Caused by	Over-winters	Control
Loose smut	*Sphacelotheca sorghi* (Link) Clinton	On seed	Seed treatment
Covered kernel smut	*Sphacelotheca cruenta* (Kuehn) Potter	On seed	Seed treatment
Head smut	*Sphacelotheca reiliana* (Kuehn) Clinton	In soil	Resistant hybrids

FOLIAGE DISEASES CAUSED BY FUNGI

Sorghum has many leaf diseases that may become important under certain environmental conditions. Damage s usually slight and control is seldom attempted. Leaf spots caused by fungi are unsightly and arouse interest whenever symptoms appear. Table 3 gives a brief summary of the characteristic disease symptoms and pathogenic fungi involved.

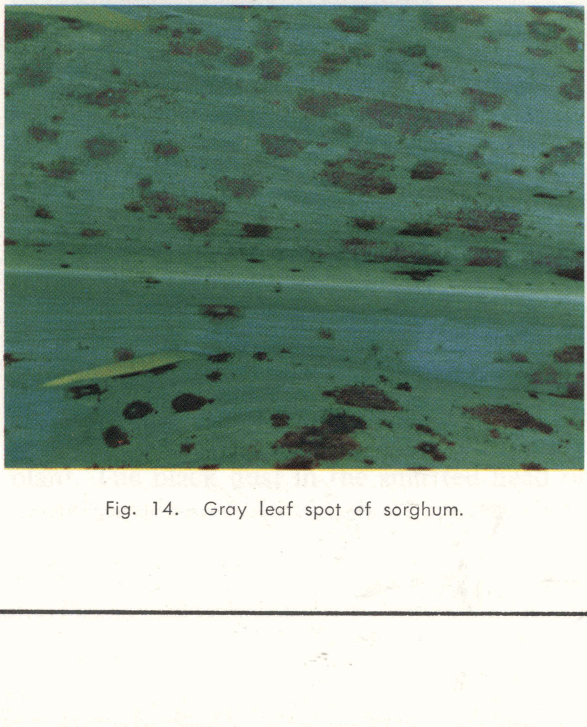

Fig. 14. Gray leaf spot of sorghum.

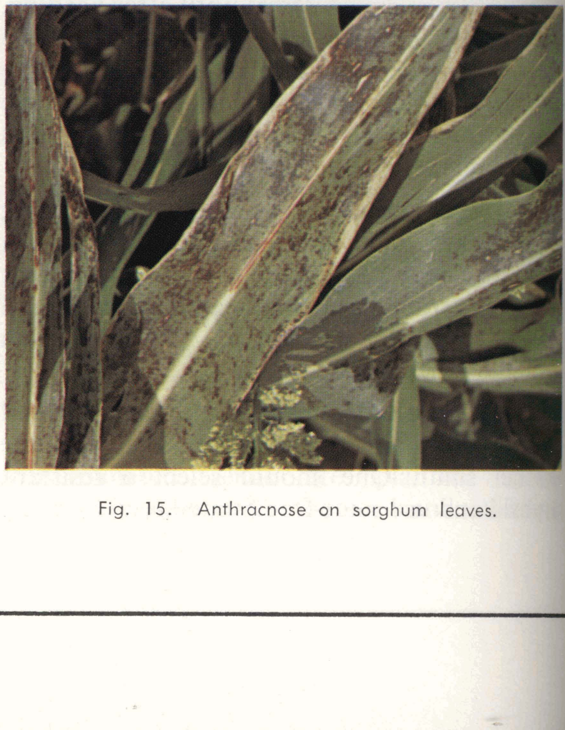

Fig. 15. Anthracnose on sorghum leaves.

Table 3. Summary of foilage diseases of sorghum caused by fungi

Name	Pathogen	Shape	Size	Color	Characteristics
Leaf blight	*Helminthosporium turcicum*	Irregularly shaped	1″ to many	Gray with tan to reddish borders	Very large elongated spots
Target leaf spot	*Helminthosporium sorghicola*	Round, elliptical spots	1/8″ to 3/8″ to 7/8″	Tan to reddish purple with tan borders	Minor significance
Anthracnose	*Colletotrichum graminicola*	Elliptical	1/8″ to 7/8″	Tan to red with distinct margin	Setae and spore masses common in lesions
Gray leaf spot	*Cercospora sorghi*	Elongate to rounded	1/4″ and larger	Dark purplish	Grayish when the pathogen is producing spores
Zonate leaf spot	*Gleocercospora sorghi*	Irregular to semicircular. Bull's eye appearance	Patches of lesions running together	Alternating dark and light bands of tissue	Similar to the red leaf symptom produced by maize dwarf mosaic virus
Rough leaf spot	*Ascochyta sorghina*	Broad, elliptical	1/4″ x 1/2″	Grayish to yellow or purple	Rough to the touch because of raised fruiting bodies
Sooty stripe	*Ramulispora sorghi*	Elongate, Elliptical	1/8″ x 3/8″	Reddish purple spots with straw-colored center	Sooty nature of lesions because of sclerotia

Anthracnose

Anthracnose, caused by a fungus, *Collectotrichum graminicola* (Ces.) G. W. Wils., has been a serious threat to broomcorn production because most broomcorn varieties are highly susceptible. Sudangrass, Johnsongrass, and some grain sorghums are susceptible to the leafspot phase of anthracnose.

Anthracnose fungus penetrates the leaf surface and develops spots or lesions that are circular to oval. They may be as large as 1 inch in diameter. Lesions are tan to reddish depending on susceptibility of the host. Mature lesions have distinct margins with sunken, darkened centers. Dark ortions of the lesion develop pink spore masses during moist periods. Dark structures in the spots are brittle hairs, while the pink masses are spore clusters. Both structures are produced by fungus, figure 15.

Foliar damage by anthracnose is not considered as damaging as the stalk rot phase.

For further discussion on development and control of this disease, see page 18.

Fig. 16. Bacterial stripe on sorghum leaf.

BACTERIAL LEAF DISEASES

Bacterial leaf diseases may be found wherever sorghum is grown. Their development is favored by warm, moist weather. Pathogenic bacteria causing the diseases are believed to overwinter on seed, in infected plant material in the soil and sometimes on overwintering plants. They may spread from leaf to leaf, or plant to plant, and field to field, by wind, rain and insects. Infection enters through natural openings in the sorghum leaf.

Bacterial leaf diseases do not usually cause serious losses. They occur when sorghum growing conditions are adverse and recede when sorghum is able to make good growth. During rainy, moist seasons, bacterial diseases may spread rapidly from lower leaves to upper leaves. Enough leaf surface may be destroyed to reduce yields and restrict grain filling.

The three bacterial diseases of sorghum in the United States are known as bacterial stripe, bacterial streak and bacterial spot.

Bacterial stripe

Pseudomonas andropogoni (E. F. Sm.) Stapp

Bacterial stripe is the most important and abundant of the three bacterial diseases, figure 16. It attacks grain and forage, and sweet sorghums, broomcorn and Sudangrass.

On sorghum, the disease is characterized by long, rather narrow, somewhat irregular stripes, which usually are red and first seen on lower leaves. The stripes are 1/4 to 9 inches or more long and tend to be confined between the leaf veins, but may adjoin to cover a large part of the leaf surface. Ends of the stripes are either blunt or extended into long, jagged points. Color is continuous throughout the stripe. Abundant bacterial slime or exudate occurs on the stripes. Unless washed off by rains, this dries and forms red crusts or thin scales, especially on the lower sides of leaves. Shape of stripes is about the same on all sorghum varieties, but their color varies somewhat. For example, on Red Amber sorgo they are light brick red; on Early Amber sorgo and common Sudangrass they are dark purplish red; on kafir they are brownish red; while on certain other sorghums they are light to dark brown, with a yellowish-brown exudate.

Bacterial streak

Xanthomonas holcicola (C. Elliott) Starr & Burkh

Bacterial streak occurs on leaves of sorghum and Johnsongrass as narrow, water-soaked translucent streaks about 1/8 inch wide and 1 to 6 inches long. These streaks may occur on plants from the seedling stage to near maturity. At first, no color is visible except the light-yellow bead-like drops of exudate standing out on young streaks. Later, narrow red-brown margins or blotches of color appear in the streaks, and after a few days the streaks are red throughout and no longer appear water-soaked or translucent. Parts of streaks may broaden into elongated oval spots with tan centers and narrow red margins. When numerous, the streaks may join to form long, irregular areas covering a considerable part of the leaf blade, and there may be more or less dead tissue with dark narrow margins between the reddish-brown streaks. In the advanced stage, the bacterial exudate, which appeared as light yellow drops on the young lesions, will dry to thin white or cream-colored scales.

Bacterial spot

Pseudomonas syringae van Hall

Bacterial spot attacks leaves of sorghum, broomcorn, Sudangrass, Johnsongrass, pearl millet, foxtail millet and corn. On sorghum, spots appear first on lower leaves and infection gradually spreads to upper leaves as plants approach maturity. The spots may occur on any part of the leaf and usually are circular to irregularly elliptical and from 1/25 to 1/3 inch in diameter. At first they appear dark green and water-soaked, but in a few hours the red color appears. The spots soon lose their water-soaked appearance and become dry and light-colored in the center, which usually is surrounded by a red border. Smaller lesions are often red throughout, with tiny, somewhat sunken centers. Color bordering the lesions varies somewhat in different varieties, being dark brown instead of red. Frequently, spots are so numerous that they unite into large diseased areas and cause death of the whole leaf.

Bacterial disease control

Control of bacterial leaf diseases is accomplished through use of seed treatment, sanitation and rotation. Seed treatment before planting will prevent seed carryover. Crop rotation, destruction of infected plant litter and removal of infected overwintering plants will reduce the amount of bacteria in the fields next season.

RUST

Rust, *Puccinia purpurea* Cke., attacks most sorghum varieties, as well as Sudangrass and Johnsongrass. It occurs regularly in areas of high humidity. In wet seasons, the disease may become prevalent in the central and northern Great Plains.

Fig. 17. Rust on upper and lower surfaces of leaves.

The disease usually appears when the plant nears maturity. Infection is confined primarily to mature leaves, which, after infection, may dry up and drop. Grain yield losses usually are not serious because the disease occurs late in the season. Forage sorghum yields and quality are more severely affected by rust than grain sorghum.

Rust appears on leaves as raised pustules or blisters covered with a brown coating that eventually breaks open, allowing the dark chestnut-brown rust spores to escape, figure 17. These pustules occur on both the upper and lower leaf surfaces. Before pustules appear, small purple, red or tan spots may appear at points where the infection is developing. As pustules develop, colored regions around them become larger and considerable leaf areas may be destroyed.

The complete life cycle of the rust fungus is not well documented. It is likely that the fungus persists through winter in warm areas of the continent on Johnsongrass or other sorghum species. Fungus spores may move miles on wind currents to start new infections if a suitable host and favorable climate exist.

Rust control may not be warranted under typical field conditions. Losses generally are light and control may not pay. Resistant hybrids offer the most promise of controlling rust. Extremely susceptible hybrids should be avoided if yields are reduced by the disease.

NONPARASITIC LEAF DISORDERS

Certain environmental conditions or hereditary factors occasionally produce symptoms on leaves of sorghum and Sudangrass, and these frequently are confused with symptoms produced by fungi or bacteria. A common sorghum condition is the presence of intensely colored leaf spots or stripes without other indications of disease symptoms. Certain sorghum varieties are more subject to such spotting than others. Spots or stripes are not covered with bacterial exudate or scales; they do not consistently have dead areas in or around them; and they show no evidence of fungus growth or fruiting bodies. Much of this nonparasitic spotting may be caused by mechanical injuries from insect punctures, wind or sand particles. When certain pesticides such as parathion or arsenical herbicides are applied to sorghum leaves, the leaves may develop irregular but characteristic spots that resemble those caused by parasitic leaf diseases. Occasional plants have leaves so badly discolored that most of their leaf area is involved. Spots may be solid, or they may follow various concentric or irregular patterns. Certain of the latter types are known to be hereditary.

One of the most common types of nonparasitic leaf discoloration is the chlorotic (yellow or yellow-striped) appearance of the leaves sorghum and Sudangrass. Nutritional deficiencies are believed to cause this chlorosis. A similar chlorotic condition caused by iron deficiency may appear in sorghum grown on highly calcareous soils. Herbicide carryover from previous crop application can cause chlorotic striping, stunting and death of sorghum seedlings.

Certain other chlorotic disturbances are definitely hereditary. Plant breeders have isolated numerous strains that produce white or yellow seedlings or plants with striped leaves and stems.

Control of nonparasitic leaf disorders on a growing crop is difficult; however, use of hybrids that are not susceptible to the specific problem and wise use of chemicals on adjacent or previous crops will help prevent these conditions on succeeding crops.

STALK ROTS

Plants infected by stalk rot organisms produce poorly because of damage caused to their water and food transporting cells. Such damage is often overlooked unless the lodging symptom occurs making harvest difficult. Stalk rotting may become severe when causal organisms build up high populations in the soil. A description of the most common stalk rots follows.

Charcoal rot

Charcoal rot caused by soil-borne fungus, *Macrophomina phaseoli* (Maubl.) Ashby, often becomes serious in areas where environmental conditions favor its development. Lodging occurs after the fungus invades and weakens the lower portion of the stalk. Lodging is only one of several symptoms that may occur and alone may result from other factors. A more positive diagnostic symptom is the shredding of the lower stem with small black bodies (sclerotia) interspread among remaining vessel fibers, figure 18. Pith tissue in stalks showing this symptom has been destroyed by the fungus. Certain other fungi cause similar shredding but do not produce sclerotia, which appear like black pepper dusted throughout shredded stalk areas.

Conditions under which charcoal rot occurs are very specific and have been documented by carefully conducted research. Soil temperature must be in excess of 95 degrees Fahrenheit and the soil must contain less than 80 percent available soil moisture for 4 days before charcoal rot can develop. Host plants also must be in the early-milk-to-late-dough stage for infection and fungus development to occur. These laboratory findings coincide with what growers have observed in the field during dry years.

Another factor which must be con-

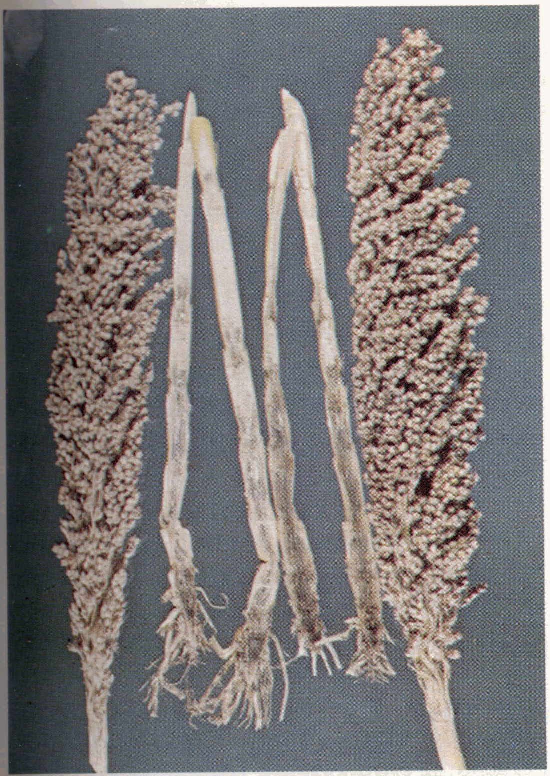

Fig. 18. Typical symptoms of charcoal rot on stalks of sorghum plant. Heads from these plants are not well filled.

sidered is presence of the organism in the soil. High inoculum potential coupled with conditions favoring development insure heavy infection.

Presence of a diseased crop and incorporation of infected crop residue increases fungus population in a given soil. If sorghum is grown again the following year and conditions favor disease development, likelihood of heavy disease losses increases.

Crop rotation with non-host crops to reduce fungus population may decrease disease loss but should not be expected to eliminate disease occurrence.

Use of resistance to control charcoal rot has been investigated. It has been possible to increase resistance levels in certain varieties; however, some infection occurs under conditions of extreme stress.

Best control can be achieved by maintaining available soil moisture at or above 80 percent during the period of maturity. Cultural practices which tend to conserve soil moisture are helpful in preventing this disease. Avoid excessively thick stands since added competition occurs as the crop matures.

Periconia root rot

Periconia root rot, caused by a fungus, *Periconia circinata* (Mang.) Sacc., was once a serious sorghum disease when commercially grown varieties were highly susceptible. More recently, resistance has been incorporated into most hybrids being used in sorghum-producing areas of the United States. Potentially, however, this disease is important since future varieties may be grown which will be affected by this organism.

Symptoms may appear as early as 3 to 4 weeks after planting in heavily infested soil when plants are only 6 to 9 inches high. First symptoms appear as a stunting and slight rolling of leaves, with older leaves turning light yellow at the tips and margins. Yellowing and drying progresses until all the leaves are affected and plants die, usually at heading time. In less heavily infested soil the disease may not appear until heading time, in which case the disease develops rapidly.

Diagnose this disease by splitting the base of the stalk lengthwise and observe a dark red discoloration in the center. Roots are similarly discolored and may slough from the plant. Diseased plants also are stunted, produce smaller heads and may even die prematurely.

After the disease appears in a field, it usually becomes more damaging each successive year if susceptible varieties are grown. The disease-causing organism may be spread by soil movement or movement of run-off water.

This disease has been controlled sucessfully by using resistant varieties and hybrids; however, there is a possibility that this disease may cause damage to susceptible varieties or hybrids in the future.

Fig. 19. Symptoms of head, neck (peduncle) and stem infection by the anthracnose fungus.

Red stalk rot

Red stalk rot is a disease caused by the fungus, *Colletotrichum graminicola* (Cesati), G. W. Wilson and was reported in Texas as early as 1911. It occurs on sorghum in most areas where the crop is grown, but it has been most severe in the southeastern states and along the Gulf Coast. In addition to the stalk rot phase, the fungus also causes a seedling disease and leaf spot. The leaf spot symptom has been described under "Anthracnose." Hybrids respond differently to attack by the fungus. Some exhibit marked resistance to the stalk rot phase, for example, while being susceptible to leaf infection. In most sorghum producing areas, resistance to the stalk rot phase is most important.

The basal portion of the stalk becomes reddened or purpled when invaded by the fungus. When the stalk is split, the pith can be observed to be noticeably discolored in a spotted or ringed pattern. This same symptom is also expressed when the peduncle or upper stem below the head becomes infected, figure 19.

Stalk infection results in plants that lodge easily, making harvest difficult or impossible. This is the most destructive phase, but losses from seedling disease, leaf damage (Anthracnose) and reduced size, weight and quality should not be minimized. Losses will be proportionate to the extent of infection, stage of plant growth when infected and inherent susceptibility of the hybrid or variety.

The use of resistant hybrids is the most satisfactory means of control. Grain sorghum hybrids vary considerably to disease reaction and growers should consult their county agricultural agents for the latest disease reaction information. Another helpful control measure is the use of crop rotation with non-susceptible crops. The casual fungus persists in crop residue from season to season and continuous cultivation increases the amount of fungal inoculum in the soil.

Other stalk rots

Stalk rots previously discussed represent those that are more widespread and cause extensive economic loss. Numerous stalk rotting conditions along with their causal agents are described in the literature. Those seeking information on stalk rots not described here may wish to consult such references as Dickson or Tarr shown in the selected reference section.

When stalk rots occurring in the field do not conform to the more common symptoms and can not be identified locally, they should be referred to a plant pathologist for diagnosis.

NEMATODE INJURY

Certain plant parasitic nematodes cause damage to sorghum by feeding on the root

Fig. 20. Sorghum plant on right stunted by nematodes.

systems. Root-knot nematodes, *Meloidogyne incognita* and *M. Arenaria*, root lesion nematodes, *Pratylenchus* spp., stubby root nematodes *Trichodorus* sp., and sting nematodes, *Belonolaimus* sp., have been shown to cause sorghum damage. Yield losses ranging from 5 to 10 percent have been recorded where root-knot nematodes have been present in high populations.

Nematode damage to sorghum is typified by some stunting and evidence of plant stress, figure 20. Root system damage prevents the plant from absorbing adequate amounts of water and nutrients. Obvious symptom expression occurs only where nematodes are present in moderately high populations. Work on population development indicates that root-knot nematodes do not increase as rapidly on grain sorghum as on more susceptible crops. The opposite appears to be true with the root lesion nematode that reproduces rapidly on grain sorghum.

Control by chemical means has been difficult to justify because of the relative expense of the chemical compared to return. Future research may devise more economical control.

Crop rotation for the expressed purpose of nematode control is difficult to justify because of the wide host range of some nematodes and the lack of variety in crops that can be profitably grown in rotation with sorghum.

SMALL SEED CONDITION

In recent years, reports of a small seed condition have become more numerous. Individual small seed may be found anywhere on the head, or may completely encompass the head. The severity of the condition, with reference to the individual seed, varies from an embryonic structure to only a slight reduction in seed size. A reduction of about one-half the diameter of a normal seed is by far the most common, however, figure 21.

Reports from Arizona, California, Kansas, New Mexico, Oklahoma and Texas indicate that the small seed condition is widespread. In Texas, this condition has been associated most often with fields where practices of heavy fertilization and frequent watering have been used. There is also evidence that root and crown injury caused by invasion of soil microorganisms may be an important contributing factor.

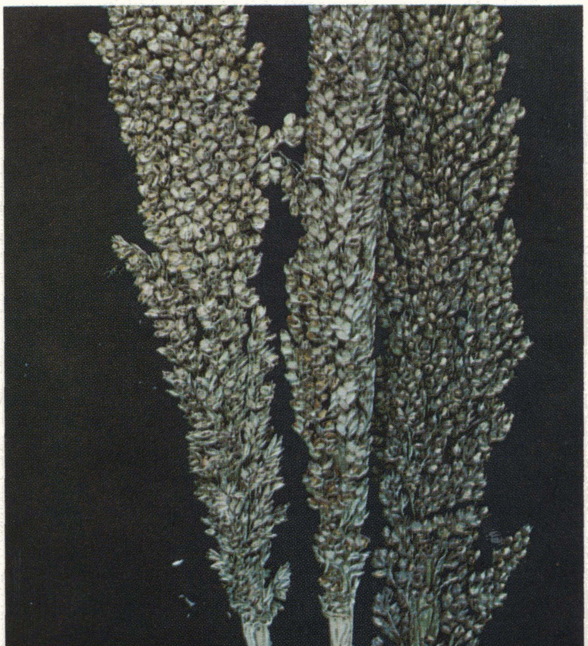

Fig. 21. Small seed condition of grain sorghum.

There are indications of varietal reaction to the condition; however, certain environmental conditions that occur before and during heading seem to be more significant. This condition does not become evident until the heads are near maturity.

MINOR ELEMENT DEFICIENCIES

Sorghum requires minor or micro-elements for normal growth. Because most agricultural soils supply enough zinc, iron, mangenese, copper, boron and other essential micro-elements, deficiency symptoms for most are relatively uncommon. Even more unusual is the appearance of minor element toxicities in sorghum fields. These elements must be present, but there is a limit that can be reached where sorghum will be injured.

Iron deficiency is most common. Leaves will be yellow with dark green veins. In more severe cases, leaves are yellow with white tips. Foliar applications of iron sulphate (three applications of 2.5 percent solution at 20 gallons per acre) or iron chelate are more effective than soil treatment.

Treatment for other suspected minor element problems should be attempted only upon advice of a soil and plant analysis by a soil chemist.

CONCLUSIONS

Sorghum diseases are easier to prevent than control. Each disease described in this publication can be prevented successfully by using prescribed practices. Furthermore, most research-proved practices are inexpensive in that they are cultural in nature. Rotating with non-related crops is a valuable practice for disease prevention. Its effective use does require, however, that long-range plans be made for maximum use of available land.

Hybrid selection is becoming a more important consideration as diseases such as downy mildew, maize dwarf mosaic and head smut become more widely distributed. A grower must know which diseases represent current or potential limiting factors and select hybrids with tolerance resistance to these factors. This, of course, assumes that inherent yield potential is as high or higher in resistant hybrids than susceptible hybrids.

Obtaining a stand has a direct relationship with optimum use of growth factors. Seed rot and seedling disease represent a threat to obtaining a stand and must be treated. Use of high vigor seed treated with a suitable fungicide is valuable in seedling disease prevention. Optimum planting conditions include planting in a well-prepared seedbed that does not include undecomposed organic matter in the seed germinating area. Ideally, sorghum should be planted when the soil is warm enough to favor rapid seed germination and seedling emergence.

Other production factors influence development of certain diseases. For example, herbicides applied improperly may predispose plants to attack by certain soil-borne organisms. In a similar manner, application of unbalanced nutrient levels may enhance disease development. Nitrogen levels out of proportion with other nutrients may cause certain foliage diseases to be more severe.

Since the advent of maize dwarf mosaic, Johnsongrass control in and around fields has become tremendously important. The virus overwinters in rhizomes of this grass and insures a source of virus for crop infection the following year. Maize dwarf mosaic in sorghum ceases to be a problem when the overwintering host is destroyed.

Sorghum producers should not expect one control practice to control all disease problems. Best results are obtained when all improved practices are fitted into a proper combination with other recommended practices.

SELECTED REFERENCES

DICKSON, JAMES G., 1956, Diseases of Field Crops, McGraw-Hill Book Company, Inc., New York, p. 517.

EDMUNDS, L. K., 1963, Combined relation of plant maturity, temperature and soil moisture to charcoal rot development in grain sorghum. Phytopathology 54:514-517.

FREDERIKSEN, RICHARD A., 1967, Small Seed, A Disease of Sorghum, Proceedings of the 5th Biennial Grain Sorghum Research & Utilization Conference.

FREDERIKSEN, RICHARD A., and DARRELL ROSENOW, 1967, Downy mildew of sorghum, Proceedings of the 5th Biennial Grain Sorghum Research & Utilization Conference, March 2–3, 1967.

FREDERIKSEN, RICHARD A., DARRELL T. ROSENOW, and LUCAS REYES, 1968, Reaction of commercially grown grain sorghum and forage sorghum hybrids and varieties to downy mildew (*Sclerospora sorghi*). Texas Agricultural Experiment Station Progress Report–PR2629.

FREDERIKSEN, R. A., D. T. ROSENOW, L. REYES, and L. K. EDMUNDS, 1969, A new race of *Sphacelotheca reliana* in South Texas. Plant Disease Reporter 53:171-172.

ORR, CALVIN C., 1967, Observations on cotton root knot nematode in grain sorghum in West Texas. Plant Disease Reporter 51:29.

RODRIGUEZ, ENRIQUE, R. A. FREDERIKSEN, LUCAS REYES, and D. T. ROSENOW, 1968, Reaction of selected sorghum lines to artificial inoculations of *Colletotrichum graminicola*. Plant Disease Reporter 52:164-166.

TARR, S. A. J., 1962, Diseases of Sorghum, Sudan Grass and Broom Corn, The Commonwealth Mycological Institute, Kew, Surrey, p. 380. Printed in Great Britain at the University Press, Oxford.

TOLER, ROBERT W., C. D. HOBBS, and A. J. BOCKHOLT, 1967, Identification, transmission and distribution of maize dwarf mosaic in Texas. Plant Disease Reporter 51:777-781.

TOLER, ROBERT W., ANTON J. BOCKHOLT, and RALPH H. LEISY, 1968, Effects of maize dwarf mosaic on grain sorghum performance. Phytopathology 58:731.

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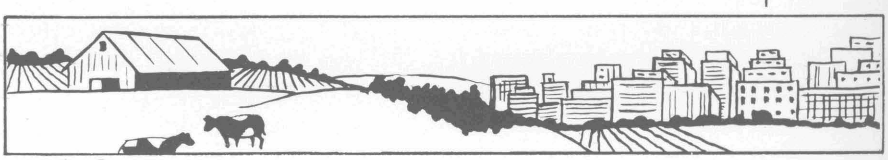

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