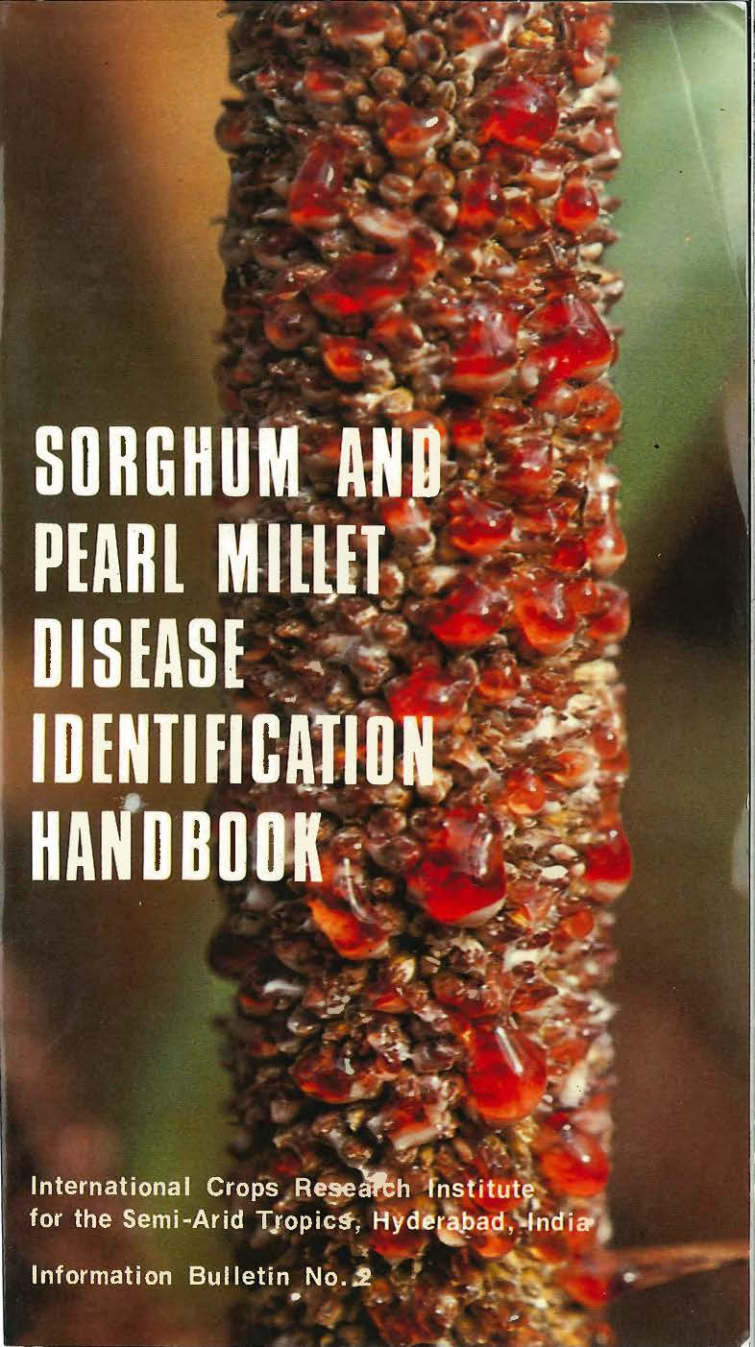

SORGHUM AND PEARL MILLET DISEASE IDENTIFICATION HANDBOOK

International Crops Research Institute for the Semi-Arid Tropics, Hyderabad, India

Information Bulletin No. 2

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SORGHUM

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PEARL MILLET

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1978

SORGHUM DOWNY MILDEW (*Sclerospora sorghi* (Kulk) Weston and Uppal)

The fungus *Sclerospora sorghi* is the cause of a systemic downy mildew of sorghum (and maize). The pathogen invades the growing points of young plants, either through oospore or conidial infection, and as the leaves unfold they show various types of symptoms. The first few leaves that show symptoms normally are only partially infected (the lower portion) with a lighter green or yellow coloration of the infected portion. Abundant downy white growth (conidiophores and conidia) is produced nocturnally on the under surfaces of infected portions of leaves during humid weather (Plate 1). Subsequent leaves on systemically infected plants show progressively more symptoms until the entire leaf blades are discolored and support conidial production. Normally three to four leaves develop the chlorotic downy-growth type of symptoms. Subsequent leaves show progressively more of a complete bleaching of the leaf tissue, sometimes in streaks or stripes (Plate 2) and sometimes over the entire leaf surface (Plate 3). These bleached tissues do not support conidial production but become packed with the thick-walled resting spores (oospores), linearly arranged between

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the veins. As the infected bleached leaves mature they become necrotic and the interveinal tissues disintegrate, releasing the oospores and leaving the vascular bundles loosely connected to give the typical shredded leaf symptom (Plate 4).

Under humid conditions conidia from systemically infected leaves may infect healthy leaves and produce local lesions which are chlorotic at first, rectangular (up to 1 cm long by 1 to 3 mm wide), support conidial production on the under surface, and later become necrotic.

CRAZY TOP DOWNY MILDEW (*Sclerophthora macrospora* (Sacc.) Thirum; Shaw and Naras.)

The symptoms vary considerably with the host cultivar. Young sorghum plants may develop mottled leaves resembling mosaic virus infection and subsequently develop thick, stiff, twisted or curled leaves (Plate 5). Yellowing occurs later. Oospores are formed in the infected leaf tissues, but the leaf shredding characteristic of SDM does not occur with this disease. Infected plants tiller profusely, may not head or the heads may be barren or they may show proliferation of the floral structures.

LEAF BLIGHT (*Exserohilum turcicum* Leo and Sug.) (*Helminthosporium turcicum* Pass.)

The leaf blight pathogen is known to cause seed rot and seedling blight of sorghum, particularly when the crop is planted in cold wet soil. On older plants the typical symptoms are long elliptical necrotic lesions, straw colored in the centers with dark margins (the color of the margin depending upon host cultivar) (Plate 6). Under humid conditions a faint grey bloom consisting of conidiophores and conidia can be observed on the lesions. The lesions can be several centimeters long by 1 to 2 cm wide. Many lesions may develop and coalesce on the leaves, destroying large areas of leaf tissue, giving the crop a distinctly burnt or blasted appearance.

SOOTY STRIPE (*Ramulispora sorghi* (Ellis and Everhart) Olive and Lefebvre)

Elongate elliptical lesions develop on the leaves with straw colored centers of dead tissue and purplish to tan lesion margins, depending on the host cultivar. The mature lesions can be several centimeters long and 1 to 2 cm wide. The lesions may coalesce to produce large areas of necrotic leaf tissue. As the lesions age, the centers darken and become greyish when conidia are produced and then blackish or sooty as numerous small black sclerotia are produced (Plate 7). The sclerotia are superficial and can easily be rubbed off. The sooty stripe lesions are somewhat similar to those of leaf blight, but the presence of the superficial sooty sclerotia is a clearly distinguishing feature of sooty stripe. In addition mature sooty stripe lesions are surrounded by distinct yellow haloes, which readily enables their distinction from those of leaf blight.

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ZONATE LEAF SPOT (*Gloeocercospora sorghi* Bain and Edgerton)

The characteristic zonate leaf spot lesions are roughly circular (or semi-circular if they originate near the edge of the leaf) with alternating bands of dark purple or red color and tan or straw color, to give a concentric or zonate appearance (Plate 8). Initially the lesions appear as small reddish-brown water-soaked spots, sometimes with a narrow green halo. They enlarge, become dark red and tend to elongate, initially parallel with the veins, and eventually spread across the leaf, developing the zonations to attain their characteristic mature appearance. Under warm humid conditions the fungus produces large pinkish gelatinous fruiting bodies (conidiophores and conidia), visible with the naked eye on and around the necrotic areas of the lesions. On heavily infected leaves lesions may coalesce over a large proportion of the leaf surface. Black sclerotia may form in mature lesions.

ROUGH LEAF SPOT (*Ascochyta sorghina* Saccardo)

The first symptom observed on leaf blades is a slight chlorosis, on and around which groups of round black pycnidia develop. The pycnidia protrude above the leaf surface so that when rubbed they give the leaf a characteristically rough feel. Subsequently the tissues within the infected area become necrotic, and light-colored circular to oval lesions with darker margins develop. The lesions are surrounded by chlorotic haloes, and are covered with the black pycnidia (Plates 9, 10). Lesions may coalesce to form large irregular necrotic areas and whole leaves may be killed.

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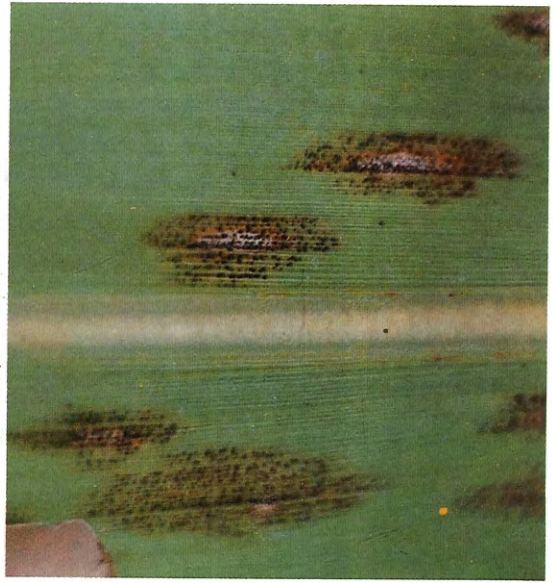

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RUST (*Puccinia purpurea* Cooke)

The first symptoms are small flecks on the lower leaves (purple, tan, or red, depending on cultivar) and in resistant cultivars the symptoms develop no further. In susceptible cultivars typical rust pustules (uredosori) develop, mainly on the lower leaf surfaces, which rupture to release reddish powdery masses of uredospores (Plate 11). The pustules are elliptical and lie between and parallel with the leaf veins. In highly susceptible cultivars the pustules occur so densely that almost the entire leaf tissue is destroyed (Plate 12). Teliospores develop later, sometimes in the old uredosori, or in teleutosori, which are darker colored and longer than the uredosori. The pustules may also occur on leaf sheaths and on inflorescence stalks (Plate 13).

GREY LEAF SPOT (*Cercospora sorghi* Ellis and Everhart)

The symptoms begin as small leaf spots which enlarge to become rectangular lesions which can be 5 to 15 mm long by 2 to 5 mm wide. The lesions are typically dark red to purplish, with somewhat lighter centers (Plate 14) although in tan plants they remain a straw color. The lesions occur on leaf blades and sheaths and are mostly isolated, but can form contiguously to give long stripes. Netting or banding can occur within these lesions. A greyish white bloom is produced on the lesions when the fungus produces conidiophores and conidia.

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OVAL LEAF SPOT (*Ramulispora sorghicola* Harris)

The symptoms first appear as small water-soaked spots. These develop into small roughly circular (2 to 4 mm in dia) lesions with dark red to brown margins and lighter centers (Plate 15), in which small black sclerotia can be produced. These symptoms resemble and can be confused with the leaf anthracnose symptoms. The two diseases can be distinguished with the aid of a hand lens, for the fruiting bodies of oval leaf spot do not possess protruding black setae.

SORGHUM – 10

TAR SPOT (*Phyllachora sorghi* v. Hohnel)

The characteristic symptom of tar spot or black leaf spot is the presence of roughly circular raised black bodies (fungal stromata) about 1 mm in dia, on the upper or lower leaf surface. The tar spots often occur in lines between the veins with chlorotic haloes around each black spot (Plate 16).

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ANTHRACNOSE AND RED ROT
(Colletotrichum graminicola (Cesati) Wilson)

The fungus *Colletotrichum graminicola* causes both a leaf spot disease (anthracnose) and a stalk rot (red rot) in sorghum.

The anthracnose phase is characterized by small elliptical to circular spots, up to 5 mm in dia but often smaller, which develop small circular straw colored centers and wide purple, red, or tan margins (depending on host cultivar). Few or numerous small black spots are seen on the surface of the centers of the lesions, which are the fruiting bodies (acervuli) of the causal fungus. When examined with a hand lens small black spikes (setae) can be seen sticking out of the acervuli. Under suitable environments creamy masses of spores are produced among the setae. Many lesions may develop close together and coalesce (Plate 17) to kill large portions of the leaf. Mid-rib infection often occurs and is seen as elongate-elliptical red or purple lesions (Plate 18) on which the black acervuli can be clearly seen.

Continued

The red-rot phase may occur in stalks and/or in the inflorescences and is characterized externally by the development of circular cankers, particularly in the inflorescence. Infected stems when split open show discoloration (depending on cultivar) which may be continuous over a large area, or more generally discontinuous, giving the stem a marbled appearance (Plate 19). Nodal tissue is rarely discolored. Stalk rot is usually preceded by leaf anthracnose, although in some instances little foliar disease is evident.

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HEAD BLIGHT (*Fusarium moniliforme* Sheldon)

Under hot humid conditions the fungus *Fusarium moniliforme* invades the tissues of the inflorescence, killing the florets to various degrees up to complete destruction of the head. If an infected panicle is split longitudinally, red to brown discoloration of the internal tissue is observed, which extends into the branches of the inflorescence and even into the upper portion of the stem (Plate 20). In severe cases the peduncles may break over.

COVERED KERNEL SMUT (*Sphacelotheca sorghi* (Link) Clinton)

The individual grains are replaced by smut sori which can be localized at a particular part of the head, or can occur over the entire inflorescence (Plate 21). The individual sori are oval or conical and are covered with a tough white or cream to light brown skin (peridium) which often persists unbroken up to threshing. The size, color, and degree of breakage of the sori varies considerably with race of the fungus and the sorghum cultivar.

The sori vary in size from those small enough to be hidden by the glumes, to those as long as 1.2 cm. All or some of the heads on an infected plant may be smutted and the incidence of smutted heads can be considerably greater on the ratoon crop than on the first crop.

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LOOSE KERNEL SMUT (*Sphacelotheca cruenta* (Kuhn) Potter)

Plants infected with loose kernel smut invariably flower prematurely (up to 2 weeks earlier than noninfected plants) and often show increased tillering. The inflorescences are characteristically looser and bushier with hypertrophy of glumes and often spikelet proliferation. Normally all florets of infected heads are smutted and sori can also occur on the rachis and branches of the inflorescence. As the peridia (enclosing membranes) of the sori normally rupture prior to head emergence, they are rarely seen. A characteristic feature of the sori, which vary in length from 3 to 18 mm, is the solid long black (often curved) pointed columella which extends almost the full length of the sorus and which remains conspicuous after the smut spores have been blown away (Plate 22). Late tillers or ratoon crops frequently have a higher incidence of loose kernel smut.

LONG SMUT (*Tolyposporium ehrenbergii* (Kuhn) Patouillard)

Normally the disease is restricted to a relatively small proportion of the florets which are scattered on a head, indicating the probable infection by wind-borne inoculum after head emergence. The sori or spore sacs are cylindrical, elongate, usually slightly curved with a relatively thick creamy-brown covering membrane (peridium) (Plate 23). The peridium normally splits, beginning at the apex, to reveal the black mass of spores among which are found several dark-brown filaments which represent the vascular bundles of the infected ovary. The sori are considerably longer and wider than those of covered kernel smut.

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HEAD SMUT (*Sphacelotheca reiliana* (Kuhn) Clinton)

The head is either completely (Plate 24) or partially (Plate 25) replaced by a large whitish gall. The galls are at first covered by a whitish-grey membrane of fungal tissue which ruptures, often before the head emerges from the boot, to expose a mass of brown-black powder (smut spores) among which are embedded long thin dark-colored filaments which are the vascular bundles of the infected head. The spores are blown away, exposing the dark filaments (Plate 26). The infected heads or portions of heads are completely destroyed, so head smut is easily distinguished from the other three smuts in which individual florets are infected. On rare occasions sori may also develop on the leaves.

ERGOT (*Sphacelia sorghi* McRae)

The first symptom of sorghum ergot (commonly known as sugary disease) is the secretion of a creamy sticky liquid (honeydew) from infected florets. Often the honeydew is colonized by *Cerebella* sp., which, if the exudate is plentiful, gives the head a blackened appearance (Plate 27). Under favorable conditions long (1 to 2 cm), straight or curved, cream to light brown, hard sclerotia develop (Plate 28). Colonization of the honeydew by *Cerebella* sp. and other fungal species considerably inhibits sclerotial development.

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CHARCOAL ROT (*Macrophomina phaseolina* (Tassi) Goid)

The evident external symptoms of charcoal rot in sorghum are lodging (Plate 29) and poor grain filling. The sclerotial stage of the causal fungus (*Sclerotium bataticola* Taub.) invades the crown via the roots and then proceeds to colonize and disorganize the cortical tissues of the lower internodes. The lower stems of infected plants become soft and weak resulting in lodging, usually at the second or third internode. If an infected stem is split open the vascular fibers are seen to be clearly separated and are usually heavily coated with the small hard black sclerotia of the causal fungus (Plate 30), which gives the disease the name charcoal rot.

The disease is promoted if the sorghum crop is subject to drought stress and high soil temperatures during the grain-filling period.

DISEASE IDENTIFICATION KEY

A. SORGHUM

1. Inflorescence or panicle symptoms ..... 5 & 6
2. Foliage symptoms ..... 16 & 17
3. Stem symptoms ..... 45 & 46
4. Root symptoms 47
5. Florets or whole inflorescence converted completely or partially to black powder which may or may not be enclosed in a membrane ..... 7 & 8
6. Other inflorescence symptoms ..... 12 to 15
7. Individual florets converted to black powder ..... 9 to 11
8. Panicle partially or completely converted into a large whitish sac which ruptures releasing the black powder and exposing long dark filaments ..... *head smut* (p 37)
9. Individual grains replaced by small conical cream to light brown sacs that persist up to threshing and contain black powder ..... *covered kernel smut* (p 30)
10. Individual grains converted to sacs containing black powder, which is released prior to or soon after head emergence, with conspicuous long black, often curved, pointed structures embedded in the powder ..... *loose smut* (p 33)
11. Generally few scattered individual grains replaced by long white-cream sacs containing black powder and long dark filaments ..... *long smut* (p 34)

12.	Florets transformed into leafy structures	*crazy top* *downy mildew* (p 6)
13.	Dry rot and internal discoloration mainly of the rachis, and its branches, sometimes extending into the peduncle	*head blight* (p 29)
14.	Florets producing droplets of sticky liquid	*ergot* (p 38)
15.	Grains covered with white, pink or black mold	*grain molds* (p 59)
16.	Discrete lesions with distinct margins	18 to 21
17.	General discoloration or diffuse yellowing or withering, leaves distorted or shredded	38 to 44
18.	Elliptical to spindle shaped large lesions up to several cm long	22 to 24
19.	Streaks or stripes several cm long	25 to 28
20.	Large circular or irregular lesions with zonate, banded or patchworked appearance	29 to 30
21.	Small (less than 1 cm) circular, oval or rectangular lesions	31 to 37
22.	Lesions with distinct yellow haloes which bear either a grey bloom or a superficial black powder	*sooty stripe* (p 10)
23.	Lesions with dark margins without distinct yellow haloes and bear a faint grey to brown bloom	*leaf blight* (p 9)
24.	Lesions on the mid-rib speckled with black dots	*anthracnose* (p 25)

25. Uniform dark colored long interveinal stripes often covered with dried exudate. — *bacterial stripe* (p 52)

26. Discontinuous streaks at first translucent then dark colored often broadening into oval spots ..... — *bacterial streak* (p 51)

27. Yellow to white stripes on upper leaves with no red striping ..... — *sorghum downy mildew* (p 2)

28. Red striping often associated with white or yellow striping ..... — *MDMV* (p 55)

29. Circular or semi-circular lesions with concentric banding ..... — *zonate leaf spot* (p 13)

30. Patchwork of light and dark discolored areas often bearing fluffy white to light brown fungal mats ..... — *banded leaf & sheath blight* (p 67)

31. Red to brown discrete powdery masses breaking through the leaf surface (mainly underside) ..... — *rust* (p 17)

32. Small circular to oval lesions speckled with black dots which consist of thin spikes (seen with hand lens) ..... — *anthracnose* (p 25)

33. Small oval lesions without bunches of black spikes ..... — *oval leaf spot* (p 21)

34. Oval to rectangular lesions limited by the veins ..... — *grey leaf spot* (p 18)

35. Chlorotic roughly rectangular lesions bearing downy white growth in humid condition ..... — *downy mildew local lesions* (p 5)

36. Small areas speckled with black bodies, developing into necrotic lesions ..... — *rough leaf spot* (p 14)

37.	Small raised black bodies with chlorotic haloes in lines between veins	*tar spot* (p 22)
38.	Irregular mottling of dark and lighter green often interspersed with longitudinal red, white or yellow streaks.....	*MDMV or sugar cane mosaic* (p 55)
39.	General yellowing of stunted plants with bunched twisted leaves	*yellow sorghum stunt* (p 56)
40.	Leaf drooping, rolling and firing and stunted growth associated with a soft root rot	*Milo disease* (p 48)
41.	General yellowing of the leaves beginning from the base with, under humid conditions, downy white growth on the under surface	*sorghum downy mildew* (p 2)
42.	Leaves completely bleached without downy white growth, become necrotic and shredded.....	*sorghum downy mildew* (p 2)
43.	Leaves thickened, stiff, twisted on stunted bushy plants	*crazy top downy mildew* (p 6)
44.	Poor growth, withering, poor grain setting of plants associated with small red, pink or white flowered plants.....	*witchweeds* (p 63)
45.	Lodging, poor grain filling, stems internally disintegrated and sprinkled with small black bodies	*charcoal rot* (p 41)
46.	Stem has marbled internal appearance with circular external cankers	*red rot* (p 26)
47.	Roots develop a soft rot and the crown shows a red coloration	*Milo disease* (p 48)

B. PEARL MILLET

1.	Inflorescence symptoms	3 to 6
2.	Foliage symptoms	7 to 10
3.	Grains replaced by dark green globose sacs which turn dark brown and contain a brown-black powder	*smut* (p 79)
4.	The inflorescence partially or totally transformed into a leafy structure	*downy mildew* (p 68)
5.	Florets exude a sticky liquid (cream to red) which develops into cream to black hard structures	*ergot* (p 75)
6.	Grains covered with white, pink or black molds	*grain molds* (p 59)
7.	Small discrete lesions with distinct margins	11 & 12
8.	Large circular or irregular lesions with zonate, banded or patchwork appearance	13 & 14
9.	General discoloration or diffuse yellowing or stunted growth	15 & 16
10.	Chlorotic rectangular lesions to irregular chlorotic areas with downy growth on undersurface in humid conditions	*local lesions of downy mildew* (p 71)
11.	Reddish to brown discrete powdery masses breaking through the leaf surface	*rust* (p 80)
12.	Diamond shaped to circular lesions with dark brown margins and chlorotic haloes	*blast* (p 83)

13. Roughly circular lesions with alternating concentric bands of straw and brown color often coalescing over the leaf surface ..... *zonate leaf spot* (p 84)

14. Patchwork of light and dark discolored areas often bearing fluffy white to light brown fungal mats ..... *banded leaf & sheath blight* (p 67)

15. General yellowing of leaves beginning from the base with, under humid conditions, downy white growth mainly on under surface ..... *downy mildew* (p 68)

16. Poor growth, withering and poor grain setting of plants associated with small red, pink or white flowered plants..... *witchweeds* (p 63)

MILO DISEASE (*Periconia circinata* (Mangin) Sacc.)

Periconia root rot or milo disease of sorghum, caused by *Periconia circinata,* has been reported only from the sorghum-growing regions of the USA. The degree of severity of symptoms on infected plants ranges from early death of seedlings to only mildly infected plants whose heads produce poorly developed seed. Other external symptoms include leaf drooping, rolling, and firing (they turn yellow and become necrotic from the tips and margins), and stunted growth. The roots are attacked before leaf symptoms occur and as the disease develops, most of the finer roots are destroyed with a soft rot. The larger roots become dark red or brown, and the crown tissue takes on a characteristic dark red color which may extend into the vascular tissue of the stalk (Plate 31).

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BACTERIAL LEAF STREAK (*Xanthomonas holcicola* (Elliot) Starr and Burkholder)

The first symptoms are narrow water-soaked translucent spots or streaks which turn red, become opaque, and develop tan centers (Plate 32). At intervals the streaks may broaden into irregular oval spots with tan centers and red margins (Plate 33). Bacterial streak is easily distinguished from bacterial stripe, as in the latter the stripes are never water soaked, are invariably continuous in color, and do not broaden into oval spots. Bacterial exudate dries to form crusts or scales on the surfaces of the lesions.

BACTERIAL LEAF STRIPE (*Pseudomonas andropogoni* (E.F. Smith) Stapp)

Symptoms, which occur on the leaves and leaf sheaths, are characterized by long (up to 40 cm) interveinal streaks or stripes with color characteristic of the cultivar (red, purple, or tan) (Plate 34). Initially the stripes are narrow (1 to 2 mm wide), and become wider later but mainly remain delimited by the veins. The color is normally the same throughout the stripe. Abundant droplets of bacterial exudate are produced from the stripes. The droplets dry to form small crusts or scales which can be washed off by rain.

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MAIZE DWARF MOSAIC AND SUGAR CANE MOSAIC

Maize dwarf mosaic (MDM) and sugar cane mosaic (SCM) are diseases caused by viruses, the symptoms of which are highly similar on sorghum. The mosaic symptom is normally most prominent on the upper two or three leaves as an irregular mottling of dark and light green, often interspersed with longitudinal white or yellow streaks (Plate 35). In red-pigmented cultivars a "red-leaf symptom" may occur with elongated red stripes which develop necrotic centers and red margins (Plate 36). The earlier the infection, the more severe the symptoms. In the most severe cases the plants may die, or growth may be stunted, flowering delayed, and the plants may fail to head or set seed.

YELLOW SORGHUM STUNT

Diseased plants are stunted (about half as tall as normal) with leaves bunched together at the tops. Leaves are rigid and curled adaxially about the blade axis with pronounced puckering resulting in undulating margins. The development of a yellow-tinged cream color makes infected plants conspicuous from a distance (Plate 37). Florets are often aborted, causing infected plants to be barren. The disease is caused by a mycoplasma-like organism transmitted by leafhoppers, and possibly by other insects. Certain cultivars are highly susceptible.

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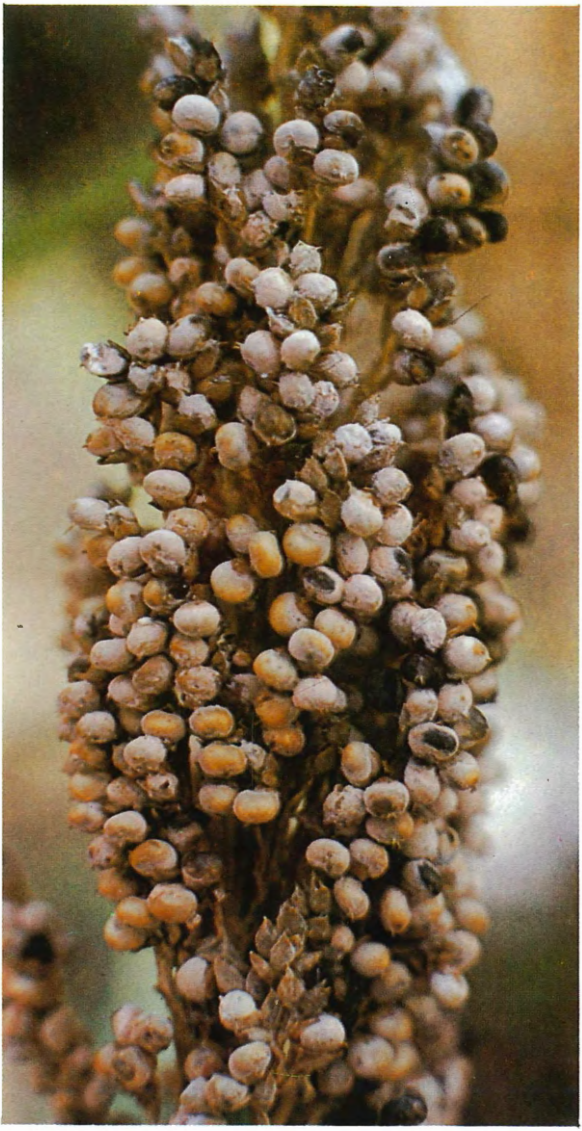

SORGHUM & MILLET – 1

GRAIN MOLDS (a complex of several fungal species)

If rains occur during the flowering and grain filling stages, severe grain molding can occur. Fungi from many genera have been isolated from moldy sorghum grain and the most frequently occurring genera are *Fusarium* and *Curvularia*. Fungi in other genera may be important in individual locations. The most commonly isolated *Fusarium* species are *F. semitectum* and *F. moniliforme,* and grain infected with these fungi develop a fluffy white or pinkish coloration (Plate 38). *Curvularia lunata* is also frequently encountered and this fungus colors the grains

Continued

black (Plate 39). The infection is deep-seated within the grain and heavily molded seed has low viability. Infection can occur on both white- and brown-grained cultivars and under very humid conditions can be just as severe on open, loose panicles as on compact panicles. Pearl millet maturing in wet conditions is also subject to similar grain-mold problems.

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WITCHWEEDS (*Striga* spp.)

Sorghum and pearl millet can be parasitized by several species of the parasitic flowering plant in the *Striga* genus, including *S. hermonthica* (Africa), *S. asiatica* (Africa and Asia), and *S. densiflora* (India). Severe witchweed attack produces leaf wilting and yellowing and the infected plants are stunted and may die prior to seed setting. There are reports of yellow blotches on sorghum leaves resulting from less severe attack.

The seeds of the witchweed are stimulated to germinate by root exudates of the young host plants, which the parasite seedling then penetrates and colonizes. The witchweed plants emerge above ground close to the attacked plant 1 to 2 months after the crop is planted. The witchweed flowers 3 to 4 weeks after emergence and its seed matures about one month later. *S. hermonthica* and *S. asiatica* are somewhat similar in appearance with red to pink flowers (Plate 40), but the former is bigger

Continued

with larger leaves and flowers and has five calyx ribs, compared with usually ten in *S. asiatica.* The flowers of *S. densiflora* are white. Plates 41 and 42 show severe infestation on pearl millet and sorghum by *S. hermonthica.* There is considerable evidence for host-specific biotypes within this species.

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BANDED LEAF AND SHEATH BLIGHT (*Rhizoctonia* spp.)

Sorghum, pearl millet, and other tropical cereals (such as maize and rice) growing in high rainfall conditions may develop water-soaked grey-green leaf and sheath lesions which become necrotic and give the infected tissues a banded appearance. Mycelial strands and fluffy white to light brown mycelial mats (sclerotia) of the causal fungus can be clearly seen on the surface of the lesions (Plate 43, 44).

MILLET –1

DOWNY MILDEW (*Sclerospora graminicola* (Sacc.) Schroet.)

Infection is mainly systemic and symptoms appear on the leaves and the inflorescences. The first symptoms can appear in seedlings at the three- to four-leaf stage. Leaves of infected plants appear chlorotic or yellowish (Plate 45) and under humid conditions profuse downy white growth (sporangiophores and sporangia) occurs predominantly on the lower surfaces of infected leaves (Plate 46). Plants infected at the seedling stage usually die within 30 days without tillering. Symptoms may appear first on the upper leaves of the main shoot, or the main shoot may be symptom-free and symptoms appear on the tillers. The first leaf that has symptoms is normally only partially infected (the lower portion) and subsequent leaves emerge with progressively more infection until leaves emerge with complete discoloration.

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The inflorescences of infected plants can be completely or partially malformed (Plates 47, 48) with florets converted into leafy structures of diverse appearance. The degree of malformation is related to the time of systemic invasion of the developing primordia. Tillers infected early in their development produce no normal head-like structure. The later the infection, the more normal the head. The range of appearances of infected inflorescences are wide and diverse. Sporulation occurs profusely on the malformed inflorescences under humid conditions.

In West Africa the sporangia from systemically infected plants can produce local lesions on leaves of nonsystemically infected plants (Plate 49). The local lesions in turn also produce sporangia. To date, these local lesion symptoms have not been observed in India.

Infected leaves and inflorescences produce sporangia over a considerable period of time under humid conditions and as necrosis begins, oospore production occurs. The dry necrotic tissues from mature infected plants contain masses of oospores which can be clearly seen with the aid of a hand lens.

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MILLET – 1 *(Continued)*

Exotic introductions into West Africa can be so severely infected with downy mildew that no plants survive to maturity (Plate 50).

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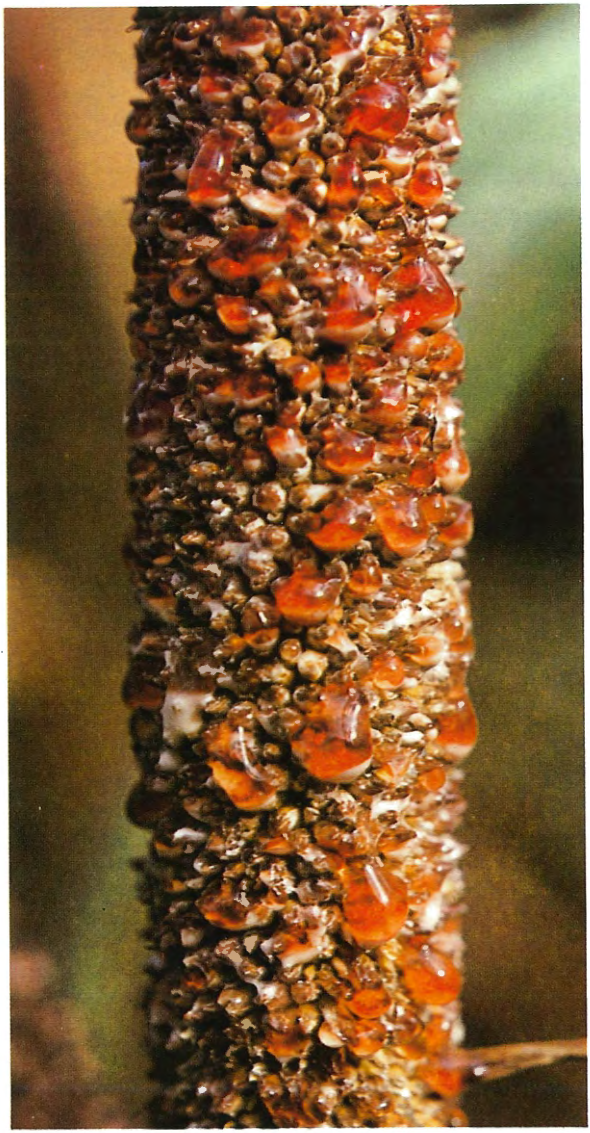


MILLET – 2

ERGOT (*Claviceps fusiformis* Loveless)

The pathogen infects the florets at the protogyny stage and develops in the ovaries, producing initially copious creamy, pink, or red colored sweet sticky liquid (Plate 51) called honeydew which contains conidia of the causal fungus. The honeydew can drip down the inflorescences onto the upper leaves making them sticky, and often pollen and shed anther sacs adhere to the honeydew. Subsequently long dark-colored hard structures, sclerotia, develop from infected florets, first dark at the tip and then becoming completely black (Plates 52, 53).

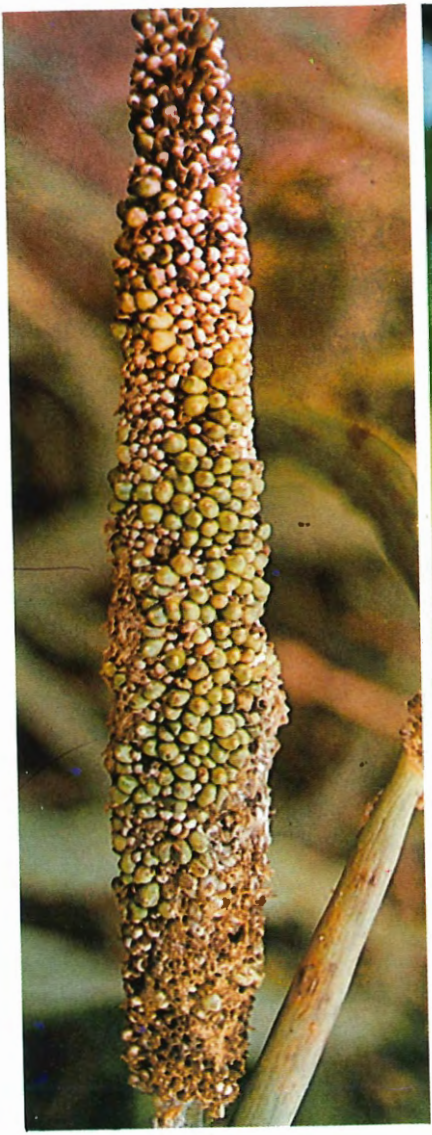
Continued

Sclerotia can be as large as 6 mm by 2 mm, may appear somewhat creamy during the early stages of their formation, but generally turn black as they mature. Infection can be so severe that all florets are infected and the head appears like a bottle-brush with large black sclerotia sticking out over the entire surface (Plate 53).

52

53

54



55

SMUT (*Tolyposporium penicillariae* Bref.)

The pathogen infects the florets and transforms them into large plump sacs (sori) containing black powder (smut spores). When young the sori are larger and greener than the noninfected developing seed, and they remain green when the normal seeds become creamy or grey colored (Plate 54). As the sori mature they become dark brown and are easily broken (Plate 55), spilling out millions of black smut spore balls.

RUST (*Puccinia penniseti* Zimm.)

Symptoms first appear on the lower older leaves as typical erumpent pustules containing a reddish-brown powder (uredospores) (Plate 56). As the leaves senesce dark brown teliospores are produced, sometimes in the uredosori, or in teleutosori which are darker colored than uredosori (Plate 57). Symptoms can occur on upper and lower surfaces of the leaves, but are common on the upper surface. Highly susceptible cultivars develop large pustules densely grouped on leaf blades and on sheaths.

56

57

58

LEAF BLAST (*Pyricularia setariae* Nisikado)

Lesions on leaf blades are roughly diamond-shaped to circular, up to 1 cm long, with dark brown margins and lighter-colored centers. Lesions have chlorotic-yellow haloes with an extension of the brown margins into the haloes at opposite ends of the lesions (Plate 58). Under humid conditions the lesion centers develop a light grey bloom of conidiophores and conidia.

ZONATE LEAF SPOT (*Gloeocercospora* sp.)

Roughly circular lesions, with alternating roughly concentric bands of straw and brown coloration, appear on the leaf blades. Lesions may coalesce to cover almost the entire leaf surface (Plate 59). In certain locations abundant black sclerotia are produced on the lesions.

59

Authors' Note :

This handbook is designed to help agricultural scientists identify the common diseases and parasites of sorghum and pearl millet. We have attempted to describe the most characteristic features of the symptoms but we recognize that local variations can occur which we may not have described. In addition, the coincidence of two or more diseases on the same plant organ may confuse the identification. For confirmation of disease identification we recommend that diseased samples are examined by plant pathologists. The most comprehensive text on sorghum pathogens and diseases is the book by S.A.J. Tarr entitled Diseases of Sorghum, Sudan Grass & Broom Corn, published by the Commonwealth Mycological Institute, Kew, Surrey, England, 1962. We recommend Dr. Tarr's book for researchers who need further details on sorghum diseases and for the necessary information on pathogen identity in order to confirm disease identifications.

RJW
RAF
JCG
August 1978

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R. J. Williams	– Plates : 1, 3, 4, 7, 9, 10, 21, 22, 25, 27, 29, 34, 38, 39, 40, 41, 46, 47, 48, 50, 53, 54.
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