

Disease management

for improved millet production

I K Das*, K B Palanna and G Rajesh

ICAR-Indian Institute of Millets Research, Rajendranagar, Hyderabad, Telangana 500 030

Milletts are a group of cereal grains used for human and animal consumption. Many diseases come in the way of high productivity of millets. There are more than a dozen major diseases that considerably affect cultivation of various millets like sorghum, pearl millet, and small millets (finger, foxtail, kodo, proso, little, barnyard and browntop millets). Millets being grown under low input agricultural conditions, management of disease by chemical is not recommended and mostly preventive measures are followed. The article describes major diseases of millets and various cost effective and economic ways of their management for higher productivity.

Keywords: Disease, Host resistance, Management, Millets

CROP damage due to diseases is one of the major causes of concerns for improvement of millets production and productivity with intensive cultivation. Losses vary depending on growth stage of the crop infected, type of disease, plant part affected and disease intensity. Losses due to fungal diseases are more compared to bacterial and viral diseases. There are more than a dozen major diseases that considerably affect cultivation of various millets like sorghum, pearl millet, and small millets (finger, foxtail, kodo, proso, little, barnyard and browntop millets). Grain mold, stalk rot and anthracnose in sorghum, downy mildew in pearl millet and sorghum, blast in pearl millet and finger millet, rust in sorghum, pearl millet and foxtail millet, ergot in sorghum and pearl millet, and smuts in all millets are economically important diseases. These diseases occur during different crop growth stages on physiologically and economically important plant parts. They need to be efficiently managed to improve yield and quality of millets.

Diseases

Seedling diseases: Root rot of seedling, damping off, anthracnose and seedling blight appear during seedling stage. Severe infection damages the roots and tender leaves, and often kills the seedling. Plant stand in the affected plot becomes less which gives a patchy look to the crop in the field. Small millets grown in poorly drained acidic soil are often affected by damping off and seedling root rot. Sorghum seedling may be infected by anthracnose and seedling blight, and depending on

intensity of infection the seedling may die prematurely.

Grain diseases: Many pathogens infect florets or developing grains, the most important part of the millets crops. One such most damaging disease is grain mold of sorghum. The others are ergots and smuts that appear on most of the millets grain. Production losses due to grain mold ranges from 30–100% in sorghum depending on cultivar and prevailing weather. Mold infection becomes visible in pink, orange, gray, white, or black colour fungal bloom on the grain surface. The disease reduces seed value of grain, nutritive value of food and feed, and cooking quality of the grain. Molded grains often contain mycotoxins which may be harmful to human, animal and poultry birds. Ergot or sugary disease is a serious limiting factor in production of hybrid seed. The disease is commonly observed in sorghum and pearl millet. First visible symptom is exudation of honeydew like droplets, which are thick, sticky or viscous, pinkish to brownish in colour and sweet in taste. Infected florets do not produce grain and other grains from infected panicles show reduced germination. Yield loss varies from 10–80% in sorghum and up to 50–70% in pearl millet hybrids depending on severity. The pathogen survives off seasons in the infected panicles left in the field or via sclerotia that are mixed with the seed during threshing and processing. Smut is a fungal disease that converts parts or whole of an earhead into fungal structure. Depending on symptoms, four different types of smuts namely, head smut, covered smut, loose smut, and long smut are observed in millets. Head smut is soil-borne, while loose and covered smuts are primarily



Grain mold, ergot and smut on sorghum grains

carried externally on the seed surface. Generally, smuts are observed sporadically on millets and they are of minor importance. Downy mildew of pearl millet affects earhead and transforms spikelet to leafy structure. Such earhead (called green ear disease) hardly produces any grain.

Leaf diseases: Leaf diseases destroy leaf surfaces meant for photosynthesis and adversely affect yield. Many types of leaf diseases occur in millet. Major categories are downy mildew, blast, rust, anthracnose, leaf blight and leaf spots. Downy mildew is important in pearl millet and sorghum and also occurs on finger and foxtail millet. Infection starts at the seedling stage and continues till death of the plant due to extensive damage of leaves. Symptoms are visible on the lower part of the leaf blade as white, downy growth consisting of conidia and conidiophores of the pathogen, which later progresses upward. Systemic infection of the plant results in a barren inflorescence in pearl millet. Losses may go up to 100% in pearl millet, 20% in sorghum and finger millet depending on the time of infection, cultivars and weather conditions. The collateral hosts serve as source of inoculums for the sorghum crop. Blast is potentially a serious disease of millets particularly pearl millet and finger millet. The disease occurs almost every year in finger millet and yield loss varies from 28–36% and may go up to 90% in endemic areas. The pathogen can infect any plant part and develop elliptical or diamond shaped lesions on the leaf, peduncle and finger. The most damaging stage is neck blast, followed by finger and leaf blast. The pathogen *Pyricularia grisea* can parasitize over 50 grasses and its life cycle is complex.

Most of the millets are also affected by rust. Generally, they appear during later part of the crop growing season, causing less damage. Sometimes, rust may infect during early growth stage of the crop and then, it becomes serious yield limiting factor. Though the disease occurs regularly in many places, it hardly becomes severe. Severely rusted plants may fail to throw panicle. Initial

symptom appears as reddish brown pustules on both the surfaces of the lower leaves. Within a leaf, the upper half develops more infection than the lower half. The pathogen survives on ratoon or stray sorghum plants in the field and also on perennial and collateral hosts. Anthracnose causes substantial economic losses to grain, forage and sweet sorghum but is not observed on other millets. Pathogen can infect any plant part during entire growth stages. Symptoms appear as seedling blight, leaf blight, stalk rot and head blight. Symptoms on the leaf appear as small, elliptic to circular spots, with straw colour centre and wide margin. Adjoining spots may coalesce to give a blighted appearance on the leaf. There may be up to 50% loss in grain yield under severe epidemics conditions. Leaf blight is an economically important disease of sorghum causing significant loss on grain and forage sorghum. Millets can be infected by various types of leaf spots including zonate leaf spot, stripe, gray leaf spot and rough leaf spot in sorghum; *Cercospora* leaf spot, *Curvularia* leaf spot, *Dactuliophora* leaf spot and *Phyllachora* leaf spot in pearl millet; *Cercospora* and *Helminthosporium* leaf spot in finger millet and others. These diseases are sporadic in nature



Smuts of kodo and barnyard millets



Pearl millet downy mildew



Leaf and finger blast of finger millets

and are less damaging, unless they are favoured by congenial weather conditions. They become significant on forage millets.

Root and stalk diseases: There are few important root and stalk diseases, which are soil-borne and severely impact plant stand and yield of millets. The most important one is charcoal rot which is commonly observed in *rabi* (winter) sorghum. Symptom appears as discolouration at the base of the stalk. Pathogen infects root, destroy cortical tissues and may block water movement through vascular bundles. Rotting and breaking of the basal internodes cause lodging of the crop, which in turn facilitates further loss of water from the cracks in the stalk, affecting fodder quality. Yield losses vary from 20–64%. Banded blight is another soil-borne disease, which is commonly observed on all the small millets. The disease is characterized by oval to irregular light grey to dark brown lesions on the lower leaf and leaf sheath. The central portions of the lesions subsequently turn white with narrow reddish brown margins. Later, the spots get distributed irregularly on leaf lamina. Under favourable conditions, lesions enlarge rapidly and coalesce to cover large portions of the sheath and leaf lamina. In severe cases, symptoms appear on peduncles, fingers and glumes as irregular to oval, dark brown to purplish brown necrotic lesions.



Rust of browntop and foxtail millets and *Cercospora* leaf spot of finger millet

Management

Millets are mostly cultivated under low input conditions and its cultivation is almost organic by default. Herbicides, pesticides, fungicides, chemical fertilizers are generally not used or if used they are in minimum

scale. Under such situation, disease management is focussed on prevention through reduction of primary sources of inoculums, minimization of infections and need based application of bio-control agents for protection from infection and curing.

Preventive measures: Practices such as deep ploughing during summer season, cleaning of field bunds after crop season, removal of crop residues from the field, regulating irrigation water from entering into other field not only reduces sources of inoculums or initial inoculums load but also lessens the chances of disease occurrence. Almost all the disease of millets can be managed or kept to a minimum by these practices.

Clean cultivation: Practice of clean cultivation includes all the activities that keep the field and the surrounding clean. Removal of weeds, alternate hosts, stray crops and crop residues from fields and bunds, and crop rotation with non-host plant help in reducing pathogen inoculums. Chances of occurring downy mildew, rust, charcoal rot, anthracnose, zonate leaf spot, sheath blight, foot rot and bacterial diseases can be minimized using these practices.

Crop rotation: Crop rotation is useful for management of soil-borne diseases of millets like wilt or foot rot of finger millet, root and stalk rots of sorghum, banded blight of small millets and downy mildews of all millets. The second crop in the rotation is selected in such a way that the crop is non-host for the pathogen in the first crop. Thus, pathogen population decreases in soil as it cannot get host to multiply.

Sowing date adjustment: Sowing time management can be practiced in conditions where farmers have flexibility in choosing preferred sowing date. Incidence of vector borne diseases like maize stripe virus in sorghum can be minimized significantly when sowing time is shifted from early September to 3rd week of October for *rabi* sorghum. Sowing *kharif* (rainy) sorghum in 1st week of July in Tamil Nadu is helpful to reduce downy mildew incidence. Grain mold severity in sorghum can be minimized to some extent by delayed sowing so that flowering and grain filling may happen in relatively rain free conditions.

Soil treatment: Promotion and utilization of disease

suppressive properties of soil is one of the best methods of disease management of millets. Treatment of soil with green manures or plant and animal based soil amendments improves disease suppressive properties. Green manures reduce *Rhizoctonia* diseases and can be useful for management of banded blight of small millets. Downy mildew of pearl millet and sorghum, root and stalk rot of sorghum, and foot rot of finger millet can be well managed in a suppressive soil.

Seed treatment: Treating seeds with antimicrobial agents eradicates seed-borne pathogens. Seed can be treated with fungicides or organically produced with substances like beejamrit. Soil-borne diseases of millets (e.g. charcoal rot in sorghum, foot rot and sheath rot in small millets), for which adequate host resistance is lacking, use of biocontrol agents are useful. Bio-control agents especially strains of *Trichoderma* and *Pseudomonas* are useful for foot rot and sheath rot in small millets. Seed treatments with *P. fluorescens* @6 g/kg seed and spraying with 2 g/litre of water manages blast in finger millet. First spray should be done immediately after noticing the symptom. The second and third sprays are given at flowering stage at 15 days interval.

Crop management: Wide spacing and withholding irrigation at flowering minimizes charcoal rot incidence in *rabi* sorghum. In hybrid seed production plots of sorghum, flowering synchrony should be such that A-lines must get sufficient pollens from R-lines for fertilization. Preventing bacteria contaminated irrigation water from entering into sorghum or pearl millets field minimizes the chances of bacterial stalk rot.

Resistant cultivars: Host-plant resistance provides the most economic and environment friendly method of managing millet diseases in organic agriculture. For grain mold management, use of a cultivar that escapes the disease is the best option. Use of mold tolerant cultivar such as hybrids CSH16, CSH27, CSH30, and varieties CSV20 and PVK801, and harvesting the crop just at maturity without leaving it for more days in the field are the second best options to avoid grain deterioration and weathering. Though high level of genetic resistance is not available against charcoal rot, the present day cultivars, viz. CSV19R, CSV216R and DSV6 possess good tolerance. All recently released cultivars of pearl millet (e.g. HHB 67, ICMH 356) possess tolerance to downy mildew as they are released only after multi-location testing. GPU 28 and GPU 48 is widely used cultivar of finger millet resistant to neck and finger blast.

Removal of diseases plants or plant parts: Incidence and severity of downy mildew of sorghum and pearl millet, all types of smuts of sorghum, pearl millet and small millets, and leaf diseases like anthracnose, leaf blight, and leaf spots and viral diseases can be greatly reduced. Collecting smutted heads in cloth bags and dipping in boiling water to kill the pathogen is the popular practice that will reduce the inoculum for the next year and minimize incidence.

Prophylactic measures: Rapid curing of an established infection is probably best done by chemicals. However, chemicals can be replaced by bio-agents or botanicals for management of foliar or panicle diseases to promote organic farming. Many reports are available on millet diseases where foliar sprays with bio-agents or botanicals have controlled diseases, e.g. pearl millet blast by *Pseudomonas fluorescens*, leaf diseases of forage sorghum by *Trichoderma asperellum* and grain mold of sorghum by *T. harzianum*. Similarly, in small millets foot rot of finger millet and banded blight in all millets can be managed by soil application of *T. viride* or *T. harzianum* and *P. fluorescens*. However, prophylactic spray of pesticides for disease management should be the last option and practices described previously should be followed stringently, so that diseases do not appear on the crop or they remain in control.

SUMMARY

Diseases are one of the major constraints of millet production and improvement in productivity. Grain mold, stalk rot and anthracnose in sorghum; downy mildew in pearl millet and sorghum; blast in pearl and finger millet; rust in sorghum, pearl, browntop and foxtail millets; ergot in sorghum and pearl millet; and smuts in all millets are economically important diseases. These diseases occur during different crop growth stages on physiologically and economically important plant parts. They need to be efficiently managed to improve yield and quality of millets. Clean cultivation, sowing date adjustment, soil and seed treatment, crop management, removal and destruction of infected plants, use of resistant cultivars and need based spray with bio-control agents are some of the practices that should be followed for cultivation of disease free millets crops.

*Corresponding author's e-mail: das@millets.res.in

Share your experiences with

Indian Farming

Write to:

Editor

INDIAN FARMING

Directorate of Knowledge Management in Agriculture

Indian Council of Agricultural Research

Krishi Anusandhan Bhavan I,

Pusa, New Delhi 110012

indfarm@icar.org.in