



Important Diseases of Millets and Its Management

(* R. J. Chaudhari, G. M. Parmar, R. P. Juneja and K. D. Mungra)

Pearl Millet Research Station (Junagadh Agricultural University), Jamnagar (Gujarat)

*Corresponding Author's email: chaudharyramesh008@jau.in

Large segment of the Indian population (70%) is dependent on agriculture which governs national economy, also food and nutritional security of the country and accounts for approximately one-fifth of the total gross domestic product (GDP). The agriculture in India comes largely under dryland conditions. Millets are mostly cultivated in dryland conditions in many parts of India where there is no scope for cultivating other cereal crops. Millets are resistant to adverse climatic conditions and can be grown with minimum access to irrigation water and various kinds of soil conditions. Thus with the increase in the earnings from millets cultivation will have a significant impact in the dryland farmers. Millets are a group of highly variable small-seeded grasses widely grown globally as cereal crops or grains for both human food and fodder. They form a diverse group of small grains cultivated in diverse and adverse climatic conditions, mostly in the dry semi-arid to sub-humid drought-prone agro ecosystems. Major millets, such as pearl millet, sorghum, finger millets (ragi), proso millet and foxtail millet are the most widely grown millets in India. Minor millets such as Indian barnyard millet, little millet and kodo millet are grown in the pockets on marginal lands.

Minor millets or small millets are the small-grained cereals belonging to the family Poaceae. Thirty-five species of grasses from 20 genera as small millets were reported so far (De Wet, 1986) and it was noted that two-thirds of that number were no longer being cultivated (Doggett, 1993). The most important cultivated species of small millets are finger millet (*Eleusine coracana*), Foxtail (*Setaria italica*), proso millet (*Panicum milliaceum*), barnyard millet (*Echinochloa frumentacea*), kodo millet (*Paspalum scrobiculatum*) and little millet (*Panicum miliare*). The description of major and minor insect-pests along with their scientific name, importance, status, nature of damage and its control measures are discussed in brief below. In India and Africa, these four fungal diseases are considered as most important which are: downy mildew or green-ear disease; smut, ergot and rust as they adversely affect the grain yield (Wilson, 1999).

Major diseases of Pearl millet

Green ear or downy mildew disease: - *Sclerospora graminicola*

The symptoms of this disease usually appear on the leaves after 25 to 35 days of sowing and in some places after one to one and a half month. To diagnose the disease, the leaves of millet should be looked upside down, white powder is deposited on the lower surface of the leaves and the leaves turn yellow. Yellowing, dwarfing and drying of leaves are also important symptoms of the disease. The flowers of crop are converted into leaf like structures, known as "green ear". There are no grains into the diseased ears. Severe infestation can completely destroy the crop.

Ergot disease: *Claviceps fusiformis*

The outbreak of this fungal disease is more at the time of flowering. A thick and sticky liquid of light pink color comes out from the flowers of the affected ears, which later turns dark

brown and on drying, a hard layer becomes on the ears. The diseased ears do not develop grains and after a few days' dark brown sclerotia are formed in place of the grains. Sclerotia are larger than seed and irregularly shaped, and generally get mixed with the grain during threshing. A toxic substance called argotin is found in the infected ears, which is harmful (poisonous) to humans and animals and causes disease.

Smut disease: *Moesziomyces penicillariae*

The outbreak of this disease usually occurs on the crops at the flowering stage. At initial stage, diseased sori are formed, which are dark green, shiny and large in size, later on become brown in color and filled with black powdery spore masses.

Blast disease: *Pyricularia grisea*

Blast disease caused by fungus and affect aerial (leaf, stem and ear) parts of crop. The initial symptoms of this disease appear on leaves 20 to 25 days after transplanting or sowing. In the initial stage, small boat shaped light brown or purple color spots are appeared on the lower leaves, which gradually become broad in the middle and narrow at the edges like eyes with gray centre. Infected plants become weak and produce less ears. The grains do not fill completely and the yield is reduced.

Integrated disease management

Cultural practices: These are the traditional methods of disease management. Sow crop on time, use recommended seed rate, follow crop rotation with non-host crops and apply balanced dose of fertilizers with efficient weed control.

Use of resistant varieties: The use of disease resistant varieties is the cheapest and most durable method of disease control. So, grow disease resistant varieties.

Seed selection and seed treatment: Inspect the seeds thoroughly and observe that there are no ergot sclerotia. If, the seeds are not taken from certified agency, then farmers are advised to treat the seeds in brine/salt solution. In this method, dip the seeds in 10% salt solution and stir for 10 minutes and remove the floating materials and wash them thoroughly with clean water. If any trace of salt remains on the surface of the seed, it affects the germination of the seed. Finally, dry the seeds in the shade and before sowing such seeds, treated with agrosan GN @ 2.0-2.5 g or thiram @ 3.0-3.5 g per kg seeds. For downy mildew (green ear disease), the seed should be treated with metalaxyl @ 6 g per kg of seed.

Removal of diseased plants: As soon as the symptoms of green ear disease appeared on the leaves of the millet crop, uproot them and destroy and the uprooted diseased plants should not be in contact with healthy plants. In susceptible varieties of millet, after removal of diseased plants, spray the crop with zineb or mancozeb 0.25 % solution.

Chemical methods: This is the most effective and easiest method of disease management, but excessive use of chemical pesticides in integrated disease management is not appropriate for the crop and soil, because these chemicals increase the resistance in pathogens to chemicals and along with decrease soil quality. There is also a harmful effect on crops and beneficial microorganisms. Always use appropriate amount of insecticides, fungicides, bactericides, insecticides and weedicides for seed, soil treatment and foliar spraying. By adopting Integrated Pest and Disease Management (IPM) with bio-control agents, the amount of chemical pesticides can be reduced and the environment can be saved.

Green ear disease (Downy mildew): Seed treatment with metalaxyl @ 6 g per kg of seed. In the standing crop, spray mancozeb @ 0.25% at first appearance of the disease. Ergot: Spray mancozeb @ 0.25% at the time of flowering. Smut disease: Before sowing, sow the seeds by treating them with Carbendazim @ 2-3 gm per kg of seed and spraying with Mancozeb @ 0.2%. Blast disease: Before sowing, treat the seeds with carbendazim @ 2g per kg seed and at appearance of symptoms, spray carbendazim + manconzeb @0.2%.

Bio-control agents: Under this component, management of diseases is done by biological methods like microbial protection (Fungus-*Trichoderma* spp. and bacterium-*Pseudomonas* spp.) by seed treatment, soil treatment and foliar sprays. Bio-fungicide (*Trichoderma* should be used @ 4 g/kg seed for seed treatment. For soil treatment, apply *Trichoderma* 2.5 kg/ha mixed with 100 kg FYM in soil.

Key points to follow during cultivation

1. Destroy affected ears of ergot. Do not use ergot affected ears for feeding to animals.
2. Adopt long crop rotation of 3 to 4 years with non-host crops in disease prone areas.
3. After harvesting, always follow deep plowing, so that ergot sclerotia, downy mildew spores etc. are destroyed in the soil.
4. Remove the sclerotia of ergot from the grain.
5. Do not allow vine weeds and grasses to grow around the bunds of the field.
6. Always keep watching the changes in the crop and if there is immediate requirement of any pesticide apply promptly with correct dose.

Major diseases of Sorghum

Downy mildew: *Peronosclerospora sorghi*

Symptom is visible as either systemic or localized infection. Systemically infected seedlings are pale yellow or have light-color streaking on the leaf, chlorotic and stunted and may die prematurely. First symptoms are visible on the lower part of the leaf blade, which later progress upward. In cool, humid weather, the lower surfaces of chlorotic leaves become covered by a white, downy growth consisting of conidia and conidiophores of the. The leaves emerging from the whorl subsequently exhibit parallel stripes of vivid green and white tissue. The infected striped areas die, turn brown, and disintegrate, resulting in a shredded appearance of the leaf. Conidia produced in the infected plants become air-borne and cause rectangular shaped local lesion on the leaf.

Smut:

Grain smut: *Sphacelotheca sorghi*

The individual grains are replaced by smut sori. The sori are oval or cylindrical and are covered with a tough creamy skin (peridium) which often persists unbroken up to thrashing. Ratoon crops exhibit higher incidence of disease.

Loose smut: *Sphacelotheca cruenta*

The affected plants can be detected before the ears come out. They are shorter than the healthy plants with thinner stalks and marked tillering. The ears come out much earlier than the healthy. The glumes are hypertrophied and the earhead gives a loose appearance than healthy. The sorus is covered by a thin membrane which ruptures very early, exposing the spores even as the head emerges from the sheath.

Head smut - *Sphacelotheca reiliana*

The entire head is replaced by large sori. The sorus is covered by a whitish grey membrane of fungal tissue, which ruptures, before the head emerges from the boot leaf to expose a mass of brown smut spores. Spores are embedded in long, thin, dark colored filaments which are the vascular bundles of the infected head.

Long smut - *Tolyposporium ehrenbergii*

This disease is normally restricted to a relatively a small proportion of the florets which are scattered on a head. The sori are long, more or less cylindrical, elongated, slightly curved with a relatively thick creamy-brown covering membrane (peridium). The peridium splits at the apex to release black mass of spores (spore in groups of balls) among which are found several dark brown filaments which represent the vascular bundles of the infected ovary.

Anthracnose: *Colletotrichum graminicola*

Initial symptoms of anthracnose on the leaf appear as small, elliptic to circular spots, with straw-color centre and wide margin. The lesion margin may be red, orange, blackish purple, or tan, depending on the pigment present in the cultivar (purple or tan). Adjoining spots may coalesce to give a blighted appearance on the leaf. A black dot like acervulus is often seen at the centre of the necrotic spot, which is the characteristic diagnostic symptom for leaf anthracnose. Apart from leaf the symptom may appear on the mid-rib. Leaf sheath on the stalk and on spikelet tissues. In case of severe infection, plants get defoliated and die before reaching maturity. Infected mature stalks may develop reddish internal lesions, which may be continuous or discontinuous giving the stem a ladder-like appearance. Nodal tissues are rarely discolored. If the infection is early and severe, pre emergence damping-off may occur and the seedlings wilt and die.

Rust: *Puccinia purpurea*

Sorghum rust appears as reddish brown pustules first on both the surfaces of the lower leaves. Generally, the upper half of the leaf gets more severe infection than the lower half. As the disease advances the infection spreads to the younger leaves. Several adjoining pustules may coalesce to form large patch on the leaves and the infected leaves die prematurely giving the plants an unhealthy appearance which becomes visible from a distance. The pustules may appear in any parts of the plant including mid-rib (arrow), peduncle and stem. The pathogen produces two types of spores in the pustules on sorghum viz., urediniospore and teleutospore.

Integrated disease management**Cultural practices**

Many agricultural practices such as deep ploughing during summer season, cleaning of field bunds after crop harvesting, removal of crop residues from the field, uprooting the diseased plant from the field and burning, regulating irrigation water from entering into other field, if followed regularly, reduce chances of disease occurrence.

- ✓ Collateral and alternate hosts, weeds, volunteer and wild crop species harbor pathogen and serve as source of inoculums. Their timely removal helps to control diseases like ergot, downy mildew, rust, blast, leaf spots and bacterial and viral diseases.
- ✓ Deep summer ploughing, destruction of crop residues and crop rotation with non-host plant help reducing inoculums of soil-borne diseases.
- ✓ Maintaining optimum plant spacing and regulating the amount of nitrogenous fertilizer reduces incidence of blast and downy mildew.
- ✓ Insect acts as vector for many viruses and injects virus inside the plant. Injury caused by insect in plants sometime help many bacteria to enter and cause disease. Insect control, therefore, helps in managing such diseases.

Chemical methods:

- ✓ Seed treatment with Metalaxyl, Captan or Thiram at 4-6 g/kg of seed.
- ✓ Spray Metalaxyl 500 g or Mancozeb 2 kg or Ziram 1 kg or Zineb 1kg/ha.

Major diseases of Finger millet**Blast:** *Pyricularia grisea*

- ✓ Infection may occur at all stages of plant growth.
- ✓ Young seedlings may be blasted or blighted in the nursery bed as well as developing young plants in the main field.

There are three stages in disease development.

Leaf blast: It is more severe in tillering phase. The disease is characterized by spindle shaped spots on the leaves with gray centres surrounded by reddish brown margins.

Node blast: Infection on stem causes blackening of the nodal region and the nodes break at the point of infection. All the parts above the infected node die.

Neck blast: At flowering stage, the neck just below the ear head is affected and turns sooty black in colour and usually breaks at this point. In early neck infections, the entire ear head becomes chaffy and there is no grain set at all. If grain setting occurs, they are shrivelled and reduced in size.

Management:

- ✓ Use of blast resistant varieties with carbendazim seed treatment at 2g/kg increases yield anywhere between 50-100 per cent.
- ✓ Seed treatment with *Trichoderma harzianum* or *Pseudomonas fluorescens* @6g/kg coupled with two sprays of *Pseudomonas fluorescens* at 0.3% first at the time of flowering can control leaf, neck and finger blasts very effectively.
- ✓ In the absence of varieties with inbuilt resistance, sprays of fungicides are advisable to minimise the disease. Two sprays of Saaf (0.2%) or carbendazim 0.05% or tricyclazole 0.05% with first spray at 50 per cent flowering followed by the second 10 days after were also effective (Madhukeshwara et al., 2004).

Brown spot or leaf blight or seedling blight: *Drechslera nodulosum*

The disease affects all the parts of plant like root, base of the plant, culms, leaf sheath, leaf blade, neck of the panicle and fingers. When infected seeds are may not germinate at all due to pre-emergence seed rot. In case such seeds germinate, post-emergence rot is very commonly seen. The characteristics symptom on leaf lamina is appearance of brown to dark brown spots. These spots are generally oval in shape and measure 8-10 mm in length and 1-1.5 mm in breadth. Later, these spots coalesce to give the blighting appearance of leaf, especially towards tip which would ultimately be killed prematurely.

Management

- ✓ Seed treatment with Agrosan G N can give complete control of pre-emergence damping off seedling blight.
- ✓ Secondary infection can be reduced by spraying of Mancozeb @ 0.2 per cent control the disease.
- ✓ Low concentrations fungicides folithion and morestan and a rhizome extract of canna inhibited germination of *H. nodulosum* pathogen of seedling blight and leaf spot of ragi.

Looking to the status of the diseases in changing climatic scenario, an integrated approach for management of millets diseases is need of the hour. A farmer friendly IDM packages for the control and management of economically important diseases focused on pearl millet, sorghum, finger millet including minor millets as priority.

References

1. De Wet, J.M.J. (1986). Origin, evolution and systematics of minor cereals. In: Small Millets in Global Agriculture (Eds) Seetharam, A., Riley, K. W. and Harinarayana, G. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India.
2. Doggett, H. (1993). Introduction. In Advances in small millets. Edited by K.W. Riley, S.C. Gupta, A. Seetharam, and J.N. Mushonga. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India. pp. 3–8.
3. Madhukeshwara, S.S, and Mantur, S.G. (2004). Finger millet blast {*Pyricularia grisea* (Cke.) Sacc.} and its management, NATP (RNPS-4), Project Coordination Cell, ICAR, GKVK, Bangalore, p127.
4. Wilson, J. P. (1999). Pearl millet diseases: A compilation of information on the known pathogens of pearl millet, Pennisetum glaucum, U. S. Department of Agriculture, Agriculture Research Service, Agriculture Handbook No. 716, pp.50