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Sorghum Grain Mold: A Fungal Complex Threatening Yield and Grain Quality

Gaje sai kiran[1] and Dr. J. Rajendar[2]

[1] M. Sc research scholar, Department of Plant Pathology, PJTAU, [2] Scientist, Institute of Biotechnology, PJTAU.

Corresponding Author: saikirangaje@gmail.com

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Abstract

Sorghum grain mold is a dangerous threat to the sorghum production especially in the *kharif* season. The disease is caused by a complex of fungi such as *Fusarium*, *Curvularia*, *Aspergillus*, and *Alternaria*. Fungi majorly infect the crop at grain filling stage and at time of storage. As a result the farmers face severe yield losses and poor grain quality. Forsustainable management of grain mold certain practices are used like use of resistantvarieties, better field and post-harvest practices, timely harvesting and drying, biological control agents, and limited use of fungicides. Such an integrated management is essential to protect grain quality, ensure food safety.

1. Introduction : Sorghum (*Sorghum bicolor* L. Moench) is one of the important cereal crop which iscultivated in both *kharif* and *rabi season* only after rice, wheat and maize in the world. Sorghumis mostlycultivated insemi-arid regions because ofdrought tolerant ability. Where in India sorghum is served as staple food and its byproducts are used as fodder and fuel.

Grain mold is amost destructive disease among the diseases of Sorghum which can rapidlygrow in warm and humid conditions of *Kharif* season. The crop is more vulnerable to disease during grain development and maturity stage. The disease is caused by the fungal complex such as *Fusarium*, *Curvularia*, *Aspergillus*, and *Alternaria* which is strongly influenced under warm and humid conditions. As time goes on the disease severity is intensified due to climate changes, cropping patterns, and the adoption of high yielding hybrids. These fungi are mycotoxigenic which leads to poorgrain quality, poor marketing value, serious health and financial risks for both farmers and consumers.

2. Fungal complex behind the disease: Sorghumgrain mold isattacked byacomplexoffungalspeciesthat infect grainsduring rainy season and which greatly show impact on grain yield and quality. The important fungiare *F. pallidoroseum*, *F. verticillioides*, *Curvularia lunata*, *Alternaria alternata*, *Aspergillus*, *Bipolarisaustraliensis*, and *Cladosporium*. *Fusarium* isthe most prominent and able to cause severedamage to grains and sometimes releases harmfultoxins. The infectionof *Curvularia*turns grains to brown discolouration and wrinkled in wet conditions. At the same time *Alternaria* can enhance the rotting of the tissue. Where *Aspergillus* is a storage fungi which can infect the mature or stored grains. *Bipolaris* and *Cladosporium* is a supporting fungi during infection fungicanhelp in weakening grains and helping for mold spread further. The severity of these complex fungi depend on weather, and farming practices.

3.Grainmoldsymptoms : Disease severity is variable depending on the fungus involved and the stage of crop and environmental conditions. Early infection at flowering stage can cause blasted florets, poor seedset,andsmallwrinkledgrains.*Fusarium*speciesarecapabletoinfectthepanicles,

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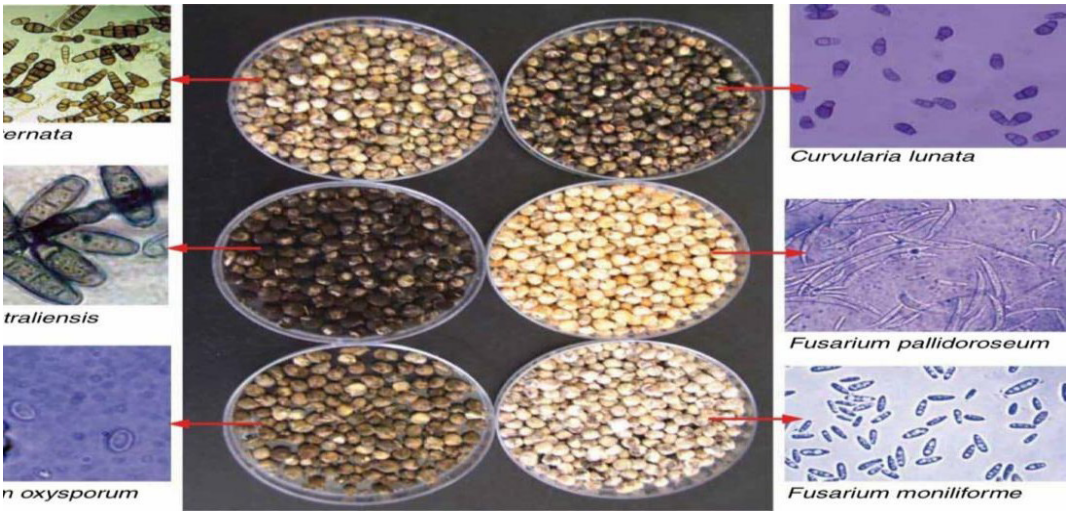

Fig.1Sorghumgrainscolonizedbydifferentmold fungi and their conidial forms.

peduncles, spikeletsandturnhead blightedappearancewithgrainsdiscolouredpinkish-white to pinkish fluffy mycelium (*F. pallidoroseum*, *F. verticillioides*). *Curvularia lunata* hasgrown rapidly to form shiny, velvety black, fluffy patches on grain surfaces. While*Alternaria alternata* produces a dull grayish black mycelium in streaks. *Bipolaris australiensis* appears as dark black mycelium and Cladosporium oxysporum forms grayish,

rain surface. Severe
ite-grain sorghums
during storagetime
ity is intact particu-
toms, sprouting the
growth.

Fig.2A)Variablesymptomsofgrainmoldonsorghumpanicles. B)Blastedfloretson sorghum panicles due to early infection by grain mold pathogens.

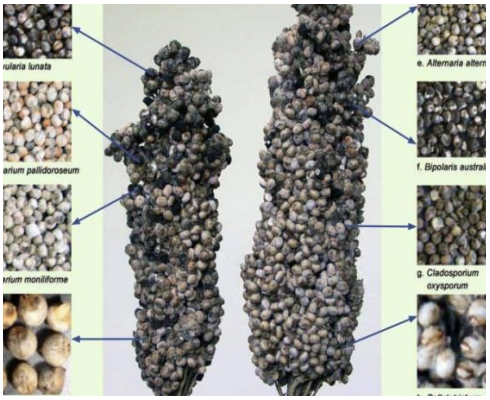

Fig.4Grainscolonizedbydifferentgrainmoldpathogensonsorghumpanicles.

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4. InfluencesofWeatheronFungalGrowth

The development of sorghum grain mold is highly correlated with temperature, humidity, and wetness duration. Which create favorable conditions for different fungal pathogens. Warm and humid conditions during flowering and grain development stage will promote infection and dry weather suppresses the growth of pathogen. Studies show that *Curvularialunata*and *Fusariumverticillioides* infect morequicklywhenpanicles-remainwet for extended periods and infection frequency increases up to 72 hours. *Cladosporium oxysporum* at particular weather conditions can survive under warm temperatures and able produce more spores compared with other fungal groups. particularly Mold fungi increase its spore production at 25–28°C with 100% relative humidity but reduce when temperatures fall below 15°C or rise above 30°C. Sudden increases in humidity, irregular rainfall will increase the spore numbers and accelerate infection.

5. ManagementStrategies

5.1 CulturalPractices

To avoid flowering in rainy periods adjust sowing dates byusingmedium to late maturingvarieties.Ensure-properspacinganddrainagetoreducehumidityaroundpanicles.

ResistantSources

Most resistance comes from the five primary sorghum races—bicolor, guinea, caudatum, kafir, and durra—and their combinations. Screening of thousands of lines worldwide has identified resistant or moderately resistant germplasm.

5.2 .Biologicalcontrol

Biological control agents play an important role in sustainable management for effectively control of complex fungi by using bioagents like *Trichoderma viride, T. harzianum,* and *Pseudomonas fluorescens.*

5. 3. Chemical Control

Fungicides provide limited protection and are mainly used on small plots or valuable lines, as wet conditions make large-scale application impractical.

Application	Treatment	Effect/Control
Seed treatment	Thiram/Chloranil@1oz/bushel; Agrosan GN 2 oz/bushel	Reducesmoldyseed

Seed treatment	(Thiram(3 g/kg)+Bavistin(2.5 g/kg	infection seed Reduces by *Fusarium*and*Curvularia*

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Foliarspray	Mancozeb+Captan@0.2%,three (sprays (flowering, 15, 25 DAF	increas- ,mold grain Reduces es grain yield
Foliarspray	Captafol@0.2%orCarbendazim+ Triademefon	*Fusarium* Controls and ,*Curvularia*
Foliarspray	Thiram + Carbendazim @ 0.2%; Captan + Mancozeb @ 0.3%, three sprays	Controlsgrainmoldinhybrid CSH14
Foliarspray	Propiconazole25EC@0.1%at flow-ering	Reducesseed-borneinfectionat milk stage

5.4.Avoidance

Time of flowering and grain filling to occur after rainy periods by following sowing adjustments or late-maturing cultivars. Dry-season irrigation also reduces mold incidence in seed production plots.

5.5.Timely Harvesting and Drying

Harvestthecropatphysiologicalmaturityand drygrainstoabout 10%moisture.

6.IntegratedDiseaseManagement(IDM)

Combine resistant varieties, cultural practices, timely harvest and drying, biocontrol agents, and targeted fungicides for maximum protection. Using resistant germplasm formsthe foundation of an effective IDM strategy.

6.EconomicSignificanceofSorghumGrainMold

The Sorghum grain mold had variable Economic importance which causes greater yield losses about 30to 100%under favourableconditions. Infectedgrains arediscoloredand shriveled due to these reducing their market value by10–30%. This not only lowers farmers' income but also makes sorghum less attractive for buyers and processors.

7.Conclusion : Sorghum grain mold is caused by a complex of fungi and causes severe threat toyield, grain quality and market. Therefore in management practices an integrated disease management play important role by combining resistant sources like IS 452, IS 455, Zera- Zera derivatives, and white-grain guinea sorghum, cultural practices, timely harvesting and drying, biocontrol agents such as *Trichoderma* spp. and *Pseudomonas fluorescens*, and chemicaltreatments including Thiram, Carbendazim, Mancozeb, and Captan. Such strategies enhance grain yield, improve seed and market quality, and protect farmers' income.

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