ISSN: 2157-7471
Journal of Plant Pathology & Microbiology

OPEN ACCESS Freely available online

Research Article

Important *Sorghum* Diseases and their Management in Ethiopia

Mulatu Gidi*

Department of Agriculture, Ethiopian Institute of Agricultural Research, Holeta, Ethiopia

ABSTRACT

Sorghum is a critical crop, especially in semiarid areas where moisture is scarce. It is the fifth-most important crop cereal crop. *Sorghum* is a C4 plant that originated and diversified in Ethiopia. It is used as feed, fuel and is consumed by humans in the form of injera, boiled porridge or gruel, malted beverages, beer, popped grain, and chips. In Ethiopia, biotic, abiotic, and socioeconomic constraints limit *Sorghum* production and productivity. Anthracnose, grain mold, cover smut, kernel cover smut, and *turcicum* leaf blight are the major biotic constraints in Ethiopian *Sorghum* production and productivity. Using resistant *Sorghum* genotypes is the best and most effective management for *Sorghum* disease.

Keywords: Biotic; Constraint; Disease; Management; *Sorghum*

INTRODUCTION

Sorghum bicolor (L) moench 2n=20 is a major cereal crop grown in arid and semi-arid regions around the world. After maize, rice, wheat, and barley, it is the world's fifth-most important cereal crop. It ranks third among cereals in terms of acreage and production. According to Mindaye, et al., Ethiopia is the world's sixth largest *sorghum* producer and Africa's third largest, following only Nigeria and Sudan [1]. In Ethiopia, *Sorghum* production is ranked 4th next to tef, maize, and wheat. The crop is a main staple food crop in East African countries, including Ethiopia, for most food insecure people where areas are characterized by arid and semi-arid conditions. The crop is cultivated in a wide range of agro-ecological conditions and farming systems, including intercropping, mixed cropping, and drought stressed areas in Ethiopia [2].

Importance of *Sorghum*

World *Sorghum* production is approximately 60 million tons per year, with a cultivated area of 46 million ha. The United States, Nigeria, India, Sudan, Ethiopia, Burkina Faso, China, Tanzania, and Niger are the top producers. According to the CSA, *Sorghum* is Ethiopia's third most important food crop, after maize and tef, in terms of total number of producers, area coverage, and grain production, and is commonly used to make local bread, injera, and various local beverages such as tela and areke. It's also a roasted vegetable and a boiled grain. *Sorghum* is a self-pollinating monocotyledon crop, with levels of spontaneous cross-pollination ranging from 5% to 30% depending on panicle type [3-9]. Furthermore, as a C4 plant, *Sorghum* is at the heart of dry land agriculture in the current scarcity crisis. *Sorghum*, in comparison to other food crops, is an ideal crop for dryland agriculture due to its high flexibility and tolerance to adverse conditions. *Sorghum* stalks are also used as animal feed, building materials, and fencing. However, abiotic and biotic factors, as well as socioeconomic constraints, influence potential *Sorghum* production. Diseases, insect pests, and weeds are major biotic impediments to *Sorghum* yield and quality losses [10].

MATERIALS AND METHODS

Sorghum production constraints

Sorghum production and productivity are affected by both biotic (diseases, insect pests, and weeds) and abiotic (nutrient deficiency, aluminum toxicity, drought, high salinity, water logging, and temperature stress) constraints [11]. Anthracnose, grain mold, *turcicum* leaf blight, and *Sorghum* smut are all important *Sorghum* diseases. Insect pests (stem borer, weevils,

Correspondence to: Mulatu Gidi, Department of Agriculture, Ethiopian Institute of Agricultural Research, Holeta, Ethiopia; E-mail: mulatugi23@gmail.com

Received: 12-May-2023, Manuscript No. JPPM-23-21342; **Editor assigned:** 15-May-2023, PreQC No. JPPM-23-21342 (PQ); **Reviewed:** 29-May-2023, QC No. JPPM-23-21342; **Revised:** 12-Jul-2023, Manuscript No. JPPM-23-21342 (R); **Published:** 19-Jul-2023, DOI: 10.35248/2157-7471.23.14.696

Citation: Gidi M (2023) Important *Sorghum* Diseases and their Management in Ethiopia. J Plant Pathol Microbiol. 14:696.

shoot fly, termites, and birds) and parasitic weeds (*striga*) major important biotic constraints on the crop.

Sorghum diseases in Ethiopia

The most important constraint to *Sorghum* production and productivity is biotic (disease). Anthracnose, grain mold, *turcicum* leaf blight, and *Sorghum* smuts are the most common diseases that affect *Sorghum* crops (Table 1).

Table 1: Important *Sorghum* diseases in Ethiopia and caused by the pathogens.

S. no	Disease	Pathogen	Importance
1	Anthracnose	*Colletotrichum sublineolum* Henn	Major
2	Covered smut	*Sphacelotheca sorghiis*	Major
3	Grain mold	*Fusarium*, *Curvularia*, *Alternaria*, *Phoma*, *Bipolaris*, *Exserohilum*, *Aspergillus*, *Colletotrichum*, and *Penicillium*	Major
4	Covered kernel smut	*Sphacelotheca sorghi*	Major
5	*Turcicum* leaf blight	*Exserohilum turcicum*	Major

Anthracnose

Sorghum anthracnose, caused by *Colletotrichum sublineolum* Henn, is the most common plant disease in all stages of *Sorghum* development, resulting in lower yields and grain quality. Anthracnose disease has been observed in all of the world's *Sorghum* growing areas. It is found in most of Ethiopia's *Sorghum* producing regions. The disease symptoms vary depending on environmental factors, plant developmental stage, and crop variety. Leaf symptoms appear as circular, elliptical, or elongated lesions of a dark reddish purple to tan color (Figure 1). The lesion's center is straw colored, with reddish brown or reddish orange margins and black acervuli with setae [12]. Under ideal conditions of high humidity and rainfall, the lesions grow in size and number, coalesce, and cover the entire leaf surface. *Sorghum* anthracnose causes yield losses of up to 70% in susceptible varieties.

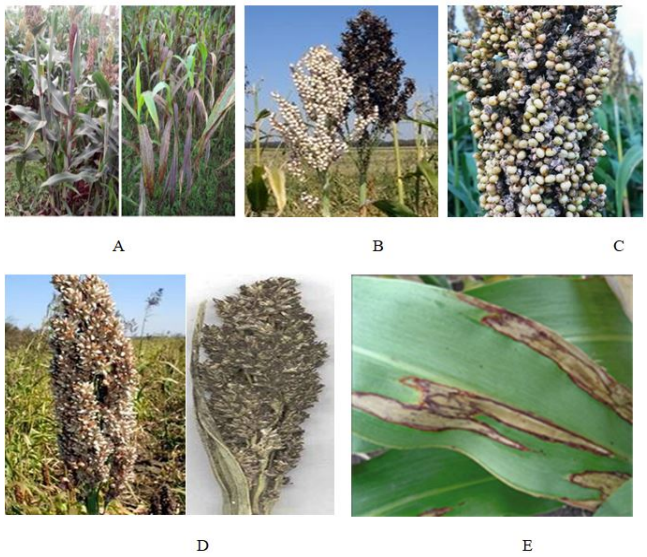

Figure 1: Important *Sorghum* diseases in Ethiopia: A) Anthracnose; B) Cover smut; C) Grain mold; D) Cover kernel smut; E) *Turicium* leaf blight.

In Ethiopia and most sub-Saharan African countries, anthracnose is a major focus of *Sorghum* breeding research. *Sorghum* landraces from the Western and South Western parts of the country were resistant to multiple leaf diseases, including anthracnose these locations are used for *Sorghum* screening under natural conditions (hot spot area) in the national *Sorghum* improvement program, particularly for disease resistance breeding [13].

Management

The use of resistant genotypes is the most effective and environmentally sound management strategy for *Sorghum* anthracnose. *Sorghum* originated in Africa, with Ethiopia having the highest genetic diversity in native *Sorghum* as *Sorghum* is a diverse crop, and this center of diversity could also serve as a center of diversity for host plant resistance to anthracnose [14]. *Sorghum* originated in Africa, with Ethiopia having the greatest genetic diversity in native *Sorghum* as *Sorghum* is a diverse crop, and this center of diversity could also serve as a center of diversity for host plant resistance to anthracnose. As a result, searching for potential sources of resistance and breeding for disease resistance are important tasks for researchers working to develop effective and long lasting methods of controlling anthracnose.

In southern Ethiopia, for example, significant variation in the response of 56 *Sorghum* accessions collected from different regions of Ethiopia showed significantly lower disease levels compared to susceptible checks, indicating that germplasm from Ethiopia may be useful sources of anthracnose resistance [15]. Similarly, Erpelding discovered 44 lines developed in the United States from Ethiopian germplasm that had a high frequency of anthracnose resistance this suggest that Ethiopian germplasm could be an important source of anthracnose resistant accessions. Chala, et al., found resistant germplasm in Ethiopia, indicating that Ethiopia is an important source of anthracnose resistance for *Sorghum* improvement. All of these reports indicate that Ethiopian *Sorghum* germplasm has the

potential to serve as a source of resistance in future breeding programs [16].

Covered smut

Among the reported *Sorghum* disease problems, covered smut disease caused by *Sphacelotheca sorghi* is the major bottleneck for Ethiopian *Sorghum* growing areas and requires close attention. Farmers in Nigeria's Sudano-Sahelian savanna recognize covered smut as a major production constraint. For the development of covered smut, an optimal temperature of 25°C and half moisturized soil during planting are more important. The incidence of cover smut varies from place to place, but it is estimated to be between 50% and 100%. The disease is mainly seed borne, with the smut sori breaking during threshing and releasing spores, which adhere to the surface of healthy seeds and remain dormant until the following season [17]. When farmers use farm saved seed without treating it, it promotes the accumulation of seed borne pathogens, which leads to disease outbreaks and spread.

Management

In Ethiopia, most farmers do not have access to clean seed, so they use seed from other farmers or their own savings from the previous cropping season. This has resulted in the spread and accumulation of seed borne diseases such as covered smut and others. Several studies indicate that seed treatment and seed dressing of *Sorghum* seed with various types of fungicide is an effective method to control seed borne disease [18].

RESULTS AND DISCUSSION

Grain mold

Grain mold is still one of the most common and serious diseases affecting *Sorghum* grain and quality, particularly in areas with high humidity and temperatures during grain development. Grain mold is defined broadly as a fungal component of pre-harvest grain deterioration caused by parasitic and/or saprophytic plant colonization. An alternative definition limits grain mold to infection and colonization of the spikelet tissue prior to grain maturity, excluding fungal damage after physiological maturity. All fungal associations with *Sorghum* spikelet tissue that occur between anthesis and harvest have an impact on grain quality and quantity, so a broader definition may better explain the damage from a practical standpoint. Regardless, grain mold is caused by multiple fungal pathogens and reduces yield and grain quality [19]. Yield reductions are caused by caryopsis abortion, reduced seed filling, and lower grain density, whereas seed quality and market value are affected by surface discoloration, embryo and endosperm deterioration, and contamination by toxigenic fungi and their mycotoxins. Mold affected grains have significantly reduced processing qualities and cannot be used for food. Grain mold is extremely damaging to the quality of *Sorghum* based foods, so resistance is a major consideration.

Management

The use of resistant genotypes is considered to be the most feasible means to mitigate *Sorghum* grain damage by grain mold in a climate favorable for fungal invasion and subsequent mycotoxin contamination. But cultural and chemical control methods are also management options.

Covered kernel smut

Covered kernel smut *Sphacelotheca sorghi* (Link) Clinton (syn. *Sporisorium sorghi*) is the most common seed borne disease of *Sorghum*. It is highly found in areas like Sheraro, Northwestern Tigray, in Northern Ethiopia, where untreated seed is sown. Field survey results in *Sorghum* growing areas in the Northwest, Northeast, Southwest, Eastern Ethiopia, and Tigray regions revealed that covered kernel smut is one of the major *Sorghum* diseases in the country. In similar studies, Teklay, et al., found that the two smut types (covered and loose smuts) had a combined prevalence of 37% in the southern Tigray Region, with incidence ranging from 0% to 5% and severity ranging from 20% to 100%. Traditional farmers' practices of using unclean and chemically untreated seeds are largely responsible for the continued occurrence of *Sorghum* smuts in the region.

Management

Several promising alternative options for managing covered kernel smut have been identified and recommended. Although treating seeds with cow or goat urine, bio-pesticide (using plant derivatives), and the use of synthetic seed treatment chemicals had profound effects, none of them were widely adopted to have an impact on disease management. Farmers most likely lack relevant information, or extension services may not have adequately addressed farmers' needs. Nonetheless, none of the management options mentioned above exist to address the covered kernel smut problem in Ethiopia, such as in Sheraro, Northwestern Tigray, and Northern Ethiopia. Notably, farmers frequently use all available varieties without seed treatment, resulting in significant losses.

Turcicum leaf blight

Among fungal diseases, *Turcicum* Leaf Blight (TLB) caused by *Exserohilum turcicum* (synonyms: *Helminthosprium turcicum* (pass.) is one of the most economically important fungal diseases in *Sorghum* producing countries around the world, including Ethiopia. The disease is widely distributed and problematic in both extensive and subsistence *Sorghum* producing communities in the producing countries of the world. The disease is widely distributed and problematic in both extensive and subsistence *Sorghum* producing communities in the producing countries of the world. In Ethiopia as well as the study areas, *Sorghum* is dominantly produced under mono cropping systems year after year. The disease epidemic's development is favored by high precipitation and relative humidity, mild temperatures (20°C to 28°C), and the existence of huge amounts of inocula. However, severe epidemic development can arise, even under suboptimal conditions, where highly pathogenic TLB strains infect vulnerable host genotypes. In this situation, the disease

can cause significant yield losses in *Sorghum* production [20]. In addition, loss of yield due to TLB in *Sorghum* may be noteworthy depending on the severity and host susceptibility, together with the time of disease onset. Yield loss due to TLB of *Sorghum* was not estimated in the study areas as well as in the country (Ethiopia). However, yield losses of 50% to 70% have been reported elsewhere on highly susceptible *Sorghum* genotypes for TLB. To this end, effective TLB management alternatives should be focused on the pathosystem elements.

Management

Efforts have been made to characterize TLB epidemic development in order to provide needed information for designing and developing better disease management strategies, as summarized by Ramathani MB and Mayada MB. TLB management strategies have included the use of high quality or disease free seeds, the removal of infected debris and residues, the cultivation of resistant genotypes, crop rotations, and fungicide applications as seed treatments and foliar sprays. The most beneficial way for TLB management is the development and use of resistant *Sorghum* genotypes with the help of good agricultural practices. As a result, when combined with appropriate agronomic practices, the development and deployment of resistant genotypes is the most cost-effective means of managing TLB. However, few efforts have been made to manage TLB disease in maize crops using resistance genotypes. However, no resistance breeding research in *Sorghum* genotype improvement has been done so far for TLB under Ethiopian.

CONCLUSION

Sorghum bicolor (L) Moench is an important food security crop grown by smallholder farmers in Sub-Saharan Africa (SSA), including Ethiopia. Abiotic and biotic factors, as well as socioeconomic constraints, all have a significant effect on potential *Sorghum* production. Diseases are major biotic impediments to *Sorghum* yield and quality losses. Management options include biological, cultural, chemical, and disease-resistant genotypes. However, among the *Sorghum* disease management strategies, using disease resistant *Sorghum* genotypes is the most effective.

ACKNOWLEDGMENT

I would like to thank my institution, the Ethiopian institute of agricultural research, and the national agricultural biotechnology research center.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

REFERENCES

1. Teferi TA, Wubshet ML. Prevalence and intensity of economically important fungal diseases of *Sorghum* in South Tigray, Ethiopia. J Plant Sci. 2015;3(2):92-98.
2. Abreha KB, Ortiz R, Carlsson AS, Geleta M. Understanding the *Sorghum-Colletotrichum sublineola* interactions for enhanced host resistance. Front Plant Sci. 2021;12:641969.
3. Chala A, Tronsmo AM. Evaluation of Ethiopian *Sorghum* accessions for resistance against *Colletotrichum sublineolum*. Eur J Plant Pathol. 2012;132:179-189.
4. Aschalew S, Fekede A, Kedir W. Evaluation of three potential botanicals against Sorghum covered smut (*Sphacelotheca sorghi*) at Bako, Western Oromia Ethiopia. Afr Plant Sci. 2012;6(8):226-231.
5. Sajjan AS, Patil BB, Jamadar MM, Patil SB. Management of grain smut in seed production of rabi *Sorghum bicolor* (L.) moench. A review. Agric Rev. 2011;32(3):202-208.
6. Binyam T, Girma A, Fikre L. Distribution and importance of *Sorghum* anthracnose (*Colletotrichum sublineolum*) in Southwestern and Western Ethiopia. Plant Pathol J. 2016;15(3):75-85.
7. Chala A, Prom LK, Tronsmo A. Effect of host genotypes and weather variables on the severity and temporal dynamics of *Sorghum* anthracnose in Ethiopia. Plant Pathol J. 2010;9(1):39-46.
8. Chala A, Brurberg MB, Tronsmo AM. Incidence and severity of *Sorghum* anthracnose in Ethiopia. Plant Pathol J. 2010;9(1):23-30.
9. Crouch JA, Beirn LA. Anthracnose of cereals and grasses. Fungal Divers. 2009;39:19-44.
10. Cuevas HE, Prom LK, Cooper EA, Knoll JE, Ni X. Genome-wide association mapping of anthracnose (*Colletotrichum sublineolum*) resistance in the us *Sorghum* association panel. The plant genome. 2018;11(2).2879-2885.
11. Debela M, Dejene M, Abera W. Management of *Turcicum* leaf blight *Exserohilum turcicum* (pass.) leonard suggs of maize (*Zea mays* L.) through integration of host resistance and fungicide at Bako, Western Ethiopia. Afr J Plant Sci. 2017;11(1):6-22.
12. Weerasooriya DK, Maulana FR, Bandara AY, Tirfessa A, Ayana A, Mengistu G, et al. Genetic diversity and population structure among *Sorghum* (*Sorghum bicolor*, L.) germplasm collections from Western Ethiopia. Afr J Biotechnol. 2016;15(23):1147-1158.
13. Ekeleme F, Kamara AY, Omoigui LO, Chikoye D, Dugje IY, Tegbaru A. Effect of sowing date on striga infestation and yield of *Sorghum* (*Sorghum bicolor* L. Moench) cultivars in the Sudan savanna of Northeast Nigeria. Afr J Agric Res. 2011;6(14):3240-3246.
14. Erpelding JE, Prom LK. Variation for anthracnose resistance within the *Sorghum* germplasm collection from Mozambique, Africa. Plant Pathol J. 2006;5:28-34.
15. Erpelding JE, Prom LK. Response to anthracnose infection for a subset of Ethiopian *Sorghum* germplasm. J Agric Univ Puerto Rico. 2009;93:195-206.
16. Gebeyehu C, Bulti T, Dagnachew L, Kebede D. Additive Main effect and Multiplicative Interactions (AMMI) and regression analysis in *Sorghum bicolor* (L) moench varieties. J Appl Biosci. 2019;136:13877-13886.
17. Tegegne G, Pretorius JC, Swart WJ. Antifungal properties of *Agapanthus africanus* L. extracts against plant pathogens. Crop Prot. 2008;27(7):1052-1060.
18. Aragaw G, Chala A, Terefe H. Spatial distribution and association of factors influencing *Sorghum* anthracnose (*Colletotrichum sublineolum*) epidemics in Eastern Ethiopia. Int J Pest Manag. 2021;67(1):20-31.
19. Hennessy GG, de Milliano WA, McLaren CG. Influence of primary weather variables on *Sorghum* leaf blight severity in Southern Africa. Phytopathol. 1990;80(10):943-945.
20. Hooda KS, Khokhar MK, Shekhar M, Karjagi CG, Kumar B, Mallikarjuna N, et al. *Turcicum* leaf blight sustainable management of a re-emerging maize disease. J Plant Dis Prot. 2017;124:101-113.