International Journal of Advanced Research in Biological Sciences
ISSN: 2348-8069
www.ijarbs.com
(A Peer Reviewed, Referred, Indexed and Open Access Journal)
DOI: 10.22192/ijarbs Coden: IJARQG (USA) Volume 13, Issue 5-2026

Research Article

DOI: http://dx.doi.org/10.22192/ijarbs.2026.13.05.007

Prevalence and incidence of sorghum anthracnose in farmers' fields in South-central of Niger

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Abstract

Among the most important cereals in Niger, sorghum (Sorghum bicolor) ranks second after millet and is used primarily as a staple food and fodder. However, its production is hampered by a number of constraints, including anthracnose, a leaf disease of sorghum that is found in all sorghum-producing areas of Niger. The aim of this study is to assess the incidence and prevalence of this disease in smallholder fields across Niger's three sorghum-producing regions. The study was carried out during the 2022 wet season, when the sorghum was at the maturity stage. The sampling method involved randomly selecting, every ten to thirty (10 to 30) km along the national road (RN1) and secondary roads, a sorghum field of at least 1 ha in area. Within this field, five (5) small sub-plots of 12 square metres each were marked out, comprising one plot in the centre and one plot in each of the four (4) corners of the field. Following the demarcation, data on the incidence and prevalence of the disease were recorded. A total of 51 smallholder fields were surveyed. With a prevalence of 100%, the incidence of this disease ranges from 12.5% to 100%, with an average of 93.83%.

Keywords: Sorghum, disease, leaf, Niger.

Introduction

Sorghum (*Sorghum bicolor* (L.) Moench.) is a cereal that plays a key role in cropping systems in general and, in particular, in the diets of many countries in sub-Saharan Africa, where millions of people depend on it (Karimou et al., 2023). It is grown primarily for its grains, which are used for human consumption in the form of couscous, a dough known as 'tôt', porridge, etc. The grains can also be fermented to produce alcoholic beverages. The chaff and stalks of sorghum are used for animal feed or as fuel or building material (Ahmadi et al., 2002). In addition, there are other industrial and artisanal uses for sorghum, such as paper, starch, anddye, more recently, as a source of biofuel (Upadhyaya et al., 2017).More demanding than millet, sorghum is a drought-tolerant cereal that can survive in harsh environmental conditions (Ahmadi et al., 2002; Ignacimuthu and Premkumar, 2014). With a production of 1,700,908 tonnes from an area of 3,535,264 ha in 2023, sorghum is the second most widely grown cereal in Niger after millet (MA/EL, 2024). Its low yield of around 481 kg/ha (MA/EL, 2024) compares with the global average yield of 1,408 kg/ha (FAO, 2019). This low sorghum yield in Niger can be attributed to several factors, such as weather conditions, the limited use of improved varieties, the use of local varieties, the limited use of fertilisers, and pests and diseases (Kadi Kadi et al., 2005).As regards sorghum diseases in Niger, there are around twenty such diseases, caused mainly by fungi, bacteria and viruses, some of which can result in yield losses of up to 100% in susceptible varieties (Prom et al., 2020). Anthracnose is one such disease that causes significant damage. It is found in all sorghum-producing regions of Niger. This study, conducted during the 2022 winter season, aims to investigate this sorghum leaf disease caused by *Colletotrichum sublineola* in smallholder fields in the Tahoua, Maradi and Zinder regions of Niger. Specifically, the aim is to assess the incidence and prevalence of this disease in randomly selected smallholder fields.

Materials and Methods

The study was conducted in the Tahoua, Maradi and Zinder regions, which constitute the main sorghum-producing regions in Niger. These regions are characterised by two main agro-ecological zones: the Sahelo-Sudanian zone in the south and the Sahelian zone in the north. The soil type is predominantly tropical ferruginous. During the rainy season from June to September, the maximum and minimum temperatures for the regions covered by this study are 33°C and 24°C for the Tahoua region, 28°C and 23°C for the Maradi region, and 40°C and 15°C for the Zinder region (MA/EL, 2019).

Fifty-one (51) smallholder fields were surveyed at the stage of physiological maturity, including 13 in the Tahoua region, 20 in the Maradi region and 18 in the Zinder region. These fields were selected at random. Thus, along national roads (National Road No. 1 and secondary and tertiary roads), stops were made at intervals of 10 km in areas of high sorghum production, and 30 to 50 km in other areas. At each stop, a randomly selected sorghum field was surveyed. The geographical coordinates, as well as the prevalence and incidence of anthracnose, were recorded. In each field, five sample plots were marked out, comprising four plots at the corners of the field and one in the centre (Rao et al., 2007; Karimou et al., 2023). Each sample plot consists of 12 sorghum plants (Figure 1).

Data entry, the calculation of incidence and prevalence, and the creation of figures were carried out using Microsoft Excel 2014. The prevalence of the disease is the percentage of sample plots containing at least one sorghum plant affected by the disease. It is calculated using the formula below:

$$\text{Prévalence rate (\%)} = \frac{\text{Number of fields showing symptoms of the disease}}{\text{Total number of fields observed}} \times 100$$

Similarly, the incidence of the disease is the percentage of sorghum plants affected by it. It is calculated using the formula below:

$$\text{Incidence (\%)} = \frac{\text{Number of spots showing symptoms of the disease}}{\text{Total number of spots observed}} \times 100$$

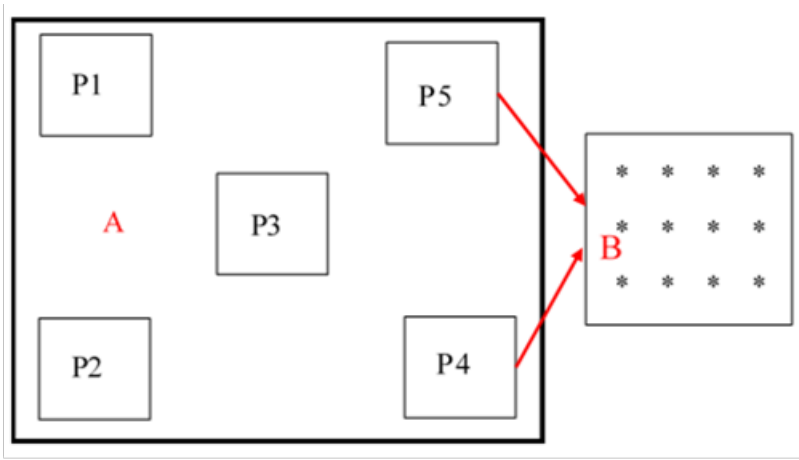

Figure 1: Diagram of a sorghum field surveyed on a smallholder farm: (A) = sorghum field; P1 to P5 = test plots; (B) = test plot comprising 12 sorghum plants.

Data entry, the calculation of incidence and prevalence, and the creation of the figures were carried out using Microsoft Excel 2014.

Results

During this study, fifty-one (51) smallholder fields were surveyed. Figure 2 below shows a map of the area surveyed for anthracnose in the three regions. The majority of the fields surveyed are planted with local varieties; a few are planted with improved varieties from the National Institute for Agricultural Research of Niger (INRAN). The cropping systems used by farmers generally consist of single crops and mixtures such as 'millet-sorghum-cowpea', 'sorghum-groundnut', 'sorghum-cowpea', etc. (Figure 3).

Figure 2: Anthracnose survey area in the three regions

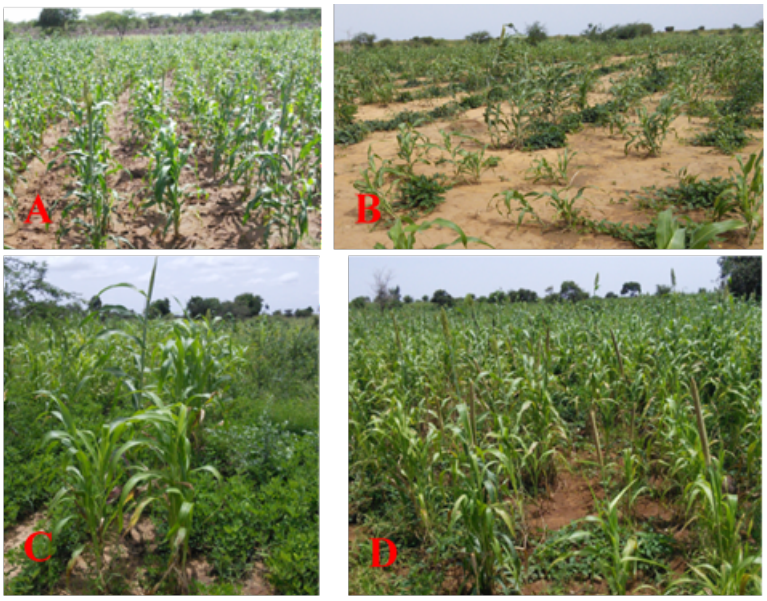

Figure 3: Different types of sorghum cropping systems in Niger; (A) = sorghum monoculture; (B) = sorghum-cowpea intercropping; (C) = sorghum-groundnut intercropping; (D) = millet-sorghum-cowpea intercropping.

The results regarding the incidence of sorghum anthracnose are shown in Table 1. It ranges from 12.5% in a field in the village of Bayan Doutchi in the Tahoua region to 100% in 38 fields, of which 45% are located in the Zinder region, 37% in the Maradi region and 18% in the Tahoua region, with an average of 93.83%. Among the fields surveyed, 74.5% have a 100% incidence of anthracnose; 15.68% of these fields have an incidence of the disease between 80% and 98%; 5.88% of the fields have an incidence between 70% and 76%; 3.92% of the fields have an incidence of anthracnose ranging from 12.5% to 33%.The assessment of the incidence of anthracnose enabled the surveyed fields to be classified into four groups. Group I comprises 90% of the surveyed fields, where the varieties found are highly susceptible (HS) to anthracnose; Group II comprises 6% of the surveyed fields, where the varieties found are susceptible (S) to anthracnose; Groups III and IV, each comprising 2% of the surveyed fields, where the varieties found in these fields exhibit moderate susceptibility (MS) to anthracnose, and 2% of the surveyed fields, where the varieties found in these fields exhibit moderate resistance (MR) to the disease (Figure 4).

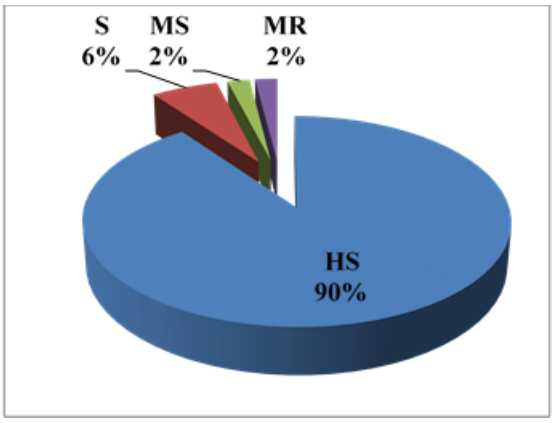

Figure 4: Response of the genotypes encountered in the surveyed fields to infection with sorghum anthracnose;
NB: (MR) = moderately resistant; (MS) = moderately susceptible; and (HS) = highly susceptible.

Table 1: Incidence (%) of sorghum anthracnose observed on smallholder farms in the Tahoua, Maradi and Zinder regions of Niger

Locations	Incidence	Locations	Incidence
Madarounfa	100	Kantché	100
Ajié Kwariya	100	Konni	100
Baban Kwari	100	Afarum	100
Guida Tanko Garkoua	100	Aguié	100
Iyyataoua	100	Angoual Tchida	100
Koudoumawa	100	Awiwi	100
Kouguéri 1	100	Babul 1	100
Kouguéri 2	100	Dan Gamji	100
Takeita	100	Dan Kada	100
Sabon Layi	83,33	Doguéraoua	100
Magéma	100	Gabawiri	100
Toudoun Agwa2	100	Garin Sassar	100
Koura Mota/Maradi	98,33	Guidan Karo	100
Babul 2	100	Janroua	100
Kangna	100	Korgom	100
Chazamaliya 2	70	Kwari Dawa	100
Acha Bissa	100	Mai Sassagué	100
Aroungouza	100	Zabré	100
Sabon Guida	100	Kadata	96,67
Toudoun Agwa1	98,57	Dirba	85
Dan Turké	100	Koura Mota Tchadoua	83,33
El Kadangna	100	Matamèye	80
Gadé Iyya	100	Dodo	76,41
Guidan Faji	100	Maradi ouest	98,33
Tounfafi	70	Bayan Doutchi	12,5
Chazamaliya 1	33	**Overall average**	**93,83**

Discussion

Sorghum (Sorghum bicolor) plays a vital role in the daily survival of hundreds of millions of people in West Africa in general, and particularly the people of Niger and their livestock. However, the cultivation of this cereal is hampered by biotic and abiotic stresses, including climate change, which likely influences diseases caused by fungal, bacterial and viral microorganisms (Prom et al, 2020). This study was undertaken due to a lack of information on sorghum diseases, particularly anthracnose, in Niger. It showed that anthracnose is present in all the fields surveyed, with varying levels of infestation. These results confirm those of Prom et al. (2020), who reported the presence of sorghum anthracnose in 99% of sorghum production fields in Niger. This study is consistent with that of Bonzi (2013), who highlighted the presence of the genus Colletotrichum among the fungal species most frequently observed on sorghum seeds during a study of the prevalence of *Phoma sorghina* in sorghum seeds and wild Poaceae in Burkina Faso.In this study, the average incidence of this disease by region ranges from 82.35% in the Tahoua region to 98.57% in the Zinder region, slightly higher than the Maradi region, which has an average of 97.24%. These results demonstrate the extent to which this disease is widespread in Niger's sorghum-producing areas; this confirms the findings of Thakur et al. (2007), who classify anthracnose among the sorghum diseases that are economically significant in semi-arid tropical

zones. An assessment of the incidence of anthracnose in the surveyed fields revealed variability between fields in terms of susceptibility or resistance to this disease. This variability may be linked either to the different varieties grown in the surveyed fields, and/or to the different locations surveyed. This study highlighted the significance of anthracnose in Niger. These results confirm those of Ahmadi et al. (2002), who emphasised the importance of anthracnose among the biotic constraints affecting sorghum cultivation in sorghum-producing areas. They confirm those of Kassankogno et al. (2022), who demonstrated variability among sorghum genotypes comprising 11 hybrids and 3 lines, tested under natural infestation; likewise, they confirm those of Blaise et al. (1999), who highlighted a significant difference in disease pressure between locations in an experiment on cultural control of sorghum leaf anthracnose.

Conclusion

This study complements other research carried out in Niger on sorghum diseases; it provides researchers working on sorghum, funding bodies and the government with a guide to the incidence and 'hotspots' (fields and locations with an incidence of over 50%) where this disease can be assessed to identify sources of resistance. The study revealed that sorghum anthracnose is present in all smallholder fields in the Tahoua, Maradi and Zinder regions, with infection rates varying from one locality to another.

Acknowledgments

The authors would like to thank all the sorghum farmers in the Maradi region, whose fields were surveyed, for their cooperation in ensuring the success of this study

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DOI:10.22192/ijarbs.2026.13.05.007

How to cite this article:
Issa KARIMOU, Hayyo HALILOU, Halilou OUMAROU, Abdoulmadjid HAMIDOU DJINGAREY. (2026). Prevalence and incidence of sorghum anthracnose in farmers' fields in South-central of Niger. Int. J. Adv. Res. Biol. Sci. 13(5): 68-74.
DOI: http://dx.doi.org/10.22192/ijarbs.2026.13.05.007