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Occurrence And Distribution of Sorghum Smuts in the Field's Producer in the South-Eastern Regions of Niger

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Abstract

In Niger, sorghum ranks second among the most important cereals after millet and is used mainly as a staple food and fodder. In 2019, a survey on the occurrence and distribution of smuts affecting sorghum in farmers' fields in the regions of Tahoua, Maradi and Zinder was carried out. During this survey, 32 fields of producers along national and secondary roads were surveyed. In each field, 5 elementary plots are materialized including 4 plots at the corners of the field and one plot in the center. Each elementary plot is made up of 12 pockets of sorghum. The study listed 4 types of sorghum smuts namely long smut, covered smut, loose smut and panicle smut. Long smut was the most common. The highest average incidence of long smut was recorded in Tahoua, while the Maradi region had the highest average incidence of covered smut. The highest incidence of panicle smut was recorded in farmer' fields in the Zinder region.

Keywords: Survey, smut, panicle, Sorghum, Niger

1. INTRODUCTION

Sorghum (*Sorghum bicolor* (L.) Moench.) is an important cereal in cropping systems and diets in many Sub-Saharan African countries, where millions of people depend on it (Frederiksen and Odvody, 2000; Abdou *et al*., 2014). It is grown mainly for its grain intended for human consumption in the form of couscous, tô, porridge, etc. The grain can also be fermented into alcoholic beverages. Sorghum stubble and stalks are used for animal feed or as fuel or construction material (Ahmadi *et al*., 2002). Added to this are other industrial or artisanal uses of sorghum, such as paper, starch, dye and recently as a source of biofuel (Gonzalez *et al*., 2011; Upadhyaya *et al*., 2017). Compared to maize, sorghum is drought resistant and can survive harsh environmental conditions, but more demanding than millet (Ahmadi *et al*., 2002; Rooney *et al*., 2007; Ignacimuthu and Premkumar, 2014). With a production of 2,132,295 tons over an area of 3,672,164 ha in 2020, sorghum is the second cereal grown in Niger after millet (Statistics Department, 2021). Its yield is low, 581 Kg.ha-1 compared to the world average yield of 1408 Kg.ha-1 (Prom and *al.*, 2020). This low yield of sorghum in Niger can be attributed to several factors such as weather conditions, low use of improved varieties, use of local varieties, low use of fertilizers, pests and diseases (Kadi Kadi *et al*, 2005; Prom *et al.*, 2020). Regarding diseases, some fungal diseases can cause yield losses of up to 100% on susceptible lines (Prom *et al.*, 2011; Cuevas *et al.*, 2016). This study was conducted to investigate the occurrence and distribution of sorghum smuts in farmers' fields in the three regions of Niger.

2. MATERIAL AND METHODS

The study was conducted in the regions of Tahoua, Maradi and Zinder constituting 3 of the 5 main sorghum production regions in Niger. Two main agro-ecological zones characterize these regions: the Sahelo-Sudanian zone in the South and the Sahelian zone in the North. The soil type is mainly tropical ferruginous. In 2020, the maximum and minimum temperatures for the three regions were

33°C and 24°C in Tahoua, 28°C and 23°C in Maradi and 40°C and 15°C in Zinder (Statistics Department, 2021). Thirty-two (32) peasant fields were surveyed at the stage of physiological maturity, including 13 in the Tahoua region, 15 in Maradi and 4 in Zinder. Along the roads, stops were made at intervals of 10 km in areas of major sorghum production, and 30 to 50 km in other areas. At each stop, a field of sorghum, chosen at random, is surveyed. Table 1 presents the coordinates of the prospected fields.

Table 1: Coordinates of prospected fields

Locations	Latitude	Longitude
Guidan Faji	13°57'20,7"	06°06'32"
Magaria Tacha Kaji	14°01'28,2"	05°49'06,8"
Bazaga	14°01'28,2"	05°49'06,8"
Hagnar Sarki	13°50'38"	05°50'36,2"
Jiko	13°46'52,6"	05°01'05,4"
Guidan Boutou	14°02'21,0"	05°19'48,1"
Tacha Illias	14°15'10,4"	05°21'38,2"
Moujia	14°23'01,8"	05°22'22,7"
Guidan Daouda	14°21'55,9"	05°19'11"
Tamaské	14°46'38"	05°39'18,6"
Gorango	14°44'45,5"	05°42'52,8"
Boulayya	14°11'37,5"	05°49'22,5"
Madaoua	14°03'37,9"	05°58'24,3"
Voyage	13°47'15,6"	06°26'14,9"
Karo Saboua	13°38'13,6"	06°28'18,6"
Dan Gao	13°40'12,0"	06°48'20,4"
Kadata	13°38'10,9"	07°03'13,0"
Guidan Karo	13°42'05,2"	06°33'6,0"
Jaja	13°50'50,3"	06°58'22,9"
Kura Mota	14°09'31,2"	06°52'48,0"
Birnin Lallé	14°24'53,1"	06°46'17,7"
Dan Toumbi	13°33'05,2"	07°35'20,3"
Maradi	13°28'19,4"	07°05'45,5"
Garin Mahaman	13°25'37"	06°59'55,7"
Guidan Bouzayé	13°28'20,5"	06°54'25,2"
Mountarou Barmo	13°35'39,4"	07°04'24,2"
Sarkin Diya	13°38'50,31"	07°06'15,9"
Karin Kapini	13°42'44,6"	07°08'15,4"
Kangna Mamam	13°44'22,8"	09°05'00,6"
Aroungouza	14°01'39,5"	08°57'10,4"
Dakwara	14°11'50,2"	08°50'09,1"
Bakin Birji	14°14'11,2"	08°48'07,1"

The prevalence and incidence of sorghum smuts namely extended smut, covered smut, loose smut and panicle smut are assessed. In each field, 5 elementary plots are materialized including 4 plots at the corners of the field and one plot in the center (RAO *et al.*, 2007). Each elementary plot is made up of 12 pockets of sorghum. The prevalence of a given smut is the percentage of elementary plots

that have at least one sorghum plant attacked by this smut. It is calculated by the formula below (Equation 1) :

$$(1)\ \text{Prevalence rate} = \frac{\text{Number of observation squares with symptoms of the disease}}{\text{Total number of observed squares}} \text{x}100$$

While the incidence is the percentage of sorghum plants attacked. It is calculated by the formula below (Equation 2) :

$$(2)\ \text{Incidence} = \frac{\text{Number of plants with diseases}}{\text{Total number of plants}} \text{x}100$$

2. Results and Discussion

2.1. Results

During this study, most of the prospected fields were sown with different local varieties. However, with few exceptions, there are fields sown with improved varieties from the National Institute of Agronomic Research of Niger (INRAN) or the International Institute of Research on Crops in Semi-Arid Tropical Zones (ICRISAT). In the regions surveyed, the majority of production systems used by producers were sole crops of sorghum and associated crops. Among the associations, we most often find associations of millet-sorghum, millet-sorghum-cowpea, sorghum-peanut, sorghum-sesame (Figure 1).

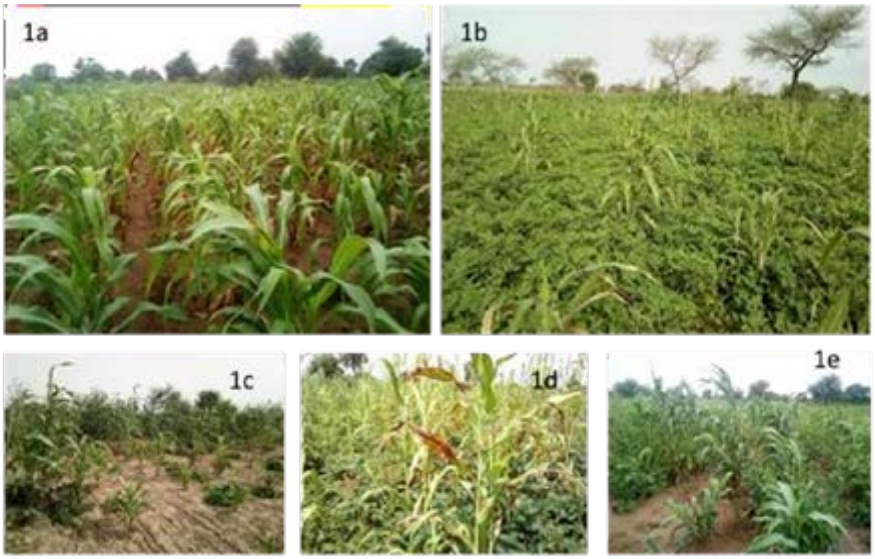

Figure 1 : 1a. Pure sorghum ; 1b. Sorghum-peanut association ; 1c. Sorghum-cowpea association ; 1d. Millet-sorghum-cowpea association ; 1e. Sorghum-sesame association

Four types of smut were encountered in all the prospected fields. They are long smut caused by *Sporisorium ehrenbergii* (Vánky), covered smut caused by *Sporisorium sorghi*, loose smut caused by *Sporisorium cruentum* [(Kühn) Potter] and panicle smut caused by *Sporisorium reilianum* (Kühn). Figure 2 presents these different smuts.

Figure 2 : (a) Healthy panicle ; (b) Long smut ; (c) Covered smut ; (d) Loose smut ; (e) Panicle smut

Long smut was found in the 32 fields surveyed, which represents a prevalence of 100%. It is followed by panicle smut (56.62%), covered smut (54.62%) and loose smut 31.41% (Table 2). Maradi Region recorded the highest prevalence of covered smut (60%), followed by Tahoua and Zinder with 53.85% and 50% respectively. The highest prevalence of panicle smut (75%) was recorded in Zinder Region, followed by Tahoua and Maradi with 61.54% and 33.33% respectively. For loose smut, the Tahoua Region recorded the highest prevalence (69.23%) followed by Zinder (31.41%). No loose smut symptoms were observed in Maradi region during this study (Table 2).

Table 2: Prevalence (%) of the 4 sorghum smuts in the three regions

Type of smut	Régions			Average
	Tahoua	Maradi	Zinder	
Long smut	100	100	100	100
Covered smut	53,85	60	50	54,62
Loose smut	69,23	0	25	31,41
Panicle smut	61,54	33,33	75	56,62

Present in all the prospected fields, long smut has the highest incidence. Indeed, for all three regions, the average incidence of long smut is 19.06%. It is followed by panicle smut, covered smut and loose smut with an average incidence of 8.88%, 4.38% and 2.44% respectively (Table 3). The highest average incidence of long smut (38.10%) was recorded in the Tahoua Region, followed by the Maradi Regions with an incidence of 13.67%.For panicle smut, the highest incidence was recorded in the Zinder Region (19.17%). The incidence of covered and loose smut recorded in the three Regions is less than 10% (Table 3).

Table 3: Incidence (%) of the 4 sorghum smuts in the three regions

Type of smut	Régions			Average
	Tahoua	Maradi	Zinder	
Long smut	38,1	13,67	5,42	19,06
Covered smut	3,7	6,11	3,33	4,38
Loose smut	6,48	0	0,83	2,44
Panicle smut	4,37	3,11	19,17	8,88

The field most infested by long smut is in the locality of Tacha Illias with an incidence of 78.33%, followed by the fields of Bazaga and Jiko with an incidence of 76.67% and 60% respectively (Table 4). For panicle smut, the most infested field is in the locality of Bakin Birji with an incidence of 66.67%, followed by the fields of Jiko and Garin Mahamane with an incidence of 28.33% and 26.67% respectively. (Table 4). For covered smut and loose smut, the most infested fields are respectively in the localities of Kadata and Madaoua with an incidence of 31.67% and 25% respectively (Table 4).

Table 4: Localities with an incidence greater than 50% for long smut and greater than or equal to 25% for covered smut, loose smut and panicle smut

Type of smut	**Location**	**Incidence (%)**
Long smut	Bazaga	76,67
	Jiko	60
	Tacha Illias	78,33
Covered	Kadata	31,67
Loosesmut	Madaoua	25
Paniclesmut	Jiko	28,33
	GuidanMahaman	26,67
	Bakin Birji	66,67

2.2. Discussion

At the end of this survey, the prevalence of long smut was 100%, covered smut 54.62%, that of loose smut 31.41% and panicle smut 56.62% in the surveyed areas. Teferi and Wubshet (2015) reported a long smut prevalence of 88.6%, a cumulative covered and loose smut prevalence of 35% in southern Tigray, Ethiopia. In each of the regions surveyed, the prevalence of long smut was 100%. The highest prevalence of panicle smut was recorded in Zinder (75%), covered smut in Maradi (60%) and loose smut in Tahoua (69.23%). These results are similar to those of Ngugi *et al*., (2002) who recorded a prevalence of 75% panicle smut, 42% covered smut and 24% loose smut in farmers' fields in western Kenya.

The a verage incidence of smut was relatively low in the study areas. The region of Tahoua recorded the highest incidence of long smut (38.1%) and loose smut (6.48%), while Maradi and Zinder presented the incidence of covered smut (6.11%) and panicle smut (19.17%) the highest respectively. Prom *et al.*, (2020), reported an average incidence of long smut of 28% in Tahoua, 24% in Dosso and 20% in Tillabéri in sorghum production fields in Niger. In the Sahelian zone, Pande *et al*. (1993), noted an incidence of long smut of more than 20%, a cumulative incidence of covered and loose smut of 1 to 10% in the Sahel and in the northern Sudanian and southern zones from Guinea. Similarly Gwary *et al.*, (2007), found low incidences of sorghum smuts in Maiduguri State in Nigeria ranging from 8.80 to 11.65%. Low incidences of loose smut (14.43%) were also found in Nigeria by Kutama *et al*., (2011). Within the regions, the highest incidence of long smut

(78.33%) was found in Tacha Illias locality and loose smut (28.33%) in Jiko locality in region of Tahoua. On the other hand, Kadata in Maradi region and Bakin Birji in Zinder respectively recorded the highest incidence of covered smut (31.67%) and panicle smut (66.67%). Similar to this study, Naqvi (2013) found incidences of covered smut ranging from 7.59 to 38.60% in farmers' fields in Hamelmalo sub-zone, Eritrea. The study by Yalew *et al*,. (2019) carried out in Sheraro, North-West of Tigray and North Ethiopia on the effectiveness of botanical treatments on sorghum covered smut showed an incidence of 30.30%. In this study, zero prevalence and zero incidence of loose anthrax was noted in Maradi region.

3. CONCLUSION

The south-eastern part of Niger is one of the areas where sorghum production is very important. Sorghum smuts, which are four in number (long smut, covered smut, loose smut and panicle smut), being one of the major constraints to sorghum production in Niger, a study on their occurrence and distribution in farmers' fields from the southeastern regions of this country, will provide scientists with important information in the management of these fungi. In this sense, this study will contribute to the creation of sorghum varieties resistant to these smuts and with high yield. The dissemination of these varieties in rural areas will undoubtedly improve the production of this cereal and thus improve the food security of rural populations who constitute the most vulnerable stratum in the event of food insecurity.

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