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A SURVEY OF SORGHUM DOWNY MILDEW IN SORGHUM IN THE SUDANO-SAHELIAN SAVANNA ZONES OF NIGERIA

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ABSTRACT
An extensive survey was conducted across the 13 states constituting the Sudan and Sahel savanna agro-ecological zones of Nigeria to determine the occurrence and distribution of sorghum downy mildew in sorghum during the 2008 growing season. The survey was conducted at two different stages of the crop development; seedling and dough stage. The first survey was in early July while the second was carried out in late September. Three farmers' fields were critically investigated at every stop on a road system. During the first survey, a total of 97 farmers' fields in 36 locations were investigated while 110 sorghum fields in 37 locations were visited in the second survey. Average incidence (%) of the disease was obtained from a sample of 100 plants selected using simple random sampling technique from each of the three farms visited per stop. Results of the survey (16.20 and 9.64% and 3.28 and 1.16% during the first and second visits in the Sudan and Sahel savanna AEZs respectively) indicated that the disease was present only at the seedling stage and virtually absent at flowering stage .In the areas where it was noticed at the juvenile stage the incidence was more prevalent in the Sudan than in the sahel savanna regions. The results also revealed that there was a relationship between soil type (which was mostly sandy loam) and disease incidence. Disease incidence was relatively higher on sandy loam soil than other soil types. The prevalence was generally low, but efforts should be made towards controlling the spread of the disease further. Farmers should be advised to use improved cultural practices like early sowing, seed dressing with the sole aim of reducing the disease.

Keywords: sorghum downy mildew, incidence, distribution, Sudan and Sahel savanna agro-ecological zones

INTRODUCTION

Sorghum Downy Mildew (SDM) induced by *Peronosclerospora sorghi* (Weston and Uppal) C.G.Shaw is a serious disease of sorghum and maize and causes heavy losses in the grain yield in many parts of the semi-arid tropics where sorghum is staple for human and other animal consumption (Kamala *et al*., 2002). The disease causes economically significant losses in sorghum production in many parts of the world (Jeger *et al.,* 1998). In the southern guinea savanna of Nigeria, loss due to the disease in maize ranges between 40-100% (Anaso *et al*., 1989). In northern Nigeria, sorghum downy mildew in sorghum was first reported in 1962 (Haris, 1962) and on maize in 1970 at Samaru (Kings and Webster, 1970). Jeger *et al*. (1998) demonstrated that the epidemics of *P. sorghi* in Africa appear to be more sporadic than *S. graminicola* causing downy mildew in pearl millet. Downy mildew is a systemic infection that affects both young and mature plants. Young plants may be infected through the shoots by conidia or through roots by soil infesting oospores (Bock, 1995). In regions with distinct dry season and no collateral host, the primary systemic infection will arise from soil-borne oospores (Jeger *et al.,* 1998).

The disease was observed on both sorghum and maize in the Guinea savanna and only on maize in the forest zone (Olanya *et al*., 1993). The disease in the southern part of Nigeria does not seem to infect sorghum even when susceptible varieties were exposed to *P. sorghi (*Anaso *et al.,* 1989). Although the disease appeared to be more severe in maize than sorghum, pockets of its occurrence have been reported in the Sudan savanna agro- ecological zone (Selvaraj, 1979). Kutama *et al*. (2008) have observed a farmer's sorghum field with >45% SDM infection in the Sudan savanna zone during the 2006 rain-fed season, although it might be an isolated case (Anaso pers. com.). Therefore, *P. sorghi* in sorghum can be found in the Sudan and Sahel (dry) savannah zones of northern Nigeria despite the erratic nature of rainfall and other environmental factors as well as the various practices employed. This may be true going by the report of Ikwele *et al.* (1990), and Zarafi and Emechebe (2005) that the occurrence and effect of downy mildew on yield of millet is influenced by genotype, aggressiveness of the pathogen and environmental conditions and or geographical locations since the two pathogens (*S. graminicola* and *P. sorghi*) are very much similar in structure and epidemiological requirements (Tarr, 1962). This connotes that a resistant variety in one region may not be resistant in other geographical settings.

In some areas and seasons, outbreaks of downy mildew of sorghum occurs but in others the disease is virtually absent or although severe on individual plant, does not appear to spread to any marked extent (Jeger *et al*.1998). However, there is paucity of information on the occurrence, distribution and severity of the disease SDM on sorghum in the Sudan and Sahel savanna zone of Nigeria where the bulk of the crop is produced. (Kutama *et al*., 2008). This study was aimed at providing baseline information on the occurrence and distribution of sorghum downy mildew in the Sudan and Sahel savanna zones of Nigeria.

MATERIALS AND METHODS

Study Area

The surveys covered the Sudan and Sahel savanna agro ecological- zones (AEZs) of Nigeria comprising of thirteen states where sorghum is grown in substantial quantity by peasant farmers. The states were Bauchi, Jigawa, Kano, Kaduna, Katsina, Kebbi, Gombe, Taraba, Adamawa, Yobe, Sokoto and Zamfara states belonging to Sudan savanna and Borno state belonging to the Sahel savanna AEZs (Figure 1.).

Field Surveys

Fields surveys were conducted twice during the 2008 rain-fed season. The first survey was conducted in July when most plants were at seedling stage or when most plants were at 1-5 leaves growth stage (Bigirwa *et al.,* 1998). The second survey was conducted at dough stage in late September, when most of the sorghum plants were about to flower or at flowering stage (Ritchie *et al*., 1989; Bigirwa *et al.,* 1998). During the study, farmers' fields were surveyed every 30-35km along accessible roads. At each location or stop, at least three sorghum farms/ fields were inspected, each field serving as a replication. Symptoms (local and systemic) were critically observed from a random sample of 100 plants in each field and the incidence was obtained by adding up the number of symptomatic plants (local and systemic) observed and expressing this as a percentage of total number of plant examined as demonstrated by James (1974) and Chaube and Punder (2005) using the formula;

$$\text{Incidence} = \frac{\text{Total number of diseased plants X100}}{\text{Number of plants examined}}$$

The same farmers' fields were visited in the first and second surveys. Other important parameters recorded during the survey were size of the farm, sorghum variety, soil type, manually determined by squeezing a sample of soil from each field visited, stage of plant development, agronomic status of the farm (whether weeded or weedy, fertilized or not, sole cropped or intercropped), the presence or absence of other diseases or pest attack, and the economic status of the farmers.

During the two visits, neighboring farms were examined at every stop to find out if the crops had any infected plants to reduce chances of missing diseased fields.

Data Analysis

The data obtained in the study were analyzed using Analysis of variance at 5% probability level using GENSTAT computer soft ware by separating the means obtained on the incidence of the disease.

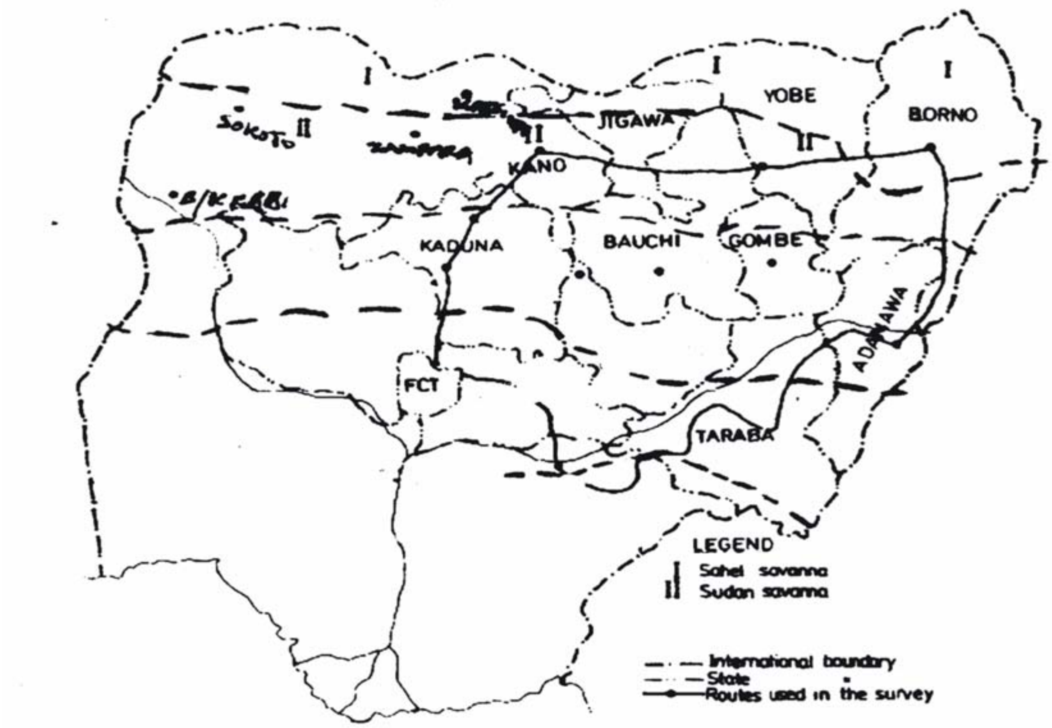

Figure1: Map of Nigeria showing the areas visited during the survey in 2008

RESULTS AND DISCUSSION

Occurrence and distribution of SDM

Downy mildew symptoms in sorghum were observed in some of the farmers' fields surveyed. Local infection symptoms were observed during the first survey, when most plants were at seedling stage. Out of the 36 locations surveyed, 19 locations had infected plants (Table 1) showing chlorosis of leaves, usually resulting from seedling infection by soil-borne oospores. Major symptoms of SDM infection on sorghum at seedling stage was observed in Bauchi, Gombe and Adamawa states. Quite numbers of the infected plants were also recorded in Kano, Borno and Katsina states (Table 2).There was a significant (P>0.05) difference in SDM infection between the different locations with SDM infection on sorghum.

Results for the second visit showed that of the 13 states, the disease was noticed in only two states; Gombe and Adamawa states (Table 2). The symptoms observed during the second survey included stunting, irregular striping of leaves, absence of panicle or panicles without grains, but without shredding and oospores production which is virtually unusual with SDM symptoms in sorghum. The overall prevalence of the disease was generally low (16.20 and 9.64% and 3.28 and 1.16% during the first and second visits in the Sudan and Sahel savanna AEZs respectively) even in areas with the initial symptom (Table 2). This suggests that the disease is of low economic importance as reported by Bigirwa *et al.* (1998) in Kenya. However, the presence of the disease at seedling stage could be a \potential danger to sorghum production in this part of the country in the future once epidemic conditions prevail.

There was significant (P>0.05) difference in the occurrence of the disease in the first and second surveys (Table 1). These wide differences in the disease incidence might be due to variation in inoculum dosage and escape from infection or recovery from symptoms as was suggested for SDM in maize by Olanya and Fajemisin (1992). Studies on symptom remission have shown that infected maize genotypes recover from downy mildew infection produced normal cobs or ears (Olanya and Fajemisin ,1992).

Soil Type, Sorghum Variety and Agronomic Status

The results of the survey have shown that sorghum is grown on sandy loam soils in most (>85%) of the agricultural fields investigated (Table 3) and that it was on very few of the farms that sorghum is cultivated on clay-loam /clay soils. There seemed to be a relationship and or trend between the soil type and the incidence of SDM at seedling stage. Soil type has significant effect on the incidence of sorghum downy mildew in Kenya (Bigirwa *et al.,* 1998) but the reason for this may be obscure. Although most reports gave inconclusive and contradictory information of the effect of nutrition on the incidence of SDM in sorghum, it appears that nitrogen and phosphorus may reduce the incidence of SDM (Williams, 1984). Bonman and Pittiporuchori (1984) found that early planted maize crops in Thailand had reduced levels of maize downy mildew when nitrogen or nitrogen plus phosphorus was applied. This might be true since clay soil contains more of these nutrients (Aliyu and Kutama, 2007).

The results of the survey also indicated that in virtually all the sorghum farms visited in both the Sudan and Sahel savanna zones, 2% of the total sorghum varieties /lines grown were improved varieties. 98% were local varieties which could be categorized into; *Kaura* (yellow/red), *Farfara, Yalai* and *Basharamba*. These varieties were grown using different cropping systems. Results of this survey have shown that 53% of the sorghum fields visited had sorghum planted as a sole crop (Table 3).Hoever. In about 47% of the fields visited, it was observed that sorghum in the two agro ecological zones was intercropped with cowpea, maize, millet, or soybean. This agrees with the report of Zarafi and Emechebe (2005) on pearl millet in Nigeria. Cropping pattern seemed to have a relation with the occurrence and distribution of the disease in the study area. These results, however, do not conform to the results obtained by Olanya *et al*. (1993) on maize who suggested that cropping system did not have any significant effect on the incidence of downy mildew in maize.

Conclusion

The incidence and distribution of Sorghum downy mildew was generally low in sorghum in the two AEZs but was relatively higher at the seedling stage than at later growing stage and in the Sudan savanna than Sahel savanna zones. Although the occurrence is not of a serious magnitude, there is still need to control the situation to avoid what happened in the forest and southern guinea savanna on maize in the 1990s would not be repeated. "Prevention, they say, is always better than cure"

Table 1: Number of locations with SDM symptoms in the Sudan and Sahel savanna AEZs during the 2008 growing season

AEZ	First visit	Number of Locations with SDM	Second visit	Number of Locations with SDM
Sudan	15	8	18	2
Sahel	17	2	18	0.0
Total	**32**	**10**	**36**	**2**
	(p>0.05)			

Table 2: Occurrence (%) of SDM in Sorghum in the states constituting the Sudan and Sahel savanna AEZs. During the 2008 growing season

	Incidence of SDM	
State	First visit[a]	Second visit[b]
Adamawa	18.2	7.3
Sokoto	0.0	0.0
Kano	2.0	0.0
Gombe	11.2	6.0
Taraba	0.5	0.0
Zamfara	0.0	0.0
Katsina	3.8	0.0
Yobe	0.4	0.0
Borno	6.9	0.2
Jigawa	1.6	0.0
Kebbi	0.0	0.0
Kaduna	0.0	0.0
Bauchi	12.2	0.0

a :First visit was done in July,2008

b :Second visit was conducted in September,2008.

Table 3: Soil type, sorghum variety and the agronomic status of locations surveyed for SDM in sorghum in the 2008 growing season.

Location	Soil type	Sorghum variety grown	Agronomic status
Makole	sandy loam	Local	sole cropped
K/Huguma	sandy loam	Local	intercropped with maize
K/babaldo	sandy loam	Local	sole cropped
Ningi	sandy loam	Local	mixed with maize &cowpea
Alkaleri	sandy loam	Local	inter cropped with soybean & millet
Bauchi	sandy loam	Local	intercropped with sorghum &cowpea
Ganjuwa	sandy loam	Local	inter cropped with sorghum
Durun	sandy loam	Local	sole cropped
Natsira	sandy loam	Local	sole cropped
Gombe	sandy loam	Local	inter cropped with cowpea
Dadin kowa	clay loam	Local	sole cropped
Kwaya kusar	sandy loam	Local	sole cropped
Biu	sandy loam	Local	sole cropped
Hawul	sandy loam	Local	sole cropped
Garkida	clay loam	Local	sole cropped
Damaturu	sandy loam	Local	sole cropped
Gujba	sandy loam	Local	sole cropped
Gumbi	clay loam	Local	sole cropped
Song	sandy loam	Local	sole crop
Murke	sandy loam	Local	sole cropped
Yola south	sandy loam	Local	inter cropped with soybean
Demsa/Numan	sandy loam	Local	sole crop
Ungogo	sandy loam	Local	inter cropped with maize
Kanye	sandy loam	Local	inter cropped with millet and cowpea
Dayi	sandy loam	Local	inter cropped with millet
K/Kankara	sandy loam	Local	sole crop
Faskari	sandy loam	Improved	intercropped with maize
Tsafe	sandy loam	Local	sole cropped
Kwatarkwashi	sandy loam	improved	sole cropped
Maru	sandy loam	Local	inter cropped with millet
Danbaza	sandy loam	Local	sole cropped
Lambar bakura	sandy loam	Local	inter cropped with cowpea
Sabon birni	sandy loam	Local	sole cropped
Dange-Shuni	sandy loam	Local	intercropped with millet
Sokoto south	sandy loam	Local	inter cropped with cowpea
Gwandu	sandy loam	Local	sole cropped

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