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STATE OF SORGHUM DOWNY MILDEW IN MAIZE IN THE SUDAN AND SAHEL SAVANNA AGRO-ECOLOGICAL ZONES OF NIGERIA

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ABSTRACT
The incidence, distribution and prevalence of downy mildew in maize were investigated during the 2008 growing season following a planned–two time survey across the Sudan and the Sahel savanna agro-ecological zones of Nigeria. The occurrence of the disease was investigated in 102 and 120 farmers' fields in 34 and 40 locations in the first and second surveys respectively. Average incidence (%) of the disease was obtained from a sample of 100 plants each from three farms per stop; each farm representing a replicate. Simple random sampling technique was employed in the selection of plants. Results of the survey have revealed that 20 out of the 34 locations visited during the first survey had maize with early symptoms of the disease while only 4 out of the 40 locations visited in the second survey was having the symptoms of the disease. The incidence of the disease was 8.20% and 1.12%, in the first and second survey respectively and therefore significantly different (p>0.05) indicating that the disease was more prevalent at seedling than at grain filling stage which is an indication of the absence of certified, sorghum downy mildew (SDM) free seeds in most of the regions surveyed. The incidence was also higher in the Sudan than in the Sahel savanna (16.28% and 3.28% first and second visits respectively). This might be probably because of differences in climate of the two zones and the fact that maize was grown more in the Sudan than in the Sahel savanna zone. Although the incidence was generally low, proper measures should be taken to avoid unexpected epidemic of the disease in the future.

Keywords: maize downy mildew, % incidence, Sudan and Sahel savannah agro-ecological zones

INTRODUCTION

Sorghum downy mildew (SDM) in maize (*Zea mays*) induced by *Peronosclerospora sorghi* is a limiting factor for the production of sorghum and maize in the tropics (Hau *et al*., 1995). The pathogen is known to cause both local and systemic symptoms (Tarr, 1962; Hau *et al*., 1995; Adenle and Cardwell, 2000; Odvody, 2002; Kling *et al*., 1994; Shaarawy *et al.,* 2002) with the latter usually producing higher economic loses. The disease can be spread by various means including air and seed and can also be soil-borne (Kutama *et al*., 2008). In Nigeria, the disease was first reported in maize in 1970 at Samaru, Zaria (Kings and Webster, 1970).The disease until 1989 was present in isolated locations in the southern part of the country. By 1992, the disease had spread westwards from southern guinea savanna at the rate of 100 km per annum and had devastated over 50,000 hectares of maize plots in Kwara State only (Cardwell, 1995).

The disease seemed to be confined to areas of high relative humidity, high temperature, and high annual rainfall and therefore the maize strain of sorghum downy mildew was confined mostly to the Southern guinea savanna and the forest zones of Nigeria where the mean annual rainfall was 1200-1800 mm (Olanya *et al.,* 1993, Bock, 1995). However, maize plants infected with sorghum/maize strains were found only in the Northern guinea savannah zone where mean annual rainfall was 1200-1300 mm. But in Zimbabwe, SDM infecting sorghum and maize plants were found where mean annual rainfall was 600-900 mm and in Zambia, sorghum plants were infected in areas where rainfall was 400-1000 mm per annum. In Mozambique SDM infection was reported on both sorghum and maize in regions reported to have 400-800 mm rain per annum (Jeger *et al.,* 1998). Therefore, *P. sorghi* in maize can hypothetically be found in the dry savanna zone of northern Nigeria where the mean annual rainfall is about 300-800 mm.

Apart from the amount of annual rainfall, other important factors for the spread and occurrence of the disease include the availability of the host plant. The host plant, maize, was a major cereal crop in the Guinea savanna zone of Nigeria up to early 1990s. However, the crop is becoming an important one in the Sudan and Sahel savanna zones in the 2000 millennium (Emechebe personal communication) probably due to the advent of early maturing varieties. Most of the improved maize varieties grown in the Guinea savanna zone of Nigeria are susceptible to downy mildew (Kim *et al*., 1990).Where maize seeds are occasionally bought from the markets by the resource poor farmers, the seeds might have been contaminated with the oospores of the inoculum as suggested by Adenle and Cardwell (2000) who reported that SDM in maize is transmitted through the seed.

Singh *et al*. (1997) reported that seed transmission of the pathogen is responsible for the failure of most cereal crop production. Although downy mildew resistant (DMR) varieties are available (Kling *et al*., 1994), the quantity of seed that is needed is considerable and may not be within the reach of the poor peasant farmers or their costs may be unaffordable to them.

Since the campaign for the eradication of maize downy mildew ended in 1994 (Cardwell,1994), there seemed to be no follow-up survey done to determine a possible resurgence of the disease in Nigeria and especially in areas that were initially found to be free of epidemic proportions of the disease but in which it occurred in localized outbreaks. This paper reports the results of a study to determine incidence and distribution of SDM in maize in the Sudan and the Sahel savanna zones of Nigeria.

MATERIALS AND METHODS

A planned, two-time survey was conducted during the 2008 growing season across the 13 states that make up the Sudan and Sahel savanna agro-ecological zones of Nigeria (Fig.1). The first survey was carried out in July, at seedling stage or when most plants were at four to seven leaves stage of growth (Bigirwa *et al.,* 1998). The second survey was conducted late September, when the crops were at grain filling or at least flowering stage (Ritchie *et al*., 1989; Bigirwa *et al.,* 1998). During the study, 102 and 120 farmers' fields were surveyed in the first and second visits in 34 and 40 locations, respectively. Three farmers' fields were examined every 30-35 km along the road network (Bigirwa *et al*., 1998; Olanya *et al*., 1993; Zarafi and Emechebe, 2005, Kutama *et al*., 2009). Incidence (percentage) of the disease was obtained through careful observation of symptoms (local and systemic) from a sample of 100 plants replicated three times as described by James (1974), thus;

$$\text{Incidence} = \frac{\text{Number of diseased plants observed}}{\text{Total number of plants examined}} \times 100$$

Prevalence (%) of the disease in the two AEZs was later obtained from the % incidence for both first and second surveys following the recommendation by James (1974), Singh (2005). During the second survey, efforts were made to revisit the farmers' fields visited during the first survey. In addition, other fields with diseased plants were visited. Other important parameters determined during the survey were; the geographical location of the field using GPS 315, MANGELLAN 2000 edition, size of the farm, maize variety, soil type, agronomic status of the farm (whether weeded or weedy, fertilized or not, sole cropped or intercropped), stage of plant development, and the presence or absence of pest and other diseases

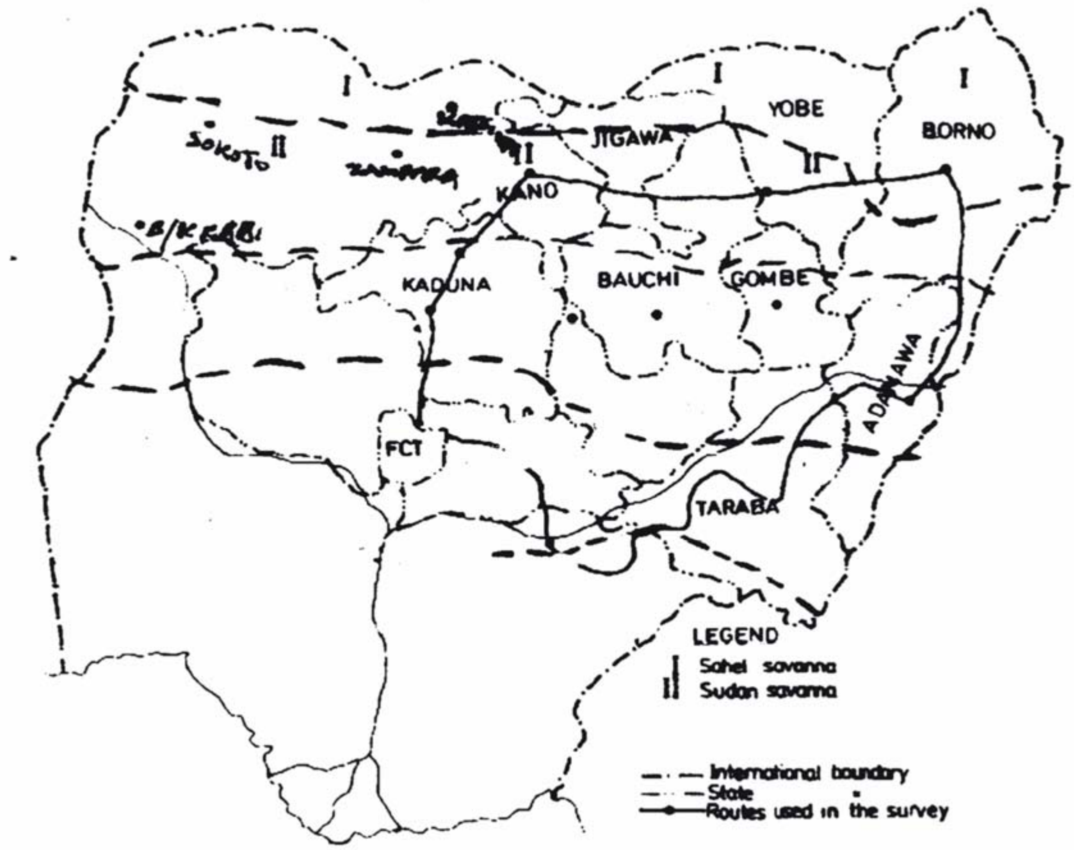

Figure1: Map of Nigeria showing the areas visited during the survey in 2008

Data analysis
Analysis of variance was employed to statistically analyse the results obtained from various agro ecological zones at 5% probability level using GENSTAT program.

RESULTS AND DISCUSSION

The outcomes of these surveys have revealed that initial symptoms of SDM in maize occurred in plants in 18 out of 34 locations investigated during the first survey in 2008. Fifteen and 19 locations were investigated in the Sudan and Sahel savanna zones, respectively, out of which plants in ten and one locations had the local symptoms of the disease (Table 2).The results have shown that the disease prevalence was higher in Sudan than in the Sahel savanna zone (Table 3). Only symptom of "half leaf" was observed in all the diseased maize plants observed in the first survey. The lower incidence of the disease in the Sahel savanna zone compared with Sudan savanna zone was probably not unconnected with the fact that the host plant (maize) was more widely grown in the Sudan savanna zone (as was noticed during the survey). Alternatively, it could be attributed to the differences in the amount and duration of rainfall received in the two zones (Table 1).Similar results were obtained by Olanya and Fajemisin (1993) on maize in the Guinea savanna and Zarafi and Emechebe (2005) on pearl millet downy mildew in Nigeria .The results also are at par with the report of Gilijamse *et al*. (1997) in the Niger republic on pearl millet downy mildew. An earlier report by Selvaraj (1979) have shown high incidence of SDM in sorghum in Kano than in Gusau. It is pertinent to note that environmental conditions of temperature, rainfall, and relative humidity influence the incidence and spread of SDM in maize in any agro-ecological zone as reported by Olanya *et al.* (1993). Drepper *et al*. (1993) reported that in addition to the presence of a suitable host, temperature and relative humidity are major factors determining asexual sporulaton and infection of *P. sorghi* in maize crops in the field.

During the second visit, the symptoms of SDM observed on maize plants at grain filling/flowering stage in the few locations (Table 4) were mostly systemic infection which included stunted plants, absence of flower or cob, stripe or total streak of the plant leaves but no oospores production. A total of 120 farmers' fields in 40 locations, were surveyed out of which 36 and 4 locations were in the Sudan and Sahel savanna zones respectively. However, only 8 out of the thirty-six and three out of the 4 locations had the symptom of the disease at grain filing stage in the Sudan and Sahel savanna zones, respectively. The disease incidence in the second visit was significantly (P>0.05) different between the two zones (Table 2).The prevalence was also low in the second compared with the first visit (Table 2). The lower incidence of the disease in the mature plants compared with young plants (Table 4) could be due to rogueing out of severely diseased plants which is a common practice by farmers. When diseased plants are rogued out, the number of diseased plants is reduced and the possibility of further infection by secondary inoculum is greatly reduced and hence the incidence of the disease. Alternatively, the lower incidence in the second survey might be due to recovery of the initially diseased plants as suggested by Jeger *et al. (*1998) in maize, sorghum and pearl millet. Age of the plant in this survey was an important factor that determined the incidence of the disease in maize. Thus, resistance or susceptibility of maize plant to downy mildew infection may be partially dependent on the plant age. This is evident in the report of Thakur and Shetty (1993) on *S. graminicola* of pearl millet and Anaso *et al*. (1989) on maize. They all showed that the incidence of downy mildew was higher when plants were inoculated at young age (up to 17 days after sowing or 5-leaf stage) than when they were much older (more than 27 days after sowing or 7-leaf stage). Earlier reports by Tantera (1975) have it that downy mildew did not cause much damage in maize if the plants were infected at 30 days of age.

Table 1: Rainfall distribution of the Sudan and Sahel savannah zones as reported by Olanya *et al*. (1993) and Zarafi and Emechebe (2005)

Zone	Annual rainfall range (mm)	Average No. of humid months
Sudan Savanna	500-900	4.5
Sahel Savannah	<500	4

Table 2: No. of locations with SDM symptoms in the Sudan and Sahel savanna AEZs during the 2008 growing season

AEZ	No. of locations visited		No. of locations with SDM	
	1st visit	location with SDM	2nd visit	location with SDM
Sudan	15	10	16	8
Sahel	19	8	24	3
Total	34	18	40	11

Table 3: Prevalence of SDM in Maize in the Sudan and Sahel savannah AEZs.2008

AEZ	Disease prevalence%	
	First survey	Second survey
Sudan savannah	16.20	3.45
Sahel savannah	3.28	0.16

(P>0.05)

Table 4.Incidence of SDM In maize in the different locations surveyed in the 2008 growing season

Location (GPS)	**Disease incidence %** **1st survey**	**2nd survey**	**G.P.S.**
Makole	2.00	0.00	08^{0}42.345E 11^{0}51.810N
K/Huguma	3.33	0.00	11^{0}32.571N 09^{0}18.518E
Birnin-kudu	0.00	0.00	11^{0}21.70 0934.449E
K/babaldo	6.00	0.00	11^{0}30.62N 009^{0}22.152E
Ningi	6.33	0.00	11^{0}15.453N 009^{0}36.136E
Alkaleri	24.33	0.00	10^{0}6.207N 10^{0}01.529E
Bauchi	37.66	0.00	10^{0}20.872N 10^{0}47.923E
Ganjuwa	---	0.00	
Durun	---	14.0	
Natsira	---	-	10^{0}16.030N 009^{0}48.478E
Gombe	29.66	-	10^{0}17.467N 11^{0}03.701E
Dadin kowa	31.0		-
Kwaya kusar	---	-	
Biu	8.66	-	10^{0}34.800N 11^{0}58.327E
Hawul	0.00	-	10^{0}30.027N 12^{0}22.257E
Garkida	0.00	-	10^{0}22.486N 12^{0}34.18E
Damaturu	1.0	-	
Gujba	2.33	-	11^{0}20.811N 11^{0}58.022E
Gumbi	26.33	-	10^{0}16.894N 012^{0}43.472E
Song	37.33	-	09^{0}53.518N 12^{0}26.46E
Murke	---	18.66	09^{0}38.928N 012^{0}33.013N
Yola south	---	11.0	09^{0}16.829N 12^{0}23.864E
Demsa/Numan	32.33	-	
Ungogo	1.66	0.00	
Kanye	1.33	0.00	
Dayi	1.0	0.00	
Yammama	0.00	0.00	11^{0}51.940N 007^{0}38.949E
K/Kankara	4.66	1.00	11^{0}45.550N 007^{0}32.975E
Faskari	0.00	0.00	11^{0}47.501N 007^{0}03.712E
Tsafe	0.00	0.00	
Kwatarkwashi	2.00	0.00	
Maru	0.00	0.00	
Danbaza	0.00	0.00	
Lambar bakura	18.33	0.00	
Sabon birni	0.00	0.00	
Dange-Shuni	0.00	0.00	
Sokoto south	0.00	0.00	
Gwandu	0.00	0.00	
Sakaba	0.00	0.00	
Yawuri	0.00	0.00	
Mean incidence	8.20	1.12	

Key: --- =not visited, - =not detected

CONCLUSION

The incidence of Sorghum downy mildew on maize was higher at the seedling stage than at later growing stage and it was directly dependent on the agro-ecological zone. In this survey, the incidence was higher in the Sudan than in the Sahel savanna and was not affected by whether the crop was sole or intercropped with other crops. The results have in one way indicated the status of SDM in maize in the two agro-ecological zones. It is therefore suggested that government of Nigeria should inform the farmers through the extension workers to use fungicide that is effective in combating the pathogen of the disease in order to avoid future epidemic.

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