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INCIDENCE OF PEARL MILLET DOWNY MILDEW [*SCLEROSPORA GRAMINICOLA* (SACC.)] IN NIGERIA

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Abstract: An extensive survey of downy mildew (*Sclerospora graminicola*) incidence on pearl millet (*Pennisetum glaucum)* grown in farmers' fields was undertaken in 2002 in pearl millet-growing areas of Nigeria – the Sahel, Sudan Savanna, northern Guinea Savanna and southern Guinea Savanna agroecological zones. Downy mildew incidence was assessed on two types of pearl millet "gero" and "maiwa" and in 32 locations in these zones. Incidence in "gero" millet was the highest in Sudan Savanna and the lowest in the Sahel zone. Cropping pattern and seed rate affected incidence of the disease which was highest in the fields with pure stand than mixed stand cropped with legumes..

Key words: downy mildew, *Sclerospora graminicola* (Sacc.) Schroet, pearl millet, *Pennisetum glaucum* (L.) B. Bruken, plant disease, disease incidence, survey, Nigeria

INTRODUCTION

In Nigeria, three types of pearl millet [*Pennisetum glaucum* (L.) B.] are grown mainly for their grain. Gero millet is the major type, while dauro (transplanted) millet is restricted to the plateau and southern part of Kaduna states. Maiwa is grown by few farmers in Niger, Taraba, Kaduna and Adamawa states, because of its long growing season (Anonomymus 1987).

Downy mildew, *Sclerospora graminicola* (Sacc.) Schroet is one of the most important pearl millet diseases and is widely distributed in the temperate and tropical areas of the world and has been reported in 51 countries where it infects pearl millet except in the U.S.A where only *Seteria* sp. is infected (Singh et al. 1993). In Africa, the disease is found in all pearl millet producing countries such as Senegal, Sierra Leone, Niger Republic, Ghana, Nigeria, Benin Republic, Cameroon, Zimbabwe, Zambia, Tanzania and many others (Jeger et al. 1998). Yield losses in pearl millet attributed to downy mildew varies with location, variety and season. Grain yield

loss of about 6% was reported in China, 27–45% and 59% in India (Singh et al. 1993; Gupta and Singh 1996), 0–6%, 20% and 70% in Nigeria (Selvaraj 1979; Werder and Manzo 1992; Anaso 1996). In a survey, a significant negative correlation between pear millet downy mildew incidence and grain yield was found by Gilijamse et. al. (1997) in Niger Republic. Using a susceptible variety, Anaso (1996) had a similar result in Nigeria however, Ouendeba et al. (1995), did not find any significant correlation between disease incidence and grain yield loss with several land race populations across Africa.

The symptoms of millet downy mildew include stunting, leaf chlorosis and white bloom of sporangia on abaxial surface of infected leaves. Leaf necrosis and shredding are other symptoms that appear at later growth stages. The disease also causes various malformations of the millet panicle commonly referred to as green ear symptom (Singh et al. 1993).

No survey has been conducted to provide information on the incidence and distribution of downy mildew in traditional pearl millet growing zones of northern Nigeria. This paper provides data on the incidence and distribution of the disease in the pearl millet growing zones of Nigeria.

MATERIALS AND METHODS

Surveys were conducted in late August and early September 2002, during pearl millet growing season. The surveys covered four agroecological zones: Sahel, Sudan savanna, northern Guinea savanna and southern Guinea savanna (Fig. 1). Climatic characteristics of these agroecological zones are presented in Table 1. Three farms in each location along main and feeder roads 50 km apart were randomly selected and sampled (each farm taken as a replication). In each farm, subplots of 50 plants each were randomly selected and assessed for disease incidence by counting diseased plants in each subplot and expressing as a percentage. Five subplots were chosen per hectare and three subplots were chosen per field of less than a hectare in size. The mean of these subplots was accepted as the disease incidence for a farm. For each of the fields surveyed, plant growth stage, millet type and cropping pattern were recorded. Fields with plants widely spaced and looking poorly fertilized were also recorded based on visual observation. A total of 96 fields in 32 locations were surveyed. The legumes cropped in mixture with millet were either cowpea, groundnut or both.The data obtained were subjected to analysis of variance (ANOVA). The Student-Newman-Keuls Test (SNK) values calculated using LSD value were used to compare the means.

Table 1. Pearl millet growing agroecological zones and their climatic characteristics

Zone	Annual rainfall range (mm)	Annual potential evapotranspiration (mm)	Average duration of humid months
Sahel	<500	1628	4
Sudan savanna	500–900	1600	4.5
Northern Guinea Savanna	950–1100	1500	5.5
Southern Guinea Savanna	1100–1400	1375	6.5

Sources: Agboola (1979), Olanya et al. (1993)

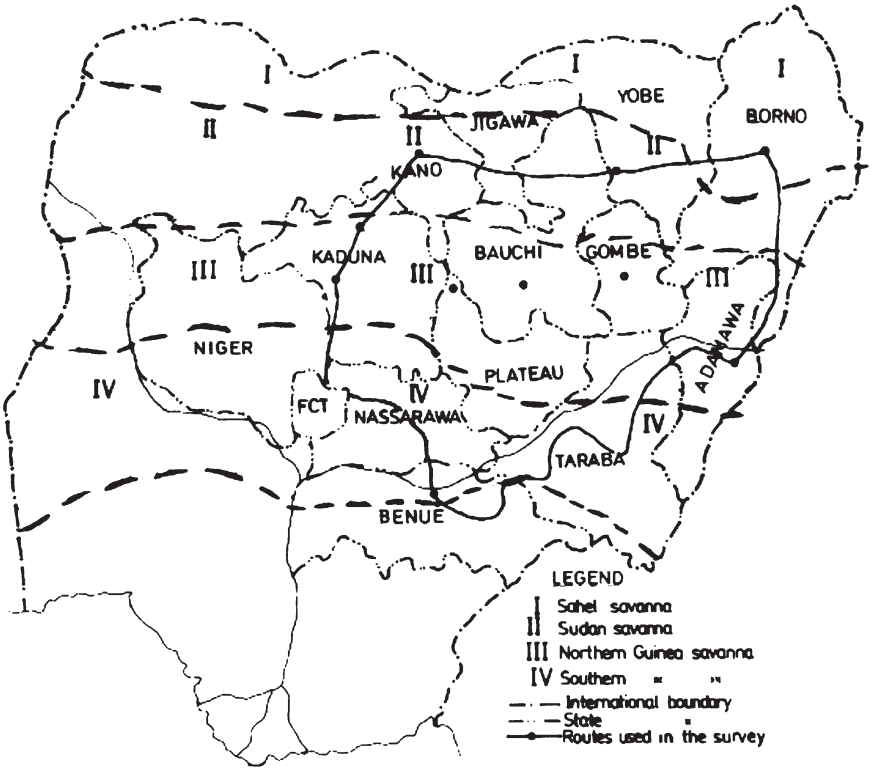

Fig. 1. Ecological zones of the surveyed States

RESULTS AND DISCUSSION

Out of 96 fields in 36 locations surveyed, 28% of the fields were sole cropped as pure stand with pearl millet or as mixed stand: pearl millet + sorghum (20%), pearl millet + sorghum + legume(s) (25%), millet + legume(s) (20%) and the remaining fields (8%) were cropped with millet + melon. The number of locations with millet cropped as pure stand and intercropped with sorghum; sorghum and legume(s); legume(s) or melon were 10,5,9,6 and 2 respectively (Table 2). Pearl millet cropped as pure stand had significantly ($p=0.05$) the highest mean disease incidence (27.63%). This was followed by pearl millet + sorghum; millet + sorghum + legume(s) intercrops (16.71; 15.11%) respectively. Pearl millet + legume(s) and pearl millet + melon respectively, had the lowest mean disease incidence (7.76; 7.65%).

Olanya et al. (1993) reported a similar result. A higher incidence of sorghum downy mildew on cropped maize as pure stand followed by maize + sorghum intercrop were reported, while maize intercropped with rice, okra, sweet potatoes, peppers or tomatoes had the lowest disease incidence.

The total number of locations surveyed were 3 in the Sahel zone, 9 in Sudan, 15 in Northern Guinea and 5 in Southern Guinea savannas (Table 3). Sudan and

Table 2. Pearl millet downy mildew incidence in different cropping patterns.

Cropping pattern	Disease incidence (%)	Number of locations
Cropped millet (pure stand)	27.63 a	10
Millet + sorghum	16.71 ab	5
Millet + sorghum+ legume(s)	15.11 b	9
Millet + legume(s)	7.76 c	6
Millet + melon	7.65 c	2
SE± (0.05)	2.23	

Legume(s) = cowpea, groundnut or both
Values marked with the same letter (s) are not significantly different (p=0.05) using SNK

northern Guinea savannas had significantly (p=0.05) highest mean disease incidence (23.58 and 22.84%, respectively). These were followed by Sahel zone (16.73%). Environmental conditions such as high rainfall, greater number of humid months and lower temperatures are conducive for disease development and are, therefore related to the high levels of disease incidence recorded in Northern Guinea savanna and Sudan savanna. The lowest mean disease incidence was obtained in southern Guinea savanna (13.30). These results are similar to those reported in the Republic of Niger by Gilijamse et al. (1997) and Sivakumar et al. (1993). Selveraj (1979) reported high disease incidence in Kano and Gusau (Sudan savanna) in Nigeria and referred to these areas as hot spot for the disease.

The variation of disease incidence observed among the zones was also reported for sorghum downy mildew (*Peronosclerospora sorghi*) on maize (Olanya et al. 1993; Fajemisin 1980). The variation was attributed to the variation in the environmental conditions such as rainfall, number of humid months and temperatures in those zones. Sweetmore et al. (1994) also reported significantly more severe yam anthracnose in areas of higher rainfall. In addition, the continuous and widespread annual cultivation of pearl millet in Sudan savanna and Sahel provides a continual and high inoculum in those zones, that, may be contributory to the high mean disease incidence recorded in these zones. Downy mildew incidence is positively correlated with the amount of oospores in the soil as a result of continuous cultivation (Pratt and Janke 1978).

Continuous cultivation has also been reported to cause disease build up resulting in higher disease incidence in wheat and potato (Heenan et al. 1994; Honeycutt et al. 1996). Extensive and intensive millet cultivation in Sudan and northern

Table 3. Pearl millet downy mildew incidence in four different agro ecological zones of the Nigerian savanna

Zone	Disease incidence (%)	Number of locations
Sahel	16.73 b	3
Sudan savanna	23.68 a	9
Northern Guinea savanna	22.84 a	15
Southern Guinea savanna	13.30 c	3
SE ± (0.05)	0.41	

Values marked with the same letter (s) are not significantly different (p=0.05) using SNK

Guinea savanna provides high initial inoculum concentration since *S. graminicola* survives in crop residues and soils. This factor further encourages rapid disease build up and spread since a large proportion of the land in these zones (Sudan and northern Guinea savanna) is under continuous millet cultivation compared to southern Guinea savanna where millet is rotated with yam, cassava, maize and sorghum. Olanya et al. (1993) reported the highest downy mildew in maize in areas of continuous maize cultivation or rotated with sorghum compared to areas that were rotated with yam/ cassava / okra or fallow proceeding the maize crop.

Agrios (1997) reported that continuous monoculture in large acreages and close spacing increases the possibility and severity of disease epidemic. This downy mildew disease survey in the pearl millet growing areas of the Nigerian savanna has revealed its occurrence in a range of agroecological zones. This suggests that downy mildew is an endemic disease and that favourable conditions for disease occurrence are prevalent.

At the time of this survey, all the "maiwa" fields (36) in 12 locations were at tillering stage (Table 4). Of the 60 "gero" farms in 20 locations visited, the fields in 11 locations were at maturity stage, while in 9 locations were at flowering stage. The farms where plants were at maturity stage at time of the survey had significantly (p=0.05) the highest mean disease incidence (25.58%) (Table 5) followed by fields at flowering stage with disease incidence of 19.24%. The lowest mean disease incidence was obtained on plants that were at tillering stage (6.34).

Olanya et al. (1993) and Anaso (1996) reported negative correlation between downy mildew incidence and age of plant but Agrios (1997) reported that plants are more susceptible to diseases such as downy mildew when young and become resistant during the maturity period. Higher disease incidence and severity of cavity spot disease; dark leaf and pod spot; and early blight on young carrot, oilseed rape and tomato plants than on old plants have been reported (Hong and Fitt 1995; El Tarabily et al. 1997; Vlsouglou and Kalogerakis 2000). In this study, however, younger millet plants had lower disease incidence, although these were only

Table 4. Downy mildew incidence on two pearl millet types

Millet type	Disease incidence (%)	Number of locations
"Maiwa"	8.76 b	12
"Gero"	23.16 a	20
SE $\pm$ (0.05)	1.72	

Values marked with the same letter (s) are not significantly different (p=0.05) using SNK

Table 5. Downy mildew incidence at different pearl millet growth stages

Growth stage	Disease incidence (%)	Number of locations
Maturity	25.58 a	12
Flowering	19.24 b	10
Tillering	6.34 c	10
SE$\pm$ (0.05)	2.11	

Values marked with the same letter (s) are not significantly different (p=0.05) using SNK

"maiwa", which, implies that the effect of plant age on susceptibility/ resistance to downy mildew is variable among the pearl millet types.

Of the 32 locations visited, 25 were cropped with gero millet while 7 were cropped with "maiwa" millet (Table 6). Gero millet had significantly (p=0.05) higher mean disease incidence (23.16%) than "maiwa" millet (8.76%).

There were significant (p=0.05) differences among the 32 locations visited (Table 6). Out of these 32 locations, ten locations (Maiduguri, Gassol, Kiyawa, Kawo, Mayere, Bugudu, Kururi, Guduma, Numan, and Zaria had the highest mean disease

Table 6. Downy mildew incidence in the different surveyed locations

S/No.	Location	Disease incidence (%)	Millet type	Growth stage	Remarks
1.	Tinenume	18.40 hi	"Gero"	Maturity	
2.	Makurdi	15.07 hij	"	"	
3.	Lafia	2.20 m	"Maiwa"	Tillering	
4.	Akwanga	0.00 m	"	"	Widely spaced and king poorly fertilized
5.	S/gida (Plateau)	0.23 m	"	"	Widely spaced
6.	S/gida (Ilowu)	2.93 lm	"	"	
7.	Kawo	38.00 abc	"	"	
8.	Zangon Aya	5.87 klm	"Gero"	Maturity	Widely spaced
9.	Zaria	29.27 def	"	"	
10.	Dumne	3.73 lm	"	Flowering	Widely spaced and poorly fertilized
11.	Yola	1.10 m	"Maiwa"	Tillering	
12.	Numan	29.87 def	"Gero"	"	
13.	Jinlari	1.07 m	"	"	Widely spaced and poorly fertilized
14.	Gombi	15.87 hij	"	"	
15.	Buzza	0.83 m	"	"	Widely spaced and poorly fertilized
16.	Guduma	30.67 de	"	"	
17.	Gassol	41.93 ab	"	Maturity	
18.	S/Tasha	9.27 jkl	"Maiwa"	"	
19.	Kano	24.13 fg	"Gero"	Tillering	
20.	Mayere	37.73 abc		Maturity	
21.	Chiromawa	24.67 efg	"	Flowering	
22.	Zimbiliwa	20.13 gh	"	Maturity	
23.	Buguma	33.73 cd	"	"	
24.	Kiyawa	36.00 bcd	"	"	
25.	Udubo	12.87 ij	"	"	
26.	Dazidau	9.67 jkl	"	Flowering	Widely spaced
27.	Gululu	14.93 hij	"	"	
28.	Damaturu	3.73 lm	"	"	Widely spaced and poorly fertilized
29.	Kururi	33.60 cd	"	"	
30.	Maiduguri	43.13 a	"	"	
31.	Auwulari	16.13 hij	"	"	
32.	Gadimari	11.47 ijk	"	"	
SE ± (0.05)		1.62			

Values marked with the same letter(s) are not significantly different (p=0.05) using SNK

incidence (25.1–50%). These were followed by ten other locations (Tinenume, Chiromawa, Kano, Makurdi, Gombi, Zimbiliwa, Gadimari, Udubo, Gululu and Auwulari), which had mean disease incidence of 10.1–24.67%. Three locations (Zangon Aya, Sabon Tasha and Dazigau) had 5.87–9.67% mean disease incidence. Fields at Akwanga were not infected while eight locations (Lafia, Sabongida Plateau, Sabongida Ilowu, Dumne, Yola, Jinlari, Buzza and Damaturu) had > 5% mean disease incidence. The variation in the disease incidence amongst locations across the pearl millet growing areas surveyed could be attributed to interaction interplay of the effects of weather, crop type, cropping patterns and other cultural practices adopted by different farmers. Olanya et al. (1993) reported that variation of Sorghum downy mildew on maize among fields was related to cropping practices and management inputs such as crop variety, fertilizer type and amount, and other cultural practices such as rotation, harrowing and deep ploughing. Durbin et al. (1980) also indicated the use of cultural practices to reduce downy mildew of the graminaceous hosts The incidence of other diseases on some other crops have been reported to be influenced by cultural and management practices (Cloud and Rupe 1994; Heenan et al. 1994; Honeycutt et al. 1996; Agrios 1997; Panique et al. 1997).

The occurrence of downy mildew in the major pearl millet growing zones and on the two main pearl millet types grown in Nigeria, under various cropping patterns suggest that the disease is a serious threat to millet production.

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POLISH SUMMARY

WYSTĘPOWANIE MĄCZNIAKA WŁAŚCIWEGO *SCLEROPSORA GRAMINICOLA* (SACC.) W UPRAWACH PROSA PERŁOWEGO W NIGERII

W roku 2002 oceniono nasilenie występowania mączniaka właściwego [*Sclerospora graminicola* (Sacc.) Schroet] w uprawach prosa perłowego [*Penisetum glaucum* (L.)] w pięciu agroekologicznych rejonach Nigerii: Sahel, Sudan Savanna, północna Guinea Savanna oraz południowa Guinea Savanna.

Badaniami objęto dwie odmiany prosa wysiewane w 32 miejscowościach. Wykazano, że nasilenie mączniaka zależało od sposób uprawy roślin oraz ilości nasion wysiewanych na hektar.