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SCREENING OF SORGHUM GENOTYPES FOR RESISTANCE TO LOOSE SMUT IN NIGERIA

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ABSTRACT
One hundred and four sorghum genotypes were screened under field conditions for loose smut disease using the hypodermic stem injection artificial inoculation technique. The experiment was laid out on a randomized complete block design (RCBD) with two replications. The results of the trial indicated that only twenty nine genotypes (27.9 %) showed loose smut symptom at varying degrees of incidence and with varying severity. Both disease incidence and severity were significantly different (P<0.01) among sorghum genotypes. More than 70 % (73 genotypes) were found to be immune (I) and 5.76 % (six) genotypes were highly resistant (HR) which included, SSV2008030, SSV2008031, SSV2008034, SSV2008066, SSV20080075, and SSV2008088 and nineteen (18.27%) were very susceptible (VS) genotypes. There was no moderately susceptible genotype obtained from the experiment. The results have shown that there are some promising sorghum genotypes that are resistant to the disease and could therefore be introduced to farmers and sorghum breeders for further breeding as well as multi-locational trials.

Keywords; field screening, hypodermic injection, loose smut, sorghum varieties, Sudan savanna

INTRODUCTION

Among the different cereal staple crops cultivated in the savanna region of Nigeria, sorghum ranks first both in terms of production and total land area put to cultivation (Purseglove, 1972; FAO, 1991; FAO, 2005; Daniel and Maria, 2000, Ngugi *et al*., 2002). Nigeria is the largest producer of sorghum in Africa producing about 8.0 million metric tons in 2004 (FAO, 2005). However, despite the importance of this crop, in Nigeria, yield at farmers' level are reported to be 1.3 t/ha which is the lowest globally and tends to decline due to limitations imposed by biotic and abiotic factors (Marley *et al*., 2002a). Sorghum suffers from more than 30 fungal diseases (USDA, 1960). Richardson (1990) listed 40 seed-borne fungal pathogens causing 32 different diseases such as downy mildew, moulds, and smuts in the crop. Among these diseases, smuts are a most limiting factor in sorghum productivity causing a threat to food security in West Africa (Louis *et al*., 2007). In Nigeria and the world over four distinct smut diseases have been identified; they are covered kernel smut induced by *Sporisorium sorghi* (synonym:*Sphacelotheca sorghi);* loose kernel smut caused by *S. cruentum* (synonym: *Sphacelotheca cruenta*); head smut incited by *S. reilianum* (synonym:*Sphacelotheca reiliana*) and long smut attributed to the fungus described as *Soroposporium ehrinbergii.* The most popular smut known and recognized by farmers in West Africa is the covered smut (Gwary *et al*., 2007). However, the other smut having similar feature which is sometimes been confused with covered smut is the loose smut.

In Nigeria, most of the sorghum varieties cultivated are mainly local land races and some few exotic or improved varieties that completely lack satisfactory resistance to smut diseases (Gwary *et al*., 2007; Nzioki *et al*., 2000; IPM, 2008). Stable and durable resistance could be obtained by properly evaluating sorghum germplasm to identify sources of resistance genes within the sub-geographical region where the crop is produced in substantial quantity. This paper reports a field screening of sorghum genotypes for loose smut in the Sudan savanna region of Nigeria.

MATERIALS AND METHODS

Collection of sorghum germplasm

One hundred and four properly labelled sorghum varieties belonging to different genotypes were obtained from the Institute for Agricultural Research (IAR) Samaru, Ahmadu Bello University, Zaria, Nigeria in January, 2009

Experimental Layout

Field screening was conducted at the Faculty of Agriculture, Bayero University, Kano Research Farm located in the Sudan savanna agro-ecological zone (AEZ) on the coordinates 11°58.981N, 008°25.298E and on 454 m elevation. Randomized Complete Block Design (RCBD) field experiment with two replications was done. The layout involved two blocks each for head smut. The plot size was 1.5 m by three rows and one sorghum line/accession was sown per plot at the rate of 3 kg/ha and 0.4 m inter plant spacing (Komolafe *et al*., 1985) so that a maximum of 15-18 stands/plots and a population of 14, 000 plants/ha was obtainable. Each block therefore was comprising of 104 plots and therefore planted with 104 sorghum lines. This was randomized in the second block. Sowing was done from 8th to 11th July.

Agronomic practices

One week after germination, seedlings were thinned to one plant per stand so that a plot may contain 15 to 18 plants or stands. First and second weeding were done manually 14 days and 28 days after germination respectively. Second weeding was done four weeks after germination. Compound fertilizer NPK, 20:10:10 was applied at the rate of 50 kg/ha (Louis *et al*., 2007) in two equal split doses, one after the first weeding and the next at boot stage.

Three weeks after sowing (3WAS), 0.5 g of previously collected, dried and stored teliospores of *S. cruentum* was made to sporulate in one litre of distilled water for 28 hours and blended for 30 seconds using an electric blender. One millilitre of the suspension was introduced into the main stem of the plant with a pediatric syringe by inserting the needle gently into the stem or growing point while carefully holding and supporting the whole plant with a hand to prevent damage. The same procedure was repeated 40 days after sowing (40DAS). The plants in both cases were allowed to grow normally up to physiological maturity.

Determination of Disease parameters

Disease Incidence

The incidence of the smut disease, was recorded by establishing the proportion of plants showing the symptoms and expressing the result in percentage in each plot.

Disease Severity

At physiologic maturity, that is when the grains were fully matured, the severity was scored on the smutted plants using the severity rating scale used by Gwary *et al*. (2001) and Marley *et al*. (2002b) as follows:

0% incidence=Immune, 1-10% incidence = Very resistant, 11-25% incidence= Moderately susceptible 26-50% incidence= Susceptible, 51-100% incidence=Very susceptible

The mean % severity was computed using the formula:

$$\frac{\Sigma n \times 100}{N \times 5}$$

Where, Σn = summation of individual ratings

N = Total number of plants assessed times the highest score

5= the highest disease rating.

Resistance Classification

Resistance rating to head or loose smut was classified following the recommendation by Marley *et al*. (2002b) and Jackson (2001) as follows; **1**= 0% incidence (Immune), **2**= 1-10 % incidence (Very resistant), **3** = 11-25 % incidence (Moderately susceptible), **4**= 26-50 % (Susceptible), **5** = 51-100 % (Very susceptible)

RESULTS AND DISCUSSION

The results in Table 1 shows that out of the 104 genotypes screened for loose smut, only 29 genotypes (27.9 %) showed loose smut symptom with significant difference ($P<0.05$) in both disease incidence and severity. More than 70 % (73 genotypes) were found to be immune (I) and 5.76 % (six) genotypes were highly resistant (HR) of which includes; SSV2008030, SSV2008031, SSV2008034, SSV2008066, SSV20080075, and SSV2008088. These genotypes showed 1-9 % loose smut incidence. 17.30 % of the genotypes screened for loose smut were very susceptible (VS) having disease incidence ranging from 50-100 %. The susceptible (S) genotypes with 30 - 49 % disease incidence per plot comprised of genotypes SSV2206002, SSV2008010, SSV2008025, SSV2008026, SSV2008048 and SSV2008181 accounting for about 5.76 % of the total genotypes screened. No moderately resistant (MR) genotype was obtained and only nineteen of the 104 genotypes were found to be very susceptible to loose smut. In general, it was observed that among all the sorghum genotypes screened for loose smut, disease incidence ranged between 1 to 92.1 % in some very susceptible genotypes.

The variations obtained on disease incidence and severity in the different genotypes screened for loose smut may be due to the differences in the individual inherent reaction to smut pathogen (Gwary *et al*., 2007). This result agreed with an earlier report by Nzioki *et al*. (2000) that most studies for resistance to smut disease is controlled by single gene and therefore, whether resistant or susceptible is a variety depends on the parent used. In this study, the reaction of various sorghum accessions has been tested for *S. cruenta* and majority (>70 %) of the candidate sorghum genotypes were immune. A ratio of almost 3:1 resistant to susceptible plants was obtained in this study. Similar results were reported by Casady (1961) and Nzioki *et al.* (2001). The low to no incidence could be due to technical fault as shown by Osorio and Frederiksen (1998) and Nzioki *et al.* (2000). In this study, injection inoculation technique was used to screen all the 104 genotypes twice; at 3WAS and 40DAS respectively. The method though very effective as demonstrated by Hoffman, (1971) is very sensitive to technical skills and monotonous (Kutama *et al*., 2011). Therefore, disease escape could be possible as reported by Claflin and Ramundo (1996).

In the same vein, climatic conditions during the study may have influenced the levels of incidence in loose smut. Kollo (2000) noted that in areas in Niger with mean annual rainfall above 700 mm, long smut incidence was minimal even though the varieties grown in these areas were highly susceptible. Emechebe *et al*. (2010) reported head and loose smuts to be more prevalent in years that had no much rainfall. Komolafe and Joy (1993) also made similar observations. Marley and Aba (1999) also observed high incidence of loose smut in areas of low rainfall.

Table 1: Mean disease incidence (%), disease severity and resistance class of sorghum germplasm screened for loose smut

S/No.	Sorghum genotype	Loose smut incidence %	Loose smut severity scale	Resistance class of sorghum genotype
1	SSV2006002	45.2	4	S
2	SSV2006006	0	1	I
3	SSV2006007	0	1	I
4	SSV2006011	0	0	I
5	SSV2006013	50.9	5	VS
6	SSV2006014	0	0	I
7	SSV2006015	0	0	I
8	SSV2006016	0	0	I
9	SSV2006017	0	0	I
10	SSV2006018	0	0	I
11	SSV2006021	55.6	5	VS
12	SSV2006024	0	0	I
13	SSV2006026	54.7	5	VS
14	SSV2006027	0	0	I
15	SSV2006029	0	0	I
16	SSV2006030	57.2	5	VS
17	SSV2006031	56.3	5	VS
18	SSV2006033	0	1	I
19	SSV2006035	0	1	I
20	SSV2006036	0	1	I
21	SSV2006039	0	1	I
22	SSV2006041	0	1	I
23	SSV2006045	0	1	I
24	SSV2006047	0	1	I
25	SSV2008001	0	1	I
26	SSV2008002	43.2	4	VS
27	SSV2008004	52.5	5	VS
28	SSV2008005	0	1	I
29	SSV2008006	90.1	5	VS
30	SSV2008007	0	1	I
31	SSV2008008	0	1	I
32	SSV2008009	0	1	I
33	SSV2008010	52.1	5	S
34	SSV2008012	0	1	I
35	SSV2008013	0	1	I
36	SSV2008017	0	1	I
37	SSV2008018	0	1	I
38	SSV2008019	0	1	I
39	SSV2008021	0	1	I
40	SSV2008022	0	1	I
41	SSV2008023	0	1	I
42	SSV2008025	43.5	4	S
43	SSV2008026	42.2	4	S
44	SSV2008028	0	1	I
45	SSV2008029	52.1	5	VS
46	SSV2008030	0	1	HR
47	SSV2008031	0	1	HR
48	SSV2008032	0	1	I
49	SSV2008033	65.5	5	VS
50	SSV2008034	0.5	1	HR
51	SSV2008035	55.8	5	VS
52	SSV2008036	0	1	I
53	SSV2008039	0	1	I
54	SSV2008040	0	1	I
55	SSV2008041	89.2	5	VS
56	SSV2008042	0	1	I
57	SSV2008044	0	1	I
58	SSV2008046	0	1	I
59	SSV2008047	0	1	I

Table 1 continue

S/No.	Sorghum genotype	Loose smut incidence %	Loose smut severity scale	Resistance class of sorghum genotype
60	SSV2008048	55.6	5	S
61	SSV2008049	0	1	I
62	SSV2008051	92.1	5	VS
63	SSV2008052	0	1	I
64	SSV2008053	0	1	I
65	SSV2008054	0	1	I
66	SSV2008055	0	1	I
67	SSV2008056	0	1	I
68	SSV2008057	0	1	I
69	SSV2008058	0	1	I
70	SSV2008059	0	1	I
71	SSV2008061	0	1	I
72	SSV2008063	0	1	I
73	SSV2008064	0	1	I
74	SSV2008066	3.2	2	HR
75	SSV2008067	0	1	I
76	SSV2008070	72.2	5	VS
77	SSV2008072	65.3	5	VS
78	SSV2008074	0	1	I
79	SSV2008075	4.6	2	HR
80	SSV2008076	0	1	I
81	SSV2008078	0	1	I
82	SSV2008079	0	1	I
83	SSV2008080	62.1	5	VS
84	SSV2008082	56.5	5	VS
85	SSV2008084	0	1	I
86	SSV2008085	0	1	I
87	SSV2008086	0	1	I
88	SSV2008087	0	1	I
89	SSV2008088	12.0	3	HR
90	SSV2008089	68.9	5	VS
91	SSV2008090	0	1	I
92	SSV2008094	0	1	I
93	SSV2008096	0	1	I
94	SSV2008100	0	1	I
95	SSV2008101	0	1	I
96	SSV2008107	0	1	I
97	SSV2008110	0	1	I
98	SSV2008111	0	1	I
99	SSV2008112	75.4	5	VS
100	SSV2008113	0	1	I
101	SSV2008116	0	1	I
102	SSV2008117	0	1	I
103	SSV2008125	0	1	I
104	SSV2008181	26.5	3	S
Mean		14.43	1.851	
CV%		2.3	6.2	
LSD		5.67	1.8239	

Key: I=Immune, HR= Highly resistant, S= Susceptible, VS= Very susceptib

REFERENCES

Casady, A. J. (1961). Inheritance of resistance to races 1, 2, and 3 of *Sphacelotheca sorghi* in sorghum. *Crop Science* 1:63-68.

Daniel, Z. and Maria, H. (2000) *Domestication of plants in the old world*. Third edition. Oxford University Press. Pp 89..

Emechebe, A.M, Kutama, A.S., and Aliyu, B.S (2010) Incidence and distribution of head and loose smuts of sorghum (*Sorghum bicolor* L Moench) in Nigerian Sudan savanna. *Bayero Journal of Pure and Applied Sciences*, 3 (2):142-147

FAO (1991) Food and Agricultural Organization. Quartely *Bulletin of Statistics* 4 (4):24-53

FAO (2005) compendium on post-harvest operations. Food and Agricultural organization 2005 *Bulletin* pp43-46

Frederiksen, R. A., Osorio J. A. (1998) development of an infection assay for *sporisorium reilianum*, the head smut pathogen on sorghum, vol. 82, no.11, pp. 1232-1236.

Gwary, D.M., B.S. Bilya and A.C. Adakole, (2001) Evaluation of pearl millet genotypes for resistance to smut (*Tolyposporium penicilliarie* BERF) in Northeastern Nigeria. *J. Arid Agric.*, 12: 81–84

Gwary, D.M., Obida A., and Gwary, S.D. (2007): Management of sorghum smuts and anthracnose using cultivar selection and seed dressing fungicide in Maiduguri, Nigeria. *International Journal of Agriculture and Biology*.9 (2):326-328

IPM (2008). Integrated Pest Management. *Reports on plant disease* (RPD) No.208. Sorghum smuts. University of Illinois. Pp 1-6

Jackson, N,G.M., (2001) Combatting head smut of maize caused by *Sphacelotheca reiliana* through resistance breeding. *Proceedings of the 7th eastern and southern Africa Regional Maize Conference* 11-15th February, 2001,pp.110-112

Kollo, A. I. (2000). Long Smut. In: Frederiksen, R.A., Odvody, G.N. (Eds.) *Compendium* of *Sorghum Diseases*, second edition. American Phytopathological society. St. Paul, MN. Pp 22-23

Komolafe, M.F. and D. C., Joy (1993) *Practical Agriculture for West African Schools and Colleges*. University Press LTD, Ibadan, Nigeria

Komolafe, M.F., Adegbola, A. A., Are, A. L. and Ashaye, T.J. (1985). *Agricultural Science for West African Schools and Colleges*. 2nd edition. University press Limited, Ibadan, pp20-120

Kutama, A.S., Aliyu, B.S., and Emechebe, A.M. (2011) Field Screening of Sorghum Genotypes for Resistance to Head Smut in Nigeria In: *The proceedings of the International Conference on Science and Sustainable Development* held at Hotel Dona, Porto novo, Benin Republic. 1(7):90-95

Louis, K.P.,Ndiaga, C. Ousmane, Ndoye (2007). Assessing the vulnerability of selected sorghum line from the united state of America to long smut (*Soroposporium ehrenberghii* Vanky). *Crop Protection* 26: 1771– 1776

Marley, P. S., and Aba, A. D. (1999): Current Status of Sorghum Smuts in Nigeria *Journal of Sustainable Agriculture*,15 **(**2 & 3**):**119 – 132.

Marley, P.S., J. A. Y., Shebayan, I. Onu, D., Aba and R.S., Musa (2002b). Analysis of constraints to sorghum production in Nigerian Sudano-Sahelian savanna. *Samaru Journal of agric. Research*, 18:41-53

Marley, P.S., S.C., Gupta and D. A., Aba (2002a) Assessment of Sorghum Genotypes for Resistance to Foliar Anthracnose (*Colletotrichum graminicola*) Under Field Conditions. *Samaru Journal of Agric. Research*, 18: 17-24

Ngugi, H. K., King, S.B., G. O. Abayo, Y. V. R., Reddy (2002) Prevalence, Incidence and severity of sorghum diseases in Kenya. *Plant Disease*, 86:65-70

Nzioki, H.S., Claflin, L. E. and Ramundo, B. A. (2000). Evaluation of screening protocols to determine genetic variability of grain sorghum germplasm to *Sporisorium orghi* under field and greenhouse conditions. *Journal of Pest Management* 46:91-95.

Nzioki, H.S., L.E. Claflin, P.J. Bramel and B.A., Ramundo (2001) Inheritance of Resistance to *Sporisorium sorghi* in Grain Sorghum *ISMN* 42:147-150

Purseglove, J.W. (1972) *Tropical crops. Monocot I*. Longman, London, 259-287 pp.

Richardson, M. J. (1990) An Annotated List of Seed-borne Diseases. 4th Edition. The internal seed testing association, Switzerland. P.186, 263,340.

USDA (1960). Index of plant diseases in the United States. *USDA Agricultural hand book.* 165:187-211.