Screening of Bi-parental and Mutant Clones of Sugarcane (*Saccharum officinarum* L.) for Resistance to Smut Disease

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Summary

*Six newly developed clones of sugarcane (*Saccharum officinarum *L.) clones obtained from gamma irradiated progenies (KRS/96/007, KRS/96/002, KRS/96/001) and from bi-parental crosses (SRS/96/305, SRS/96/210 and SRS/96/004) were used in the study of their level of smut disease resistance. The results of the application of the standard smut disease scale of sugarcane showed that all the clones from bi-parental crosses and only one clone (KRS/96/002) from gamma irradiated progenies were highly resistant to smut disease of sugarcane with zero incidence of the disease. Diseased plants were observed on the remaining two clones from gamma irradiated progenies (KRS/96/007 and KRS/96/001), but the percentage of infection was very low (1.1%) and they were therefore also rated as resistant clones.*

Résumé

Screening des clones de la canne à sucre (*Saccharum officinarum* L.) obtenus par croisement et par irradiation à la résistance au charbon

*Cette essai étudie la résistance au charbon de la descendance de six clones de la canne à sucre (*Saccharum officinarum *L.) dont trois mutants (SRS/96/004, SRS/96/305 et SRS/96/210) obtenus par irradiation aux rayons gamma et trois variétés obtenues par croisement (KRS/96/001, KRS/96/002, KRS/96/007). L'évaluation de la résistance au charbon a été faite suivant une échelle établie du niveau de sensibilité à l'attaque de la maladie. Les résultats obtenus montrent que tous les clones obtenus par croisement ainsi que le mutant KRS/96/002, obtenu par irradiation aux rayons gamma, étaient très résistants au charbon avec une incidence de la maladie égale à 0. Les autres mutants obtenus par irradiation aux rayons gamma (KRS/96/001 et KRS/96/007) avaient un niveau de sensibilité bas (1,1%) et ont été classés comme clones résistants.*

Introduction

Sugarcane is the major primary source of sugar for both household and industrial purposes in Nigeria. The fungus *Ustilago scitaminae* Syd popularly known as smut disease of sugarcane seriously threatens its production. The scourge of this disease has been reported in many sugar producing african countries such as South Africa, Kenya and Angola (13). Smut disease of sugarcane can be of epidemic proportion especially when a susceptible variety or a diseased set is planted (1). The smut disease of sugarcane is characterised by a distinctive whip-like structure from the apices of affected stem with a fairly hard woody core surrounded by a powdery mass of soft spores (5). The disease can spread by wind as well as by irrigation water (14). Usually in most disease prone sugarcane varieties, smut whips emerge within 120 days after planting and an average size whip produces about 10^{11} spores/cm^2 (1).

Data on quality parameters indicate that in smutted canes, brix and purity of sugar are adversely affected (13). Yield losses of up to 50% in plant crops and 73% in the ratoon crops due to smut disease has been reported in India (9), and significant yield losses of sugarcane in South Africa (5 & 8). In Nigeria, smut was first recorded in 1969 (18). Since then the disease has continued to spread and threaten the sugar industries in Nigeria and discouraged peasant farmers from cane cultivation (2, 3, 4, 17).

Various methods have been employed to evolve indigenous resistant clones to smut disease of sugarcane in Nigeria through mutation by gamma radiation (12), and through bi-parental crosses (15). This study was designed to compare the level of smut disease resistance among sugarcane progenies from bi-parental and gamma rays induced parents.

Material and methods

Six clones of sugarcane propagules comprising three from gamma radiation induced mutant clones (KRS/96/001, KRS/96/002 and KRS/96/007) and three from bi-parental crosses (SRS/96/004,

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SRS/96/210 and SRS/96/305) were used to study their resistance to smut disease of sugarcane. The clones were obtained from the National Cereals Research Institute, Badegi sub-station located at Savannah Sugar Company Ltd, Numan, Adamawa State Nigeria. The trial was conducted at the farm of the Federal College of Forestry, Jos from 2nd May 1999 to February 2001. A randomized complete block design was used. Plant spacing was 0.5 m x 0.5 m. There were six replications and seventy-two cuttings per replicate.

Cultural practice

Land preparation was done manually two weeks before planting (2 WBP). Fertilizer was applied using 15:15:15 NPK at the rate of 50 kg/N/ha at 4,12, and 16 weeks after planting (WAP). Hoe weeding was carried out at 6, 8 and 10 WAP. Granular Furadan® granules (Ciba geigy) was applied at the rate of 20 kg/ha to control termite out break at 10 and 40 days after planting (DAP). The crops were watered every morning from October 1999 to February 2000, to ensure good plant growth.

Field observation

Visual field observation for smut infection was made from two weeks after planting (2 WAP) up to the time of harvest at forty weeks after planting (40 WAP). Standard smut disease scale for sugarcane (10) was used in the estimation of level of disease resistant reaction as shown in next table:

Scale	% infection[1]	Disease rating
1-4	0-10	Resistant (R)
5-6	11-15	Moderate resistant (MR)
7-8	16-25	Intermediate infection (I)
9 and above	26 and above	Susceptible (S).

[1]Percentage infection= Number of infected plants x 100/total number stools.

Source: Adapted from Hutchinson, 1972.

Results and discussion

The reaction of six sugarcane clones to *Ustilago scitaminae* Syd is presented in table 1. The results show that the progenies from clones SRS/96/305, SRS/96/210, SRS/96/004 (from bi-parental crosses) and KRS/96/002 (gamma irradiated sources) did not showed any symptom of smut infection. However two plants (KRS/96/001 and KRS/96/007) from gamma irradiated progenies showed symptoms of infection.

The apices of both the susceptible plants produced a whip-like appendage. The progress of the disease on the infected plants influenced their stalk development, which assumed grass like appearance. The leaf and stem girth development were adversely effected. The diseased plants found in KRS/96/007 dried up prematurely including almost all the leaves, while that of KRS/96/001 also dried up gradually from the middle, lower to upper leaves. Smutted plants usually display various types of abnormalities in their vegetative parts including general reduction in size, and girth of intern-

Table 1

Reaction of six sugarcane clones to *Ustilago scitaminae* Syd

Clone	Symptom of infection observed	Number of susceptible plants	% infection	Remark's[1]
SRS/96/305	Nil	Nil	0	HR
SRS/96/201	Nil	Nil	0	HR
SRS/96/001	Nil	Nil	0	HR
KRS/96/001	Plant showed smut whip on the apex of the stalk, later dried together with the lower, middle and upper leaves.	1	1.1	R
KRS/96/002	Nil	Nil	0	HR
KRS/96/007	Plant prematurely dried with almost all the lower, middle, and upper leaves. The apex of the stalk produced a whip of smut.	1	1.1	R

[1]HR stands for Highly Resistant.
R stands for Resistant.

odes and leaves (6, 7, 16). The brix of the diseased plants was also found to be lower than that of healthy plants.

In this study there were two diseased plants from gamma irradiated progenies (KRS/96/001 & KRS/96/007). However, in other four clones, three from bi-parental crosses (SRS/96/004, SRS/96/210 and SRS/96/305) and one from gamma irradiated progenies, (KRS/96/002), no plant was infected. In each of the smutted plants from gamma irradiated progenies, reported in this study, the level of smut infection was very low (1.1%), this percentage of smut level of infection is low, a range of 0-15% had been recommended for resistant reaction of sugarcane to smut disease (19). In Hawaii the standard for measuring resistant reaction in smut screening trials for sugarcane, is that a clone is classified as resistant if 16% or less plants are infected (11). This standard have been adopted for use in Florida. According to this standard, we accept the four clones (SRS/96/001, KRS/96/002, SRS/96/201 and SRS/96/305), as highly resistant. The highly resistant clone will be very useful for development of smut resistant commercial clones.

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Literature

1. Agnihoti V.P., 1990, Smut. *In*: Disease of sugarcane and sugar. Eds Revised Edition. Oxford and IBH Publication Company Ltd, New Delhi. India pp. 73-103.
2. Anon, 1990, Annual report of sugarcane research programme. National Cereals Research Institute Badegi, Nigeria.
3. Anon, 1992, Annual report of sugarcane research programme, National Cereals Research Institute Badegi, Nigeria.
4. Anon, 1994, Annual report of sugarcane research programme, National Cereals Research Institute Badegi, Nigeria.
5. Antoine R., 1961, Smut. *In*: Sugarcane disease of the world, Vol. **1**. Eds. Martin J.P., Abbort E.V. & Hughes C.G., Elsevier publishing Company, Amsterdam and London.
6. Bhombe B.B. & Somai R.B., 1978, An atypical symptom of sugarcane smut, India Phytopathology, 31, 239-240.
7. Byther R.S. & Steiner G.W., 1974, Unusual smut symptoms on sugarcane in Hawaii. Plant disease reporter, 58, 401-405.
8. Cormstock J.C., Ferreia S.A. & Tew T.L., 1993, Hawaii's approach to control sugarcane smut, Plant Disease, **67**(4), 452-457.
9. Durairaj V., Natarajan S. & Padmanabbhan D., 1972, Reaction of some sugarcane varieties to smut (*Ustilago scistaminea* Syd) PANS, **18** (2), 171-172.
10. Hutchinson P.B., 1972, Alternate hosts for disease of sugarcane, Sugarcane Pathology, Newsletter, 8, 36-40.
11 Jack L.D., 1981, The effect of wounding and high pressure spray inoculation on smut reaction of sugarcane clones. United State Department of Agriculture Journal Vol. **72**. N° 8, 1023-1024.
12. Kwon-Ndung E.H., Ifenkwe O.P. & Misari S.M., 1996, Sensitivity response and variability in sugarcane clones induced by gamma rays. International Conference on Biotechnology for Development in Africa, Priority for 21st century, Enugu, Nigeria, 9-13th February 1996.
13. Martin J.P., Abbort E.V. & Hughes C., 1961, Sugarcane disease of the world Vol. **1** Elsevier publication company, Amsterdam, 542 pp.
14. Martin Mc., 1948, Sugarcane smut. A report on the visits to sugarcane estates of South Rhodesia. South Africa Sugar Journal, 32, 737-739.
15. Misari S.M., Busari M. & Agboire S., 1998, Current status of sugarcane research and development in Nigeria. Inaugural workshop of the national coordinated programme on sugarcane. National Cereal Research Institute Badegi, Nigeria. 17-18th August, 1998.
16. Nasr I.A. & Talballa H.A., 1976, Association of unusual symptoms with smut of sugarcane in the Sudan, Sugarcane, Phytopathology Newsletter, 15/16, 6-8.
17. Obakin F.O., 1978, Sugarcane improvement at National Cereals Research Institute. *In*: Proceedings, International symposium on sugarcane in Nigeria. August 28th - September 31st 1978. Published by NCRI, pp 12-16.
18 Robertson D.G., 1969, Addendum, *In*: A checklist of plant disease in Nigeria by Bakey A.G., Federal Department of Agricultural Research, Ibadan. Memorandum, Nº 96, 36.
19 Wu K.K., Heinz D.J. & Meyer H.K., 1978, Heritability of sugarcane smut resistance-race A. Annual report experimental station. Hawaii Sugarcane Planters Association.

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