Evaluation and Characterisation of Sugar Cane Germplasm Accessions for their Breeding Values in Nigeria

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Abstract

Thirty local sugar cane *(Saccharum* spp.) accessions were evaluated and characterised for smut *(Ustilago scitammeaSyd.)* resistance during four years under field conditions. The results showed that nine accessions, BD-07, KN-08, LS-01, OG-07, OY-10, OY-11, OY-16, OY-22 and OY-26, were resistant and had high brix content and other useful yield related traits. Their reaction to smut under natural and artificial infection indicated that they are naturally adapted to the smut fungus. The accessions might be safely grown in areas of low smut inoculum density without chemical control. The nine accessions are recommended for incorporation in sugar cane breeding schemes for high yield and smut resistance.

Key words: Breeding, characterisation, disease resistance, evaluation, smut, sugar cane, Nigeria

Introduction

Sugar cane *(Saccharum* spp.) is an important food crop of the tropics and subtropics (Sivanesan and Waller 1986). It is cultivated in about seventy-four countries between 40°N and 32.5°S, encompassing approximately half the globe (Aikulola 1978).

European sailors introduced sugar cane into Nigeria along the western and eastern coasts in the fifteenth century. It was primarily grown for chewing and for livestock feed (Naidu 1987). Current emphasis is, however, on sugar production. Sugar cane accounts for 62% of world sugar production and sugar beet *(Beta vulgaris* L.) 38% (Naidu 1987; Fry 1997). In Nigeria, as in other tropical countries, sugar cane is the major raw material used for sugar production.

Four sugar estates (Bacita, Numan, Sunti and Lafiagi) in Nigeria grow sugar cane on a relatively large scale, while the majority of smallholder farmers grow soft sugar cane (chewing cane) on land holdings of 0.2-0.5 ha (Anon. 1997). Sugar cane is grown on 25-30,000 ha in Nigeria, of which industrial cane covers about 12,000 ha (Akobundu 1987). The major disease limiting production of both industrial and chewing sugar cane in Nigeria is smut, caused by the pathogen *Ustilago scitamineaSyd.* (Wada 1997).

Research on sugar cane is still in its infancy in Nigeria, and therefore establishment of good sources of sugar cane germplasm, of both exotic and local origin, and its characterisation are of great importance to provide a diverse genetic base for cane improvement. This study was undertaken to evaluate and characterise some local germplasm accessions in order to gauge their commercial and breeding qualities.

Materials and Methods

Thirty local sugar cane germplasm accessions collected from different areas of Nigeria were studied. Four collections each were made from former Bendel State (now Edo and Delta), Kano and Ogun, and nine each from Lagos and Oyo States. Canes were cut into three-budded sets and planted in single row plots of 5 m x 1 m at the upland sugar cane research field of the National Cereals Research Institute at Badeggi. The experimental design was a randomised complete block with three replicates. Fertiliser was applied at planting (200kg N, 100kg P_2O_5 and 180kg K_2O/ha) on a sandy loam soil containing 4.6% organic carbon, (OC), 0.07% organic matter (OM), 0.62% total nitrogen (TN), 0.05 meg/100g exchangeable K and comprising 87.8% sand, 11.0% silt and 1.2% clay.

To investigate the reactions of the accessions to smut, three-budded sets with exposed buds were immersed in a smut spore suspension (4g spores/litre of sterile water at 4 x 10^6 spores/ml) for one hour as described by Nasr (1977). They were removed and incubated in wet jute gunny bags and kept in the shade for 14 hours. The sets were then planted in the field the following morning. Whip-like smut

Table 1. Selected terms from the analysis of variance for yield-related traits and smut reaction of 30 sugar cane accessions grown at Badeggi in Nigeria

Variable	MS	F	P
Stalk length	0.724	42.05	<0.001
Stalk weight	0.303	30.71	<0.001
Brix	17.336	19.38	<0.001
Stalk diameter	0.227	24.00	<0.001
Millable stalks/stool	5.705	7.26	<0.001
Smut reaction			
1993 crop	608.179	46.73	0.001
1st ratoon 1994	447.49	23.42	0.001
2nd ratoon 1995	553.21	32.54	<0.001

Table 2. Agronomic and quality characteristics of some sugar cane germplasm accessions maintained at Badeggi, Nigeria

Accession	Stalk colour	Stalk length (cm)	Stalk wt. (kg)	Brix	Stalk diameter (cm)	No. of millable stalks/stool
BD-02	Purple	2.4	0.9	14.0	2.8	11.5
BD-03	Purple	2.4	1.1	15.3	2.4	10.5
BD-06	Purple	2.1	1.0	16.2	2.9	10.6
BD-07	Yellow	3.6	1.8	22.0	3.4	14.3
KD-01	Yellow	2.7	1.3	16.3	3.2	14.0
KD-10	Green	3.1	1.6	20.6	2.8	12.0
KN-06	Green	2.6	1.1	14.8	2.5	11.0
KN-08	Purple	1.9	0.9	16.9	3.0	10.8
KN-10	Green	1.8	1.0	17.0	3.3	12.5
LS-01	Green	1.9	1.2	14.5	3.1	13.1
LS-05	Green	2.3	0.7	16.0	2.7	12.7
LS-09	Yellow	2.5	0.9	15.3	3.3	13.6
LS-15	Green	1.7	1.0	14.6	3.1	10.0
LS-16	Green	2.6	1.2	14.3	2.9	13.2
LS-17	Green	2.8	1.4	17.0	2.7	11.8
LS-20	Yellow	3.0	1.2	16.1	3.2	12.5
LS-22	Green	2.1	0.9	17.2	2.5	12.7
OG-03	Purple	1.8	1.0	18.5	2.8	13.3
OG-11	Brown	2.1	1.2	15.8	3.1	14.0
OG-07	Brown	1.7	1.0	20.1	3.0	11.5
OG-09	Green	2.3	1.4	16.7	2.6	10.8
OY-01	Green	1.9	1.3	14.9	2.8	9.9
OY-09	Brown	2.6	1.3	15.6	2.9	10.8
OY-10	Purple	3.4	1.9	21.8	3.0	12.8
OY-11	Green	1.8	0.9	14.3	3.1	13.6
OY-12	Purple	2.4	1.1	17.4	2.5	11.7
OY-16	Purple	3.0	1.7	20.8	3.4	13.7
OY-18	Purple	2.3	1.0	18.0	2.6	9.8
OY-22	Purple	2.0	0.8	16.3	2.8	12.1
OY-26	Purple	3.2	1.5	21.7	3.4	13.6
LSD(P=0.05)		0.21	0.16	1.55	0.16	1.45
CV (%)		5.44	8.26	5.55	3.35	7.31

Table 3. Reaction of 30 local Nigerian sugar cane accessions to smut disease (%)

		Smut reaction (%)			
Accession	stalk colour	1993 crop	1st ratoon (1994)	2nd ratoon (1995)	Class*
BD-02	Purple	49.47	44.99	48.18	S
BD-03	Purple	29.54	36.94	41.00	S
BD-06	Purple	26.95	34.88	38.35	S
BD-07	Yellow	0.00	15.49	18.85	R
KD-06	Yellow	44.90	41.16	45.57	S
KN-08	Green	0.00	0.00	0.00	R
KN-10	Green	28.48	37.94	36.13	S
KD-10	Purple	42.41	35.59	46.16	S
LS-01	Green	29.00	29.89	29.98	I
LS-08	Green	35.81	37.27	47.29	S
LS-05	Green	44.85	46.61	42.09	S
LS-09	Yellow	42.34	47.97	49.02	S
LS-15	Green	40.46	45.00	51.35	S
LS-16	Green	36.22	42.09	42.11	S
LS-17	Green	42.29	38.94	43.18	S
LS-20	Yellow	37.97	40.01	43.37	S
LS-22	Green	41.77	51.91	50.77	S
OG-03	Purple	29.90	33.56	36.71	S
OG-11	Brown	36.87	38.98	44.00	S
OG-07	Brown	24.23	19.70	20.86	R
OG-09	Green	51.03	47.45	40.05	S
OY-01	Green	39.17	43.87	49.68	S
OY-09	Brown	42.45	50.35	53.74	S
OY-10	Purple	14.76	22.73	20.50	R
OY-11	Green	19.94	25.26	22.49	I
OY-12	Purple	45.00	45.00	49.04	S
OY-16	Green	26.83	19.18	19.12	R
OY-18	Purple	39.20	50.60	53.76	S
OY-22	Purple	15.86	24.56	21.92	R
OY-26	Purple	0.00	20.93	23.03	R
LSD(P=0.05)		5.85	7.09	6.69	
CV(%)		11.30	12.34	10.88	

* R = resistance; S = susceptible; I = intermediate

Table 4. Characterisation of Nigerian sugar cane accessions according to their usefulness for breeding new varieties

Disease score (%)	Accessions	Significance for breeding
0-14	BD-07, KN-08, OG-07, OY-10, OY-16, OY-22, OY-26	Highly resistant accessions. Very useful in hybridisation schemes as parents.
15 - 25	LS-01, OY-11	Intermediate resistance. Usefulness in hybridisation questionable.
>25	BD-02, BD-03, KN-10, LS-05, LS-09, LS-15, LS-17, OG-07, OY-01, LS-20, KD-06 etc.	Highly susceptible accessions. Not useful in hybridisation.

structures appeared 5 months after planting (MAP) and ratooning (MAR).

Data on stalk colour, stalk length, stalk diameter, stalk weight, number of chewable/millable stalks per stool and field sucrose (brix) at harvest (12 MAP) were collected from 10 randomly selected stalks. Stalk length was measured from ground level to the top visible dewlap using a 4-metre rule. Stalk diameter was taken at the mid portion of the stalk with a pair of vernier callipers. The number of chewable/millable stalks was counted using a tally counter, and field sucrose (brix) was measured using a hand-held refractometer.

The smut reaction data were arcsine transformed according to Gomez and Gomez (1984) and were subjected to analysis of variance along with the agronomic data. Mean separation was done using least significance difference (LSD) at the 5% probability level. The accessions were characterised as recommended by Hutchinson and Daniels (1971).

Results and Discussion

It is important to have large numbers of sugar cane germplasm accessions in genebanks to allow diverse germplasm to be made available for use in sugar cane improvement programmes (Alexander 1989). From the present study, analysis of variance revealed significant differences between accessions in yield and yield-related traits (**Tables 1 and 2**). Five accessions, BD-07, KN-08, OY-10, OY-16 and OY-26, combined high brix and juice content with a desirable number of stalks per stool. Shah *et al.* (1966) reported that these traits are directly related to cane yield. Other accessions, KN-10, LS-16, LS-17, OG-03 and OY-22, had profuse tillering and a high number of stalks per stool.

Nine of the accessions were consistently smut resistant from the initial crop through to the second ratoon crop (**Table 3**). This suggests that the accessions are naturally adapted to the smut pathogen. The accessions were accordingly classified into groups based on their resistance to smut and their usefulness for breeding and/or for direct

planting by cane farmers where smut poses a major problem to sugar cane production (**Table 4**)

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