Volume 1 Issue 1

Journal of
CROP SCIENCE RESEARCH

Full Paper

JOCSR, 1(1), 2016 [001-015]

Yield components and cane yield losses of two sugar cane varieties affected by whip smut (*sporisorium scitaminem* sydow) in nigeria

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ABSTRACT

The yield components and cane yields of two sugar cane varieties Bida local and Co 957 were reduced by varying concentrations of *Sporisorium scitaminem* (H. Sydow & Sydow) [M. Piepenbr., M. Stoll & Oberw. 2002 (Syn: *Ustilago scitamiea* H. & P.Sydow)]) the causal organism for whip smut of sugar cane at Badeggi, (lat. 9°045'N; long 6°07'E at an altitude of 70.57m above sea level). The two varieties of sugar cane were inoculated with four levels of *S. scitaminem* inoculum, 0 x 10^6, 2 x 10^6, 4 x 10^6 and 6 x 10^6 teliospores/ml respectively and planted in a split plot design in four replicates between 1998 and 2000. Results showed that their yields were significantly impaired by the effect of whip smut. The 6 x 10^6 teliospores/ml inoculum concentration recorded the least yield in the two test cane varieties. The yields of Bida local in all the two crop cycles from 1998 to 2000 were significantly lower than the yields of Co 957 because the chewing sugar cane yields higher than the industrial sugar cane. Since the present study is an inoculated one and heavy inoculum loads were used and as the chewing sugar cane is hardly ratooned because of heavy *S. scitaminem* infection and its resultant poor yield in this report is not surprising. In contrast, the Co 957, an industrial variety, in spite of heavy smut incidence survives and ratoons better with high yield. However, the effect of the different concentrations of *S. scitaminem* obviously accounted for the observed yield declines, particularly in the ratoon canes of the two cane types in the present study.

KEYWORDS

Teliospores;
Inoculum concentration;
Crop cycle;
Chewing sugar cane;
Ratoon.

INTRODUCTION

Steady production of sugar cane in Nigeria by both sugar estates and smallholder farmers has been hampered by biotic constraints posed by pests and diseases. Many sugar cane diseases and pests reported in different parts of the world have also been reported in the country[32, 29, 8]. They include smut, red rot, leaf blast, sugar cane mosaic, pineapple disease, ratoon stunting disease, leaf scald, mottled stripe, pokkal boeng, sugar cane wilt disease[29, 34]. Wada (1997) and Wada *et al.*, (1998, 1999a) listed whip smut as the most important disease of sugar cane in Nigeria.

Whip smut is the most widespread disease of sugar cane and has been of importance at one time or another in many sugar cane growing areas[6, 29]. Whip smut is a serious disease of sugar cane and reaches epidemic proportions where susceptible cultivars are grown[30]. Whip smut, therefore, causes significant quantitative losses to cane growers worldwide.

Sugar cane yield losses by *S. scitamineum* are usually assessed on the percentage damage caused on the stalks or stools as Irvine (1982) and Bebee (1988) observed that accurate assessment of the damage caused by smut is not easy. Generally, damage assessments have been more in terms of the percentage of shoots and stools affected than of loss in yield. However, quantitative and qualitative forms of damage caused to cane by *S. scitamineum* have been reported from across the world. From India, Durairaj *et al*., (1972) reported yield losses of up to 50% in plant and 73% in ratoon crops, while Mathur (1975) observed reduction in sugar recovery of 40 - 90% in smut infected cane. Bachchhav *et al.*, (1979) also reported yield losses of 100% and juice reduction of 56 - 62%. Waraitch (1981) admitted the importance of smut in the Punjab, India and indicated that losses of up to 75.3% in tonnage and 22.2% in sucrose content occurred in the country. Alexander (1982) also noted a drop in sucrose by 2 -4 units of infected cane in India. Similarly, other workers have reported both qualitative and quantitative losses caused by smut in India. These losses in cane crops caused drastic reduction in yield of 80 to 120 day-old crops, increased invertase activity in leaves and apical meristem of infected sugar cane by *S. scitamineum*[23, 24, 25] Kumar *et al*., (1989) also reported a change in yield attributes juice quality and nutrients reduction in infected canes caused by smut. They observed reduced stalk length, girth, number of internode, moisture content and weight of canes and chlorophyll a and b content and constituents of smut infected cane.

In Brazil, Astiz - Gasso (1988) reported morphological abnormalities on sugar cane cultivars of varying resistances to *S. scitamineum* infection.

In Florida, USA, Valladares and Gonazales (1986) investigated the quality and juice lowering effect of *S scitamineum* and found that the disease caused a highly significant decrease in the height and diameter of the stalk, plant weight and juice in plant and ratoon crops. In Louisiana, Irvine (1982) reported drop in sucrose; purity and viscosity of cane juice and 20% loss in sugar recovery of smut infected cane. Also, other workers reported reduced number of healthy stalks of sugar cane infected by smut in Louisiana[16].

Peros (1984) reported sucrose inversion effect of *S. scitamineum* in France. Also Peros *et al*., (1986) studied carbohydrate metabolism of *S. scitamineum* from Florida and indicated that glucose, fructose or sucrose could be used interchangeably as C sources and noted the rapid inversion of sucrose. This result demonstrates the negative effect of *S. scitamineum* on sucrose, the actual yield of sugar cane. The negative effect of *S. scitamineum* on sucrose concentration in sugar cane leaves had earlier been reported.

From the West Indies, report by Whittle (1982) shows that *S. scitamineum* caused low yield of infected cane. Elsewhere, Gomez *et al*., (1989) conducted studies on exudate effects of *S. scitamineum* on cells of sugar cane. They observed that addition of the exudate of the pathogen unto media containing suspensions of known sugar cane varieties increased cell size and caused cell death, particularly in the more susceptible variety.

In Nigeria, the only report on *S. scitamineum* was that it led to the discontinued cultivation of the commercial variety D141/46 by the Nigerian Sugar Company, Bacita in 1978[22].

There have been no detailed studies carried out to investigate the quantitative losses caused on sugar cane in terms of yield components and cane yield in Nigeria. In order to bridge this gap in knowledge and provide sugar cane growers with information on the quantitative losses, the present study was, therefore, set up to investigate varying concentrations of *S. scitamineum* on the yield components and yields of two cane varieties.

MATERIALS AND METHODS

Two experiments were conducted between 1998 and 2000 at the sugar cane research field at Badeggi (lat. $9^{o}045$'N; long $6^{0}07$'E at an altitude of 70.57m above sea level) to determine the effect of different whip smut (*S. scitamineum*) inoculum concentrations on the yields of two sugar cane varieties.

Smut teliospores preparation

Fresh smut whips were collected from the field of a Bida local cane in the early hours of each morning for three days. These were dried under shade for one hour, scrubbed with hands covered with sterilized gloves to obtain smut teliospores, and then sieved using 53µm mesh. The sieved teliospores were weighed out in three categories of 10g, 20g and 30g and sealed in cellophane bags and stored in the refrigerator in the laboratory for inoculation process at a later date.

Preparation of planting setts

Cane cuttings of variety Co 957 and Bida local cane were made from 7 months old canes. The stalks were detrashed to expose the buds. The stalks were then cut into 3 budded setts and subjected to hot water treatment at 52^{o}C for 30 minutes in separate batches until the whole planting setts were heat-treated. The cane setts were then separated into groups of 120 stalks each representing the four treatments of 30 setts per treatment.

Preparation of smut teliospores suspension and inoculation

The 10, 20 and 30g smut teliospores earlier weighed out and stored in cellophane bags were each emptied into separate 50 litres of sterile water in three different inoculating containers. These were vigorously stirred to obtain a homogenous suspension of the teliospores' corresponding to 2, 4 and 6 g teliospores litre^{-1} which gave haemocytometer values of 2 x 10^{6}, 4 x 10^{6} and 6 x 10^{6} teliospores/ml concentrations. The cane cuttings were then immersed in each of these three-teliospore concentrations for 1 hour and then incubated overnight in wet sterile gunny jute bags and kept under the shade as described by Nasr (1977). They were then removed and planted in 5m x 5m plots in the field. There was uninoculated control for each of the two varieties.

Planting of the field trial for yield loss assessment

Each treatment (2 x 10^{6}, 4 x 10^{6} and 6 x 10^{6} teliospores/ml concentrations and the control from the 4 groups) was taken to the field in the sterile jute bags and planted in shallow furrows on flat ground. The two varieties treated with hot water were planted in main plots; while those inoculated with the different teliospore concentrations (0, 2 x 10^{6}, 4 x 10^{6} and 6 x 10^{6} teliospores/ml) were tested in sub plots in a split plot design with four replicates randomized using a table of random numbers. Each plot consisted of six- 5m rows and 1m apart, and the planting setts were laid continuously end-to-end, thus giving no intra-row spacing. The study lasted for two overlapping croppings consisting of two-plant cane (PC) (one each in 1998 and 1999) and two - ratoon canes (RC) (first ratoon of each trial in 1999 and 2000).

The 1999 trial was established in a separate field adjacent to the 1998 trial. Normal agronomic practices were carried out at the required growth stages of the canes till harvest.

Percent smutted stools and stalks were calculated by first counting the total number of stools and stalks in a plot using a tally counter. Then the number of smutted stools and stalks in the same plot was counted and expressed as a percentage of the total to determine the incidence of whip smut at 3, 6, 9 and 12 MAP or MAR.

Data collection

Observation and data collection were made on percent smutted stools at 3 and 5 months after planting or ratooning (MAP or MAR) using four inner rows of each plot (net plot) for percent smutted stools at 3, 6, 9 and 12 months after planting (MAP). The same procedure for data collection was followed for the first ratoon crop at 3, 6, 9 and 12 months after ratooning (MAR).

Procedure for the different measurements:

Percent smutted stools (smut disease incidence)

Percent smutted stools and stalks were calculated by first counting the total number of stools and stalks in a plot using a tally counter. Then the number of smutted stools and stalks in the same plot was counted and expressed as a percentage of the total to determine the incidence of whip smut at 3, 6, 9 and 12 MAP or MAR.

Plant height and stalk girth

Plant height was measured using a 4-metre rule from the ground level to the first visible dewlap. Stalk girth was measured using a pair of Vernier callipers. It was taken from three portions viz bottom, middle and top of five pre tagged stalks each for healthy and smutted plants in each plot.

Internode and leaf area measurements

The number of internodes per stalk of smutted canes was recorded at harvest from five randomly selected and tagged cane stalks using a tally counter. Internode and leaf area in smutted canes were measured with a 30cm ruler also from the base, middle and top or tip of the stalk or leaf. Leaf area was calculated by multiplying the length and width of the leaf with a factor of 0.89 as described by Basnayake *et al.*, (2015).

Number of millable /chewable stalks

The number of millable and chewable stalks was also taken at 6, 9 and 12 months after planting and first ratoon with the aid of a hand operated tally counter per plot and later converted to per hectare by multiplying the plot value by a factor of 666.67.

Single stalk and cane weight at harvest

The weights of single healthy and smutted cane stalks and cane yield were taken at harvest using a 50kg scale. The cane weight (yield) per plot was converted to tonnes per hectare by multiplying with a factor of 0.667.

All collected data were subjected to analyses of variance (ANOVA), and means were separated using standard error (SE) and Duncan's Multiple Range Test (DMRT).

RESULTS

Disease and yield assessments

Effects of inoculum concentration and sugar cane variety on plant height, 1998 – 2000

TABLE 1 shows that the two varieties had no significant height difference in 1999 plant and 1999 ratoon canes. In 1998, the plant cane of Bida local was taller at 9 MAP while at 12 MAP Co 957 was taller than Bida local. Similarly, Co 957 was taller in 2000 ratoon cane assessed at 9 and 12 MAR. TABLE 1 also shows that there was significant (P=0.05) increase in cane height with increase in inoculum concentration in 1998 plant crop at 12

TABLE 1 : Effects of variety and inoculum concentration on smut incidence and yield components of sugar cane at 9 MAP/MAR 1998 - 2000

Treatment	% smut incidence				Plant height (m) Stalk Girth (cm)							
	Plant Crop		Ratoon Crop		Plant Crop		Ratoon Crop		Plant Crop		Ratoon Crop	
	1998	1999	1999	2000	1998	1999	1999	2000	1998	1999	1999	2000
Variety (V)	25.3a	29.7a	42.8b	46.3a	0.7b	1.5a	1.4a	1.5a	2.9b	2.2a	2.3b	2.5b
Co 957	31.9a	36.0a	66.1a	51.8a	0.8a	1.1a	1.0a	0.7b	3.6a	2.6a	3.1a	3.0a
Bida local	32.9	54.5	49.1	0.8	1.3	1.2	1.1	3.3	2.4	2.2	2.8	28.6
Mean	6.0	4.80	2.80	0.02	0.10	0.20	0.20	0.9	0.30	0.04	0.60	0.60
SE+	NS	NS	*	NS	*	NS	NS	*	**	NS	**	**
Inoculum Concentration (I) teliospores/ml	0.0d	28.7b	59.2a	40.2b	0.0	1.3a	1.1c	1.1a	3.3a	2.6a	2.7a	2.9a
0.0	25.2c	28.7b	50.1a	48.2b	1.0a	1.3a	1.1c	1.1a	3.3a	2.5a	2.7a	2.7a
2×10^6	38.3b	22.1b	49.2a	45.7b	1.0a	1.3a	1.3b	1.1a	3.2a	2.4a	2.7a	2.6a
4×10^6	50.9a	51.2a	59.4a	62.2a	0.96	1.4a	1.5a	1.1a	3.1a	2.2a	2.6a	2.6a
6×10^6	28.6	32.3	54.5	49.1	0.7	1.30	1.3	1.1	3.2	2.4	2.7	2.7
Mean	2.30	6.00	6.80	3.90	0.06	0.10	0.10	0.20	0.10	0.20	0.10	0.10
SE+	**	**	NS	**	**	NS	NS	NS	NS	NS	NS	NS
Interaction V x I	NS	NS	NS	**	**	NS	NS	NS	NS	NS	NS	NS

Means followed by similar letter(s) are not significantly different at P=0.01, P=0.05 according to duncan's multiple range test (DMRT); NS = Not significant

MAP, and 1999 plant cane at 9 and 12 MAP. Similarly, there was significant increase in the heights of plant cane in 1998 at 9 MAP with increase in inoculum concentration; except that the height of the plants inoculated with 6 x 10^6 teliospores/ml inoculum was significantly shorter than those inoculated with 2 x 10^6 teliospores/ml and 4 x 10^6 teliospores/ml. The same table shows that differences in plant height of ratoon canes at 9 and 12 MAR in 1999 and 2000 were not significant. There were significant interactions of variety and inoculum concentration on plant height at 9 and 12 MAP in 1998 and at 9 and 12 MAR in 1999 (TABLE 1).

Effects of inoculum concentration and sugar cane variety on stalk girth, 1998 - 2000

TABLE 1 again shows that Co 957 canes treated with 6 x 10^6 teliospores/ml inoculum level were not significantly (P=0.01) shorter from those of Bida local, but were significantly shorter with the 4 x 10^6 teliospores/ml inoculum concentration at 9 MAP in 1998. At 12 MAP, Bida local had significantly (P=0.05) shorter canes than Co 957. The 2 x 10^6 teliospores/ml and 4 x 10^6 teliospores/ml inoculum concentrations did not produce canes with significant differences in height in Co 957, while canes treated with these concentrations were significantly different in height. The inoculated control did not produce smutted plants. For the 1999 ratoon cane, Co 957 inoculated with 6 x 10^6 teliospores/ml had significantly (P=0.01) taller canes than Bida local treated with the same concentration. However, Co 957 treated with 2 x 10^6 teliospores/ml and 4 x 10^6 teliospores/ml inoculum had cane plants with no significant differences in height, while Bida local showed significant differences in cane height from the two inoculum levels at 9 MAR. The uninoculated control had significantly shorter canes of Co 957 and taller canes of Bida local. At 12 MAR, however, significantly (P=0.01) shorter canes were obtained of Co 957 and Bida local treated with 6 x 10^6 teliospores/ml and 4 x 10^6 teliospores/ml inoculum concentrations respectively. Significantly taller canes were obtained of Co 957 and Bida local treated with 2 x 10^6 teliospores/ml and the uninoculated control respectively. Uninoculated Co 957 and Bida local setts inoculated with 2 x 10^6 teliospores/ml had canes that were not significantly different in height (TABLE 1).

Results presented in TABLE 1 also show that differences in stalk girth of smutted canes of plant canes in 1998 and 1999 at 9 and 12 MAP and of ratoon canes in 1999 and 2000 at 12 MAR were not significant. Smutted stalks of Bida local were significantly bigger than those of Co 957 at 6 MAP and at 6, 9 and 12 MAR in 1999 and at 6 MAR in 2000. The difference in stalk girth of smutted canes of the two varieties was not significant at 9 and 12 MAP in 1998 and at 9 and 12 MAR in 1999 and at 9 and 12 MAR in 2000. The same table shows that cane setts treated with 6 x 10^6 teliospores/ml inoculum concentration had significantly (P=0.01) thinner smutted stalks than other inoculum concentrations at 9 and 12 MAP in 1998 and at 9 and 12 MAR in 2000. The 1998 plant cane produced smutted stalks at 6 MAP and also with the uninoculated control at 9 and 12 MAP that were extremely tiny and so could not be measured. The 2 x 10^6 teliospores/ml inoculum concentration had significantly bigger smutted stalks at 9 and 12 MAP in 1998, while the check produced significantly bigger smutted stalks at 9 and 12 MAR in 2000. Interaction of variety x inoculum concentration was significant only at 6 MAR in 2000.

Effects of inoculum concentration and sugar cane variety on number of internodes, 1998 - 2000.

TABLE 2, shows that there was significant difference between the two varieties in the number of internodes in 1998 and 1999 plant canes at 9 MAP and at 9 and 12 MAR respectively, while the 1999 and 2000 ratoon canes shows significant difference between the two varieties at 6, 9 and 12 MAR. TABLE 2 also shows that there were significant differences in the number of internodes in smutted canes of the 1998 plant cane at 6, 9 and 12 MAP, except that the differences in the number of internodes of canes treated with 6 x 10^6 and 4 x 10^6 teliospores/ml and 4 x 10^6 and 2 x 10^6 teliospores/ml inoculum concentrations were not significant.

The same table shows that there were no significant differences in the number of internodes of smutted canes of the 1999 plant, and the 1999 and 2000 ratoon canes. There were significant interactions of variety and inoculum concentration on num-

TABLE 2 : Effects of variety and inoculum concentration on number of internodes of smutted canes, 1998 and 1999 plant and 1999 and 2000 ratoon canes

Treatment	1998 plant crop			1999 ratoon crop			1999 plant crop			2000 ratoon crop		
	6MAP	9MAP	12MAP	6MAR	9MAR	12MAR	6MAP	9MAP	12MAP	6MAR	9MAR	12MAR
Variety (V)												
Co 957	4.0a	6.8b	11.2a	6.9a	8.3a	8.4a	7.6a	8.3a	8.7a	14.2a	14.6a	15.0a
Bida local	4.5a	7.9a	9.7a	5.3b	5.5b	7.4b	7.6a	5.5b	7.2b	8.5b	9.2b	9.7b
Mean	4.3	7.4	10.5	6.1	6.9	7.9	7.6	6.9	8.0	11.4	11.9	12.4
SE±	0.30	0.14	0.56	0.50	1.10	0.80	0.60	1.10	0.90	1.7	1.50	1.40
	NS	**	NS	*	*	*	NS	*	*	*	*	*
Inoculum concentration (I) teliospores/ml												
0.0	0.0c	0.0c	0.0c	6.4a	7.5a	7.7a	7.9a	7.6a	7.4a	13.4a	13.8a	14.3a
2 x 10^6	6.1a	10.2a	14.7a	6.0a	7.0a	7.4a	7.8a	7.0a	7.3a	11.3a	11.8a	12.4a
4 x 10^6	5.8ab	9.7b	13.9ab	6.0a	6.4a	6.7a	7.3a	6.6a	7.1a	10.9a	11.6a	12.0a
6 x 10^6	5.3b	9.6b	13.3b	6.0a	6.2a	6.1a	7.3a	6.4a	6.4a	9.7a	10.3a	10.8a
Mean	4.3	7.4	10.5	6.1	6.8	7.0	7.6	6.9	7.1	11.3	11.9	12.4
SE±	0.60	0.12	0.93	0.90	1.1	1.10	0.60	1.10	1.10	1.6	1.5	1.5
	**	**	**	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction V x I	NS	**	NS	NS	NS	NS	*	NS	NS	*	*	*

Means followed by similar letter(s) are not significantly different at P=0.01, P=0.05 according to duncan's multiple range test (DMRT), NS = Not significant

ber of internodes at 9 MAP in 1998 and at 6 MAP in 1999 plant canes and at 6, 9 and 12 MAR in the 2000 ratoon cane.

Effects of inoculum concentration and sugar cane variety on internode length, 1998 – 2000

TABLE 3 shows that there was no significant difference in length of internodes between the two varieties except in the 1999 plant cane at 9 and 12 MAP. Bida local had significantly shorter internodes than Co 957 at 9 and 12 MAP in the 1999 plant cane. The other crop cycles produced no internodes with significant length difference.

TABLE 3 also generally shows that length of internodes of smutted canes was significantly (P=0.01) increased with increase in inoculum concentration at 6, 9 and 12 MAP and at 9 and 12 MAP in 1998 and 1999 plant canes respectively. Length of internodes of smutted canes of the 1999 plant cane at 6 MAP and the 2000 ratoon cane at 6, 9 and 12 MAR was not significant. Significantly, longer internodes of smutted canes were produced from the 6 x 10^6 teliospores/ml inoculum concentration compared to the significantly shorter ones from the 4 x 10^6 and 2 x 10^6 teliospores/ml inoculum concentrations, which were not significant between themselves at 6 and 9 MAP except at 12 MAP in 1998. On the contrary, the length of internodes of the 1999 plant cane was significantly different with increase in inoculum concentration. Except the 1998 plant cane at 6 and 12 MAP and the 1999 plant cane at 9 and 12 MAP, where differences in interactions of variety and inoculum concentration were significant, the other cane cycles had no significant interaction of variety x inoculum concentration.

TABLE 4 shows that there was no significant difference in length of internodes between the two varieties except in the 1999 plant cane at 9 and 12 MAP. Bida local had significantly shorter internodes than Co 957 at 9 and 12 MAP in the 1999 plant cane. The other crop cycles produced no internodes with significant length difference.

TABLE 4 also generally shows that length of internodes of smutted canes was significantly (P=0.01) increased with increase in inoculum concentration at 6, 9 and 12 MAP and at 9 and 12 MAP in 1998 and 1999 plant canes respectively. Length of internodes of smutted canes of the 1999 plant cane at 6 MAP and the 2000 ratoon cane at 6, 9 and 12 MAR was not significant. Significantly, longer internodes

TABLE 3 : Effects of variety and inoculum concentration on length (cm) of internodes of smutted canes, 1998 and 1999 plant and 1999 and 2000 ratoon canes

Treatment	1998 plant cane		1999 ratoon crop				1999 plant crop			2000 ratoon crop		
	6MAP		6MAR		9MAR	12MAR	6MAP	9MAP	12MAP	6MAR	9MAR	12MAR
Co 957	4.0a	4.8a	5.1a	5.9a	6.4a	6.4a	2.9a	9.2a	9.2a	7.4a	7.8a	7.7a
Bida local	3.2a	3.7a	5.2a	4.2a	4.1a	4.1a	2.9a	7.7b	7.7b	6.2a	6.1a	6.2a
Mean	3.6	4.3	5.2	5.1	5.4	5.4	2.9	8.5	8.5	6.8	7.0	7.0
SE+	0.46	0.85	0.32	0.90	1.10	1.10	0.20	0.30	0.30	0.30	1.20	1.00
	NS	NS	NS	NS	NS	NS	NS	*	*	NS	NS	NS
Inoculum concentration (I) (teliospores/ml)												
0.0	0.0c	0.0c	0.0c	4.3a	4.5a	4.5a	2.5a	7.4c	7.4c	6.2a	6.6a	6.6a
2×10^6	4.1b	5.3b	6.3b	5.1a	5.4a	5.4a	3.1a	7.6c	7.6c	6.5a	6.6a	6.6a
4×10^6	4.6b	5.8b	7.0a	5.3a	5.5a	5.5a	2.8a	9.0b	9.0b	6.9	7.1a	7.1a
6×10^6	5.7a	6.0a	7.4a	5.6a	6.1a	6.1a	3.2a	9.8a	9.8a	7.8a	7.5a	7.5a
Mean	3.6	4.3	5.2	5.1	5.4	5.4	2.9	8.5	8.5	6.9a	7.0	7.0
SE+	0.68	0.85	0.29	0.90	1.10	1.10	0.40	0.80	0.80	1.30	1.10	1.10
	**	**	**	NS	NS	NS	NS	*	*	NS	NS	NS
Interaction V x I	**	NS	*	NS	NS	NS	NS	*	*	NS	NS	NS

Means in a column followed by similar letter(s) are not significantly different at P=0.01, P=0.05 according to Duncan's Multiple Range Test (DMRT), NS = Not significant

of smutted canes were produced from the 6×10^6 teliospores/ml inoculum concentration compared to the significantly shorter ones from the 4×10^6 and 2×10^6 teliospores/ml inoculum concentrations, which were not significant between themselves at 6 and 9 MAP except at 12 MAP in 1998. On the contrary, the length of internodes of the 1999 plant cane was significantly different with increase in inoculum concentration. Except the 1998 plant cane at 6 and 12 MAP and the 1999 plant cane at 9 and 12 MAP, where differences in interactions of variety and inoculum concentration were significant, the other cane cycles had no significant interaction of variety x inoculum concentration.

Effects of inoculum concentration and sugar cane variety on leaf area, 1998 - 2000

TABLE 5 shows that there was significant (P=0.01) difference between the two varieties in the leaf area of smutted canes of the test varieties for the 1998 plant cane at 12 MAP and the 1999 plant cane at 9 and 12 MAP and the 1999 ratoon cane at 6 and 12 MAR. Smutted leaves of Co 957 were significantly larger than those of Bida local at these growth stages. Similarly, there were significant decreases in the area of leaves of smutted canes with increase in inoculum concentration in 1998 plant cane at 6, 9 and 12 MAP. The 1999 plant cane and the 1999 and 2000 ratoon canes did not produce smutted leaves that were significantly different in area as the result of increase in inoculum concentration. Interaction of variety x inoculum concentration was generally not significant except at 6 MAP in the 1998 plant cane.

Effects of sugar cane variety and inoculum concentration on number of millable and chewable canes, 1998 – 1999.

Results presented in TABLE 6 show that the two varieties had no significant millable and chewable number difference in 1998 plant cane. In 1999 ratoon cane Bida local consistently had less number of chewable canes than the number of millable canes produced by Co 957.

On the other hand, TABLE 6 also shows that there was no significant decrease in the number of millable and chewable canes with increase in inoculum concentration in 1998 plant cane at 6 and 9 MAP and in 1999 ratoon cane at 9 MAR. Significant (P=0.01) number difference was recorded at 12 MAP in 1998

TABLE 4 : Effects of variety and inoculum concentration on leaf area (cm^2) of smutted canes, 1998 - 2000

Treatment	Leaf length (cm)											
	1998 plant crop			1999 ratoon crop			1999 plant crop			2000 ratoon crop		
	6MAP	9MAP	12MAP	6MAR	9MAR	12MAR	6MAP	9MAP	12MAP	6MAR	9MAR	12MAR
Variety (V)												
Co 957	0.6a	0.7a	0.7a	0.7a	0.5a	0.1.0a	0.3a	0.7a	0.8a	0.5a	1.2a	1.2a
Bida local	0.6a	0.6a	0.5b	0.4b	0.3b	0.7b	0.3a	0.6b	0.6b	0.3a	1.1a	1.1b
Mean	0.6	0.7	0.6	0.6	0.4	0.9	0.3	0.7	0.7	0.4	1.2	1.2
SE+												
	*	NS	*	*	NS	*	NS	*	NS	NS	NS	NS
Inoculum concentration (I) teliospores/ml												
0.0	0.0c	0.0d	0.0d	0.6a	0.8a	1.0a	0.5a	0.7a	0.9a	0.5a	1.4a	1.4a
2 x 10^6	1.2a	1.6a	1.6a	0.5a	0.5b	0.9b	0.3b	0.5b	0.6b	0.3b	1.2b	1.2b
4 x 10^6	1.1a	1.3b	1.3b	0.5a	0.5b	0.7d	0.3b	0.5b	0.6b	0.3b	1.2b	1.2b
6 x 10^6	0.8b	0.9c	0.9c	0.4a	0.4c	0.8c	0.3b	0.5b	0.5c	0.3b	1.0c	1.1c
Mean	0.8	1.0	1.0	0.4	0.5	0.9b	0.4	0.6	0.7	0.4	1.2	1.2
SE+	0.10	0.10	0.08	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	**	**	**	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction V x I	**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means in a column followed by similar letter(s) are not significantly different at P=0.01, P=0.05 according to duncan's multiple range test (DMRT), NS = Not significant

TABLE 5 : Effects of variety and inoculum concentration on number of millable and chewable canes, 1998 plant and 1999 ratoon canes

Treatment	Number of millable and chewable canes					
	1998 plant crop			1999 ratoon crop		
	6 MAP	9MAP	12 MAP	6 MAR	9 MAR	12 MAR
Variety (V)	68740a	105800a	105000a	99710a	91150a	106400a
Co 957	62420a	83830a	82580a	25750b	18850b	20080b
Bida local	65580	94315	93790	62730	55000	63240
Mean	16650	13860	9040	10760	11350	4660
SE+	NS	NS	NS	**	**	**
Inoculum Concentration (I) teliospores/ml	78720a	1085a	107400a	64920a	59690a	72750a
0.0	73330a	103800a	102900a	64830a	56420a	64920b
2 x 10^6	56920a	92170a	102000a	61420a	53170a	61500b
4 x 10^6	53330a	74670a	62830c	59750a	50710a	53750c
6 x 10^6	65575	100335	93783	62730	54998	63230
Mean	9569	12500	11530	13150	11710	4477
SE+	NS	NS	**	NS	NS	**
Interaction V x I	NS	NS	NS	NS	NS	NS

Means in a column followed by similar letter(s) are not significantly different at P=0.01 P=0.05 according to duncan's new multiple range test (DNMRT), NS = Not significant

plant cane and at 12 MAR in 1999 ratoon cane on millable and chewable canes with increase in inoculum concentration, except that the number of canes from setts inoculated with 6 x 10^6 teliospores/ml inoculum was significantly less than that from setts inoculated with 4 x 10^6 and 2 x 10^6 teliospores/ml Interactions of variety x inoculum concentration were not significant on number of chewable and

TABLE 6 : Effects of variety and inoculum concentration on number of millable and chewable cane, 1999 and 2000

Treatment	Number of millable and chewable cane/ha					
	1999 plant crop			2000 ratoon crop		
	6 MAP	9MAP	12 MAP	6 MAR	9 MAR	12 MAR
Variety (V)	111600a	116700a	119100a	95880a	90330a	85040a
Co 957	80220a	79750a	82080a	2800b	17130b	20580b
Bida local	95910	148225	100590	61940	53730	52810
Mean	12310	14660	14760	5616	5041	2471
SE+	NS	NS	NS	**	**	**
Inoculum Concentration (I) teliospores/ml	109200a	103800a	106800a	69250a	65000a	62500a
0.0	101400a	98750a	100800a	60500a	57250a	53330ab
2 x 10^6	96820a	109800a	111800a	58000a	45420a	49420b
4 x 10^6	76280a	80670a	83000a	60000a	47250a	46000b
6 x 10^6	95925	98255	100600	61978	53730	52812
Mean	17200	16910	17030	7823	9858	3304
SE+	NS	NS	NS	NS	NS	**
Interaction V*I	*	*	*	NS	NS	NS

Means in a column followed by similar letter(s) are not significantly different at P=0.01 P=0.05 according to duncan's new multiple range test (DNMRT), NS = Not significant

millable canes in the 1998 plant and 1999 ratoon canes.

Results presented in TABLE 6 show that the two varieties had no significant number difference of millable and chewables canes at 6, 9 and 12 MAP in 1999 plant cane. On the other hand, the 2000 ratoon cane had significant number difference of millable and chewable canes at 6, 9 and 12 MAR. Bida local had consistently less number of chewable canes than the number of millable canes in Co 957 at 6, 9 and 12 MAR.

TABLE 6 also shows that there was no significant decrease in the number of millable and chewable canes with increase in inoculum concentration in 1999 plant cane at 6, 9 and 12 MAP.

Similarly, there was no significant decrease in the number of millable and chewable canes in 2000 ratoon cane at 6 and 9 MAR, except at 12 MAR where significant (P=0.01) decrease was recorded on number of millable and chewable cane with increase in inoculum concentration. Differences in number of millable and chewable canes were not significant with 6 x 10^6 and 4 x 10^6 teliospores/ml, 4 x 10^6 and 2 x 10^6 teliospores/ml and 2 x 10^6 teliospores/ml and check concentrations. Interactions of variety x inoculum concentration were significant (P=0.05) on number of chewable and millable canes at 6, 9 and 12 MAP in 1999 plant crop but not significant in the 2000 ratoon cane.

Effects of inoculum concentration and sugar cane variety on incidence and yield, 1998 plant crop and 1999 ratoon crop

TABLE 7 shows that in 1998, there was highly significant (P = 0.01) decrease in yield of the two test canes. Also at 3, 6, 9 and 12 MAP, there was significantly higher incidence of smutted stools of Bida local than Co 957. The same table also shows that in 1998, at 3, 6, 9 and 12 MAP, there was highly significant (P = 0.01) increase in incidence of whip smut on sugar cane stools with increase in inoculum concentration. There was highly significant (P = 0.01) interaction of variety and inoculum concentration on incidence of smutted stools. There was no significant interaction of variety and inoculum concentration on cane yield.

TABLE 7 also shows that in 1999 at 3 and 6 MAR, there was highly significant (P = 0.01) incidence of smutted stools of Bida local than Co 957, but no significant difference on disease incidence was observed at 9 and 12 MAR between the two varieties. At 3, 6, and 9 MAR, there were highly significant (P = 0.01) increase on disease of whip smut on sugar cane stools with increase in inoculum concentration, except that at 12 MAR the difference in incidence of whip smut on stools was not significant.

TABLE 7 again shows that the yield of the two varieties was significantly different from each other, with Bida local producing lower yield than Co 957. Similarly, the 1999PC gave highly significant (P = 0.01) decreased yield as inoculum concentration increased. The differences between the yield of cane following application of inoculum concentration of 6 x 10^6 and 4 x 10^6 teliospores/ml, 4 x 10^6 and 2 x 10^6 teliospores/ml were not significant but significant with the check. Interaction of variety and inoculum concentration on the yield of cane inoculated with whip smut was similarly significant.

TABLE 7 also shows that in 2000, there was no significant difference between the yield of Bida local and Co 957. In contrast, the ratoon yield was significantly (P = 0.01) decreased with increase in inoculum concentration. Interaction of variety and inoculum concentration was not significant.

DISCUSSION

In achieving the objectives of the yield components and cane yield losses studies, two varieties of sugar cane, Co 957 and Bida local, of known susceptibility to *S. scitamineum*[21, 34] were evaluated from 1998 to 2000.

Significant size difference was observed on Co 957 and Bida local healthy and smutted cane stalks at several growth stages of the canes assessed in 1998, 1999 and 2000. There was a contrasting reduction in stalk girth of smutted canes compared to bigger stalks in healthy canes. Whip smut drastically reduced the sizes of smutted Co 957 and Bida local cause at all the growth stages of the canes assessed, thus confirming its negative effect on affected sugar cane. Generally, no significant size difference was observed on stalk girth of healthy canes with increase in inoculum concentration in 1998 and 1999 plant and 1999 and 2000 ratoon canes. On the other hand, stalk girth was significantly reduced with increase in inoculum concentration at 9 and 12 MAP and 9 and 12 MAR in 1998 plant and 2000 ratoon canes respectively.

Interaction of variety and inoculum concentration was significant at 6 month growth stage each in 1999 plant and 2000 ratoon healthy canes and of 2000 ratoon smutted canes respectively, as well as at 12 month growth stage of 1999 and 2000 ratoon healthy canes. Best interactions of variety and inoculum concentration were obtained with 6 x 10^6 teliospores/ml inoculum and Co 957 and Bida local, where significantly thin stalks in healthy and smutted canes were got at 6 and 12 Mar in 2000. The generally significant interactions of variety x inoculum concentration observed with increasing inoculum concentration with significantly decreased cane sizes of affected sugar cane at 9 and 12 month (270 and 360 – d) in this study; is similar to reports by Padmanaban *et al.*, (1986b). The workers asserted that when smut appeared in 210-d old sugar cane, there was no marked reduction in yield. Stalk girth is a yield component of sugar cane, therefore, the significant smut effect at 9 month (270-d) and 12 MAR (360-d) suggest marked reduction in yield in terms of millable and chewable stalks at harvest. This observation therefore, differs from the report by Padmanaban *et al*., (1988b) probably because the significant smut effects occurred at later stages of the canes in the present study than the stages reported by these workers. Stalk reduction effect of whip smut on infected canes has been widely reported[19, 31]. Hence, the generally observed reduced stalk girth of the test canes in the present study agrees with the reports by these workers.

Investigation was also carried out on the effect of whip smut on number of internodes in healthy and smutted canes in the quantitative loss assessment in sugar cane from 1998 to 2000. Difference in number of internodes of Co 957 and Bida local was significant only in 1999 and 2000 ratoon canes at 9 MAR. Generally, effects of inoculum concentration and variety were not significant on number of internodes in healthy and smutted canes, except in 1999 ratoon cane at 12 MAR and in 1999 plant cane at 9 MAP and in 2000 ratoon cane at 9 and 12 MAR. Interactions of variety x inoculum concentration were also significant only in 1999 and 2000 ratoon canes at 12 MAR and 9 MAR respectively.

There was significant decrease in the number of internodes with increase in inoculum concentration only in 1998 plant cane at all the three growth stages assessed for number of smutted internodes. Interactions of variety and inoculum concentration were

TABLE 7 : Effects of variety and inoculum concentration on smut incidence and sugar cane yield of two plant and two ratoon crops at 9 MAP/MAR 1998 – 2000

Treatment	% smut incidence				Cane yield (tha)			
	Plant Crop		Ratoon crop		plant crop		Ratoon crop	
	1998	1999	1999	2000	1998	1999	1999	2000
Variety (V)	25.3a	29.7	42.8b	46.3a	115.1a	49.5a	85.0a	42.8a
Co 957	31.9a	36.0a	66.1a	51.8a	82.4a	39.0b	45.7b	47.1a
Bida local	28.6	32.9	54.5	49.1	98.9	44.3	64.4	45.0
Mean	2.30	6.0	4.80	2.80	11.50	0.90	2.60	10.0
SE+	NS	NS	*	NS	NS	**	**	NS
Inoculum Concentration (I) teliospores/ml								
0.0	0.0d	28.7b	59.2a	40.2b	117.9a	56.2a	81.9a	64.8a
2 x 10^6	25.2c	28.7b	50.1a	48.2b	106.2ab	48.16	68.5b	43.6ab
4 x 10^6	38.3b	22.7b	49.2a	45.7b	98.6ab	42.4c	59.06c	38.1ab
6 x 10^6	50.9a	51.2a	59.4a	62.2a	72.63	30.3d	52.2c	33.4b
Mean	28.6	32.3	54.5	49.1	98.8	44.3	65.8	45.0
SE+	2.30	6.00	6.80	3.90	12.0	2.50	3.80	7.00
	**	**	NS	**	**	**	**	**
Interaction V x I	NS	NS	NS	NS	NS	NS	**	NS

Means in a column followed by similar letter(s) are not significantly different at P=0.01 P=0.05 according to duncan's new multiple range test (DNMRT), NS = Not significant

significant in 1998 and 1999 plant canes at 12 and 6 MAP and in 2000 ratoon cane at 6, 9 and 12 MAR. The generally no significant reduction in number of internodes in smutted canes except in 1998 plant cane observed in the present investigation, differs from report by Kumar *et al*., (1989) who obtained reduced number of internodes in cane variety infected with *S. scitamineum* in India, but agrees with reports by Msechu and Keswani (1982), who also observed no significant differences in the number of internodes of infected canes in their yield determining study in Tanzania.

The few significant interactions of variety x inoculum compared to the greater number of non significant interactions of variety and inoculum concentration on number of internodes in healthy and smutted canes observed in the present study; suggest that the observed differences between Co 957 and Bida local might not be due to effect of smut. Bida local and Co 957 have contrasting characters with each other. While Co 957 is an industrial cane variety used in the processing of sugar, Bida local is the native variety known mainly for chewing[2] with characteristic different number of internodes from those of Co 957. However, the reduced number of internodes obtained in smutted canes in this study, could be as the result of elongated growth forced on affected plants by the effect of whip smut[18, 11]

The significant interactions of variety and inoculum concentration observed on the number of internodes in smutted stalks in 1998 and 1999 plant canes at 12 and 6 MAP, and in 2000 ratoon cane at 6, 9 and 12 MAP shows that Co 957 and Bida local treated with 6 x 10^6 teliospores/ml inoculum concentration, produced significantly fewer number of internodes. Msechu and Keswani (1982) noted similar behaviour to *S. scitamineum* in the different varieties studied in Tanzania, where whip smut effects ranged from no significant to significant on number of internodes.

The length of internodes in healthy and smutted canes was also assessed in the quantitative loss of sugar cane to whip smut in the present investigation. Difference in length of healthy internodes of Co 957 and Bida local were not significant, except in 1998 and cane at 6 and 9 MAP and in 1999 - plant cane at 9 MAP. Similarly, effects of inoculum concentration and variety on length of healthy internodes were not observed to be significant with increase in inoculum concentration. Interactions of variety x inoculum concentration were significant on length of healthy internodes in 1999 - plant cane at 9 MAP.

Similarly, significant length difference was observed on internodes of smutted Co 957 and Bida local canes only in 1999 plant cane at 9 and 12 MAP. On the other hand, significant length differences were observed with increase in inoculum concentration on internodes of smutted stalks only in 1998 plant cane at 6, 9 and 12 MAP and in 1999 plant canes at 9 and 12 MAP. The rest of the cane cycles had no significant length difference on internodes of smutted cane stalks. Interactions of variety x inoculum concentration were also significant only in 1998 - plant cane at 6 and 12 MAP, and in 1999 plant cane at 9 and 12 MAP and length of internodes of smutted cane stalks. The observed significant and no significant length differences of internodes in healthy and smutted stalks in the present study agree with reports by several workers. Antonie (1961); de Ramallo, (1980) and Kumar, *et al*., (1989) reported the effects of whip smut on infected cane to include slender stalks and shorter or longer internodes, depending on the variety. On the other hand, the significantly longer internodes observed with increasing inoculum concentration in the present study, differ from report by Msechu and Keswani (1982) who obtained reduced length of internodes in infected canes by *S. scitamineum* but agree with reports by Sivanesan and Waller (1986) and Comstock *et al*., (1983).

Variety difference only could not be responsible for the observed effect of *S. scitamineum* observed on length of internodes in Co 957 and Bida local as both were significantly increased with increase in inoculum concentration. The significantly long internodes of smutted Co 957 and Bida local observed in the present study, support reports by Mathur (1975) and de Ramallo (1980) who observed significantly longer internodes of affected canes by whip smut, especially the upper internodes[11]. Thus the aggregated effects of such elongated upper internodes could also be responsible for the observed significantly long internodes of Co 957 and Bida local treated with 6 x 10^6 teliospores/ml inoculum concentration in this study.

The 6 and 9 month growth stages of the 1998 and 1999 plant canes, where significant interactions of variety and inoculum concentration were observed on length of smutted Co 957 and Bida local canes, represent the midway as well as being close to the maturity stages of sugar cane, respectively. Thus, the significant interactions of Co 957 and Bida local and inoculum concentrations observed on internodes lengths of the two varieties could be due to added external inoculum from secondary infection which is expected to be higher at these stages of the growth of the two varieties. This could be so because, Hoy and Grisham (1988) reported on the spread and increase of smut and concluded that these were affected by interplay of interactions of cultivar infection characteristics. Such characteristics include smut recurrence rate in ratoon stools and the height of smut whips in relation to the crop canopy. Some of these interaction effects would have, therefore, added to the observed significant interactions of vareity and inoculum concentration on increased length of internodes of smutted Co 957 and Bida local.

The other yield component assessed in the evaluation of quantitative loss of sugar cane to *S. scitamineum* was leaf area of smutted canes.

Significant difference was observed on smutted leaf area of Co 957 and Bida local in 1998 plant cane at 6 and 12 MAP, in 1999 plant cane at 9 and 12 MAP and in 1999 ratoon cane at 6 and 12 MAR. Effects of variety and inoculum concentration were not significant on leaf area of smutted canes, except in 1998 plant cane at 6, 9 and 12 MAP. Interactions of variety x inoculum concentration were significant on area of smutted leaves only in 1998-plant cane at 6 MAP.

Generally, *S. scitamineum* reduced the area of leaves in infected canes in this study. The leaf area of infected canes were drastically with increasing inoculums concentration. Leaf reduction affects sucrose manufacture and subsequent accumulation in the stalk. The significant reduction in the area of leaves of infected canes by whip smut in the present study is also in agreement with reports by several workers[18, 19, 10, 24].

The numbers of healthy and millable as well as chewable stalks are yield components of sugar cane. Consequently, these were also assessed in the quantitative loss evaluations of sugar cane to *S. scitamineum*. Except in 1998 plant cane at 9 MAP, the number of healthy canes was significantly greater in Co 957 than in Bida local in 1998 and 1999 plant canes at 12 and 9 and 12 MAP respectively and in 1999 and 2000 ratoon canes at 9 and 12 MAR. Effects of variety and inoculum concentration were significant on number of healthy canes with increase in inoculum concentration in 1998 and 1999 plant canes at 12 and 9 MAP, and in 1999 and 2000 ratoon canes at 9 and 12 MAR. Interactions of variety and inoculum concentration were significant on number of healthy canes only in 1999 plant cane at 9 and 12 MAP and in 2000 ratoon cane at 12 MAR.

Significant difference was observed on number of millable and chewable canes in 1999 ratoon cane at 6, 9 and 12 MAR, but not in 1998 plant cane of the two varieties at any growth stage assessed. Effects of variety and inoculum concentration were observed to be significant on number of millable and chewable canes only in 1998 plant and 1999 ratoon canes at 12 MAP and MAR. Similarly, interactions of inoculum concentration x variety were also not significant.

In the second year evaluation, the two varieties had no number difference of millable and chewable canes between them. Effects of variety and inoculum concentration were significant on number of millable and chewable canes only in 2000-ratoon cane at 12 MAR. On the contrary, interactions of variety and inoculum concentration were observed to be significant in 1999 plant cane at 6, 9 and 12 MAP and not with 2000 ratoon cane.

Generally, the two test varieties showed significant difference on number of healthy and millable and chewable canes produced by them. Similarly, the number of healthy as well as millable and chewable canes was reduced with increase in inoculum concentration in the present study.

The observed significantly reduced number in healthy and millable and chewable stalks with increasing inoculum concentration corroborate reports by Mathur (1975) and Hoy *et al*., (1986); who observed that the most significant effect of whip smut on cane was the reduction in the number of healthy stalks of affected canes. They also corroborate others by Valladares and Gonazales (1986) and Villalon and Warfield (1988), who observed reduction in crushable or millable stalks by *S. scitamineum* in their separate studies and of course the significant reduction in chewable canes as well, recorded in the present study.

The observed seeming good yield in terms of number of healthy and millable and chewable stalks of Bida local in spite of severe whip smut effects in 1998 plant canes agrees with reports by Phelps and Donelan (1991) and Cawich and Rancharan (1980) who recorded clear evidence of recovery and eventual attainment of good yield following marked symptoms of whip smut in their test varieties, and good yield in spite of high smut severity respectively. Bida local, however, subsequently trailed behind Co 957 in the number of healthy and chewable stalks compared to higher millable stalks in the latter.

The observed generally greater number of healthy and millable stalks in Co 957 than Bida local show the inherent differences between the two varieties in terms of number of tillers per stool, the ability to survive ratooning as well as their ability to withstand high whip smut effects or not.

Cultivar Co 957 tillers more than Bida local, which is again more susceptible to *S. scitamineum*[34] than Co 957. These confounding factors might have, therefore, contributed to the observed significantly less number of healthy and chewable stalks in Bida local than the significantly greater number of millable stalks in Co 957 in the present investigation. The results of the present study are similar to reports by Glaz *et al*., (1989) who indicated that actual levels of smut produced in their inoculated studies to quantify levels of disease in infected canes and assess the resulting yield loss, were not as expected for all treatments. Thus, the differential response to *S. scitamineum* by the two varieties shows that actual levels of smut in them were also not as expected for all the different inoculum concentration.

Furthermore, the markedly reduced cane weights resulting from the highest inoculum concentration in this study supports the findings by several workers that smut infection reduces cane yield[19, 24, 16]. Each of the inoculum concentrations recorded its own markedly reduced weight effect on the test canes corresponding to the strength of the inoculum present at the time of infection at inoculation. Differences in smut effect have been known to occur as a result of initial inoculums[7]. Therefore, the observed significant differences on weights of infected canes in the present investigation are in line with the findings by other workers in other sugar cane producing areas such as Brazil where smut effects have been documented[7].

Whip smut caused significant loss of Co 957 and Bida local in all the two plant cycles between 1998 and 2000 in terms of reduced cane weight and this study has thus established detailed documented evidence on the yield components and cane yield losses incited on sugar cane by *S. scitamineum* in Nigeria. Sustainable management strategies are the next line of research to reduce the effect of whip smut on sugar cane in the country.

CONCLUSION

A detailed account of the effect of *Sporisorium scitamineum* Sydow & H. Sydow on yield components and yield of sugar cane has been given in this report. Earlier reports by Bergamin and Amorim, (1994) that increase in inoculums concentration increases whip smut disease impact on sugar cane have been corroborated by the present study. Studies on effective management strategies for whip smut are needed to combat the effect of the fungus on sugar cane.

ACKNOWLEDGEMENT

The first author is appreciative of the financial and logistic support to him by the Executive Director, National Cereals Research Institute, Badeggi to undergo the studies on whip smut of sugar cane leading to the award of the Ph. D degree at the University of Maiduguri, Nigeria. The second author guided and supervised the first author and he thankfully acknowledges the University of Maiduguri Management for giving him the chance to supervise the work. All field and laboratory staff of NCRI are thanked for their respective efforts to see the study through successfully.

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