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Research Article

COMPARATIVE SUSCEPTIBILITY OF SOME SUGARCANE GENOTYPES (*SACCHARUM SPP.*) TO MOTH BORERS *SESAMIA CRETICA LED.*, (NOCTUIDEAE) AND C*HILO PARTELLUS SWINHOE* (CRAMBIDAE); UNDER FIELD CONDITIONS AND THEIR EFFECTS ON YIELD IN SUDAN

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ABSTRACT

These trials were conducted at Sugarcane Research Center, Guneid; located at latitude 15°N, longitude 33°E, for three consecutive seasons namely, 2007/08-2009/10. Nine sugarcane genotypes, (hybrids of *Saccharum* spp.) Namely, B 70531; B 79136; BJ 7451; BJ 7938; BJ 82105; BT 74209; COC 671; DB 75159 and TUC 75-3 were evaluated against sugarcane stalk borers in a field trial with; three commercial varieties namely, CO 527; CO 997 and CO 6806 were incorporated as checks. Results showed the percentage of bored jointsof 1.68%, 1.21% and 1.63% in plant cane (PC); this gradually stabilized at 1.7%, 1.6%, and 1.74% in first ratoon crop (R1), and 1.26%, 1.17%and 1.14% in second ratoon crop (R2). The mean number of dead hearts determined per 15m2 tended to decrease from 1.13, 1.49, 1.31, 0.84 and 1.05 during successive counts from March to May.Accordingly, the infestation levels by cane borers during the trial period were very low therefore;no specific control measures were recommended rather, the continuation with current field practices.

INTRODUCTION

Sugarcane, hybrids of *Saccharum* spp. is grown in roughly 200 countries and is the main source of sugar, providing close to 70-75% of the world's sugar and the remaining 25-30% come from is from sugar beet (*Beta vulgaris*) and other artificial sweeteners (Draycott, 2000; Francis, 2006). It is a high management crop and probably the most domesticated amongst the various crop systems cultivated today. Sugarcane however, attained a strategic status as an important agro-industrial crop in the Sudan only recently; and currently contributessubstantially to the national economy. However, sugar productivity of this crop is adversely affected by several diseases caused by bacterial, fungal, viral pathogens worldwide and a variety of pests. (Rao *et al*., 1995; Ricaud *et. al*., 1989). Alexander (1982) indicated that diseases and pests cumulatively can cause yield reductions of between 15-20% under moderate levels of disease and pests. Easwaramoorthy and David (2005), also cited similar figures namely, 20% loss in yield and 15% loss in sugar recovery. However, Karla (1967) indicated that, total yield losses with certain diseases and pest patho-systems under epiphytotic conditions could be total.

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In the Sudan sugarcane smut disease caused by the fungus *Ustilago scitaminea* (Sydow) which is one of the earliest recognized diseases of sugarcane (Mc Martin, 1945) and the borer complex (mostly *Sesamia* spp and *Chilo* spp.) are most important on sugarcane. Smut appeared in the Sudan at Guneid Sugar Scheme in 1964/65 following the inception of the sugar industry (Abu Gideiri, 1965; Nasr and Ahmed, 1974).By 1968 it gained epiphytotic status and wiped out from production the best varieties of the time namely, NCO 310 and NCO376. Currently, smut is under good control through the use of resistant and/ or tolerant genotypes; such as CO 6806 and CO 997.

However, screening for smut resistance continues to be a major activity. The present work was undertaken to evaluate introduced sugarcane genotypes for resistance/ tolerance to sugarcane borer infestation under natural local field conditions; and to determine their economic status. Two important species in the Sudan are; the pink borer S*esamiacretica* (Led.) [Noctuidae: Lepidoptera] and the maize borer *Chilo partellus* (Swinhoe) [Crambidae: Lepidoptera]. Both species are known to act either as shoot borers, stalk borers and or top borers depending on the cane stage and environmental conditions specially temperature and relative humidity.

MATERIALS AND METHODS

The trials were conducted at the Sugarcane Research Centre-Guneid; located at latitude 15°N, longitude 33°E, for three consecutive seasons during the period 2007/08-2009/10.

Land and seed cane preparation

Standard methods of cane seed bed preparation of heavy disking, harrowing and ridging at 1.5m row spacing were adopted. Nine sugarcane varieties, mainly introductions from the West Indies (Barbados) namely, B 70531, B 79136, BJ 7451, BJ 7938, BJ 82105, BT 72209, COC 671, DB 75159, and TUC 75-3. The three genotypes e.g. CO 527, CO 997 and CO 6806 are commercial varieties and were included as local checks in the evaluation. Three eyed cane seed pieces or 'setts' were prepared from healthy un-bored 10 month old field grown cane and utilized as planting material for each genotype. Plot size was 1 row x10 m and 20 setts were planted per row; the trial was laid in a complete randomized block design with three replications. Cane was harvested at 14 months for plant cane and 12 months each for the ratoon crops.

Evaluation of borer damage

Plants with symptomatic dead heart were counted starting from first whip emergence about 60 days after planting (DAP), for plant cane and immediately after ratoon establishment in ratoons; the trials were inspected at monthly intervals for the characteristic dead heart symptoms of dead spindles either 'pullable' or 'unpullable' alike and the mean number of dead hearts was expressed on a per unit area basis per plot ($15m^2$). At harvest 10 stalks were sampled randomly from each plot and each stalk was inspected individually for borer holes, number of bored internodes, and total number of nodes per stalk was recorded. The number of bored (joints) nodes was determined and expressed as a percentage to the total number of nodes per stalk.The data was subjected to square root transformation and the statistical software 'MSTATC' was used to run the ANOVA and DMRT was used to locate differences between the means.

RESULTS AND DISCUSSION

Table 1. Details the incidence and percent bored joints in mature cane; in the plant cane (PC), and first ratoon (R1) crops are almost similar but,this gradually stabilized at much lower figures namely, 1.26%, 1.17% and 1.41% for the second ratoons (R2.) Table 4. Shows the incidence of 'dead heart' symptoms or killed spindles due to borer activity calculated on a $15m^2$ area basis. The general trend is downward from 1.13, 1.49, 1.31, 0.84, and 1.05 starting from March through May. These findings indicate that all the cane cultivars tested were prone to infestation and attack by the borer pest complex including the adapted check varieties; but, all at low intensities the refore, the amount of losses is hard to estimate. Nevertheless, Earwaramoorthy (1995), working in India indicated a yield loss of 3.5% for every 5% increase in the level of borer incidence. Therefore, utilizing this threshold as a benchmark it can be inferred that, the current incidences of between 1.17% and 2.42% as shown in Table (3), should give losses in terms of tons cane (TCF)/ feddanof about 1.0-1.5% (1ha=2.38 feddan). Furthermore, Earwaramoorthy (1995) stressed that under favorable conditions in certain geographical locations shoot borers could inflict mortality rates of up to 60% dead mother shoots and 6.4% primary tillers in plant cane and 20% shoots in ratoons.

However, in our view despite the excellent work of Earwaramoorthy (1995), reduction in sucrose is extremely variable and difficult to assess *per see* as it depends on several variables namely, the cane variety, age of crop, and the intensity of attack; henceforth more difficult to estimate. It was also shown that in Tamil Nadu losses amounted to 19.0, 16.3 and 8.6 tons per ha. When the mean percent damage was 40%, 42.9% and 55.4%. Mukunthan (1986) reported 4% yield loss at 10% incidence and loss in sugar recovery of 0.2-4.1 units from tropical India. In a separate study Marchelo-d'Ragga (2015) found losses to be about 1.22 units under Sudan conditions, which compares favorably. Also, it is evident that from the mean percent damage or bored joints as given in Table (1),

Table 1. Percent bored joints in the different sugarcane genotypes and artificial inoculation methods

Variety	Plant Cane (PC)			First Ratoon (R1)			Second Ratoon (R2)		
	(PPM)	(DM)	(NIM)	(PPM)	(DM)	(NIM)	(PPM)	(DM)	(NIM)
B 70531	1.78	0.95	1.67	1.45 abcd	2.29 a	1.30 c	1.07abcde	1.35 ab	1.40 ab
B 79136	1.57	1.87	1.96	2.28 ab	1.60 abcd	2.75a	1.62 ab	1.19 ab	1.37 ab
BJ 7451	2.29	1.67	1.84	2.42 a	1.99 abc	1.72 bc	1.52 abc	1.16 ab	1.30 ab
BJ 7938	1.78	1.17	1.72	1.97 abcd	1.33 cd	1.74 bc	1.24 abcde	1.89 a	1.44 ab
BJ 82105	1.32	1.33	1.23	1.42 bcd	1.31 cd	2.03 b	1.73 a	0.71 b	0.98 ab
BT 74209	1.19	1.05	1.26	1.07 d	1.44 bcd	1.83 b	0.71 e	0.71 b	1.26 ab
COC 671	1.57	1.23	1.7	1.40 bcd	2.23 ab	1.62 bc	0.95 cde	1.01 ab	1.78 ab
DB 75159	2.10	1.30	1.78	2.16 abc	1.89 abc	1.89 bc	1.57 abc	1.24 ab	1.19 ab
TUC 75-3	1.86	1.09	2.09	1.64 abcd	2.00 abc	1.89 bc	1.47 abcd	1.22 ab	1.26 ab
CO 527	2.06	0.98	1.24	1.20 cd	1.35 cd	1.34 bc	1.03 abcde	1.00 ab	1.84 a
CO 997	1.36	1.03	1.46	1.90 abcd	0.91 d	1.55 bc	1.43 abcd	1.36 ab	1.92 a
CO 6806	1.31	0.81	1.58	1.56 abcd	1.50 abcd	1.27 c	0.81 de	1.31 ab	1.22 ab
MEAN	1.68	1.21	1.63	1.7	1.6	1.74	1.26	1.17	1.41
SE	0.46	0.36	0.34	0.41	0.34	0.30	0.32	0.46	0.31
CV	33.3	36.63	26.2	29.4	25.2	21.3	31.4	47.3	27.2
LSD	ns	ns	ns	0.85	0.71	0.63	0.67	0.95	0.65

PPM = pin-prick methodDM = Dipping methodNIM = natural spreader row infection methods
Figures followed by the same letter do not differ statistically at (P=0.05) according to DMRT

Table 2. Cane juice quality of sugarcane varieties as influenced by the different crop cycles

VARIETY	PLANT CANE (PC)					FIRST RATOON (R1)					SECOND RATOON (R2)				
	BRIX	POL	PURITY	REC	FIBRE	BRIX	POL	PURITY	REC	FIBRE	BRIX	POL	PURITY	REC	FIBRE
B 70531	21.48bc	19.11abc	89.25	11.58	16.56a	21.49abcd	18.66bc	86.80b	10.97bc	-	21.30cd	19.45ab	91.31	11.59ab	-
B 79136	21.91ab	19.58abc	89.28	11.64	16.6a	21.39abcd	19.02abc	88.90ab	11.27abc	-	22.53b	20.08ab	89.09	12.06ab	-
BJ 7451	20.67bc	17.97c	88.09	11.41	17.05a	20.93bcd	18.96abc	89.16ab	10.97bc	-	21.22cd	18.51b	87.39	10.89ab	-
BJ 7938	21.73b	19.45abc	90.95	12.10	16.9a	22.02abc	19.42abc	88.15ab	11.57abc	-	22.26bc	19.77ab	88.76	11.89ab	-
BJ 82105	20.32c	18.17c	91.53	10.88	16.67a	20.31d	18.09c	89.08ab	10.57c	-	20.84d	18.60ab	89.24	10.95b	-
BT 74209	21.80ab	19.09abc	88.06	12.22	17.11a	21.91abcd	19.56abc	92.28a	11.67abc	-	22.62b	19.97ab	89.04	11.98ab	-
COC 671	23.07a	20.61ab	88.57	11.96	16.89a	22.61a	19.96ab	88.29ab	11.97ab	-	23.82a	20.99a	88.13	12.75a	-
DB 75159	21.00bc	19.27abc	90.19	10.81	16.9a	20.59cd	17.97c	87.24b	10.48c	-	22.06bc	19.32ab	85.97	11.49ab	-
TUC 75-3	21.10bc	19.17abc	90.29	10.93	17.13a	21.42abcd	19.19abc	88.67ab	11.25abc	-	22.08bc	19.76ab	89.45	11.82ab	-
CO 527	20.91bc	18.95bc	85.84	11.43	16.83a	22.23abc	19.81ab	89.11ab	11.86ab	-	22.57b	20.16ab	89.31	12.12ab	-
CO 997	23.65a	21.08a	90.58	11.44	16.53a	22.32ab	19.82ab	88.80ab	11.86ab	-	23.04ab	20.77a	90.13	12.58.a	-
CO 6806	2097bc	19.19abc	85.97	11.93	17.17a	22.51ab	20.62a	91.62a	12.46a	-	22.01bc	19.32ab	87.75	11.49ab	-
S.E.	0.62	1.01	1.72	0.47	0.35	0.50	0.48	1.25	0.38	-	0.36	0.54	1.6	0.45	-
C.V.	3.56	6.38	3.34	7.04	2.52	3.98	4.36	2.43	5.75	-	2.78	4.75	1.58	5.95	-
L.S.D	1.29	2.08	ns	ns	0.72	1.46	1.423	3.66	1.10	-	1.044	1.58	ns	1.188	-

REC = Recovery; Figures followed by the same letter do not differ statistically at (P=0.05) according to DMRT.

Table 3. Some growth and yield parameters for the different crop cycles

VARIETY	PLANT CANE (PC)			FIRST RATOON (R1)			SECOND RATOON (R2)		
	CTh (cm)	CHt (cm)	No of Nodes	CTh (cm)	CHt (cm)	No of Nodes	CTh (cm)	CHt (cm)	No of Nodes
B 70531	3.7a	274.4ab	32.0a	3.08ab	125.10e	20.67a	3.13a	140.3bc	24.4a
B 79136	3.1bc	248.8ab	25.5bc	2.36c	151.13abcd	19.47a	2.73ab	170.0ab	21.5bc
BJ 7451	3.1bc	263.2ab	23.6bc	2.63cde	172.4a	18.03a	2.60abc	199.9a	20.7bc
BJ 7938	2.9bcd	251.4ab	26.9bc	2.50de	130.07de	19.17a	2.70abc	138.0c	22.1abc
BJ 82105	3.3ab	268.5ab	28.0abc	2.54cde	163.87ab	19.33a	2.69abc	164.7bc	22.7ab
BT 74209	3.2ab	270.4ab	27.6abc	2.85bc	141.03cde	18.97a	2.82ab	152.5bc	21.0bc
COC 671	3.1bc	280.9a	28.1abc	2.77bcd	153.53abc	20.83a	2.69abc	131.2c	22.7ab
DB 75159	3.3ab	253.1ab	26.3bc	3.23a	145.43bcde	19.47a	2.83ab	160.7bc	21.0bc
TUC 75-3	2.9bcd	257.7ab	26.4bc	2.50de	145.47bcde	18.63a	2.64abc	163.0bc	22.5ab
CO 527	2.7cd	254.2ab	26.6bc	2.58cde	140.83cde	20.13a	2.33bc	154.8bc	20.6bc
CO 997	3.2b	235.8b	28.6abc	2.63cde	132.37cde	19.40a	2.57bc	159.4bc	20.5bc
CO 6806	2.6d	269.5ab	24.7bc	23.1e	153.67abc	17.97a	2.18c	159.3bc	19.4c
SE	0.14	10.8	1.53	0.10	6.8	1.0	0.16	10.2	0.85
CV	8.12	7.3	9.83	6.73	8.12	9.16	10.54	11.2	6.88
LSD	0.43	31.9	4.50	0.30	20.1	2.99	0.47	30.00	2.49

CTh = Cane thickness (cm),CHt = Cane height (cm), TCF = Tons cane per Feddan.
Figures followed by the same letter do not differ statistically at (P=0.05) according to DMRT.

Table 4. Mean number of dead hearts in the different sugarcane genotypes in the second ratoon crop estimated from a plot of 15 m^2

VARIETY	10/MAR	30/MAR	10/APR	30/APR	10/MAY	30/MAY
B 70531	0.966 b	1.403 b	1.274 ab	-	0.84 a	0.84 a
B 79136	0.966 b	1.185 b	0.966 b	-	1.05 a	1.05 a
BJ 7451	1.314 ab	1.403 b	1.476 ab	-	0.71 a	1.05 a
BJ 7938	1.127 ab	1.654 a	0.998 b	-	0.84 a	0.97 a
BJ 82105	1.386 ab	1.538 b	1.387 ab	-	0.71 a	0.71 a
BT 74209	0.925 b	1.031 b	0.926 b	-	1.05 a	0.84 a
COC 671	0.925 b	1.055 b	1.217 ab	-	0.71 a	0.84 a
DB 75159	1.464 ab	1.71 ab	1.319 ab	-	1.05 a	1 22 a
TUC 75-3	1.736 a	2.31 a	1.998 a	-	0.84 a	1.36 a
CO 527	1.055 ab	1.61 ab	1.44 ab	-	0.71 a	0.93 a
CO 997	0.925 b	1.76 ab	1.217 ab	-	0.93 a	1.35 a
CO 6806	0.836 b	1.27 b	1.45 ab	-	0.71 a	1.48 a
MEAN	1.13	1.49	1.31	-	0.84	1.05
SE	0.221	0.223	0.29	-	0.20	0.13
CV	36.23	31.27	44.7	-	33.18	33.7
LSD	0.65	0.642	0.839	-	0.40	0.26

Figures followed by the same letter are not different statistically at P=0.05 according to DMRT. Data was subjected to transformation by $\sqrt{(x + 0.5)}$.

the actual losses is bound to be as little and often goes undetected; in a hardy and vigorous crop as sugarcane which often responds by some compensatory tillers to borer attack. Karla, (1967), cautioned that although shoot borers usually attack the shoot stage it is also sometimes found to attack and act as cane stalk borer. Furthermore, Karla, (1968) demonstrated that if high temperatures and low relative humidity prevail *Chilo* spp. will behave as active shoot borers, but, under drought conditions and low rainfall and at temperatures of about 35^{0}C-38^{0}C and 50-75% RH shoot borers will continue on as stalk borers. And, he further stated that these conditions are also favorable and apply for other borer groups such as the root borer *Emmalocera depressella* (Swinhoe.). The behavior of these borers *Chilo* spp. and *Sesamia* spp. under Sudan conditions as top borers by way of creating the characteristic bunchy top symptoms/appearance due to the formation of side shoots resulting from dead spindles in older canes has not been observed; therefore, it can be concluded that their current damage is mainly confined as shoot and stalk borers and rarely as top borers. Cane performance both in cane quality, juice analysis and some growth parameters are given in Tables (3) and (4); no divergent differences were detected amongst the varieties compared to the check varieties; in all the parameters tested.

Conclusion

On the basis of findings in this study, the following suggestions and recommendations are made:

- Due to the low percent damage (bored joints) and low number of dead hearts per unit area; losses if at all are quite low; therefore no specific control measure is advised.
- It is believed that some biological agents/ parasitoids still otherwise unidentified, are keeping the borer populations at the current low levels. Therefore, more work is required in this area.
- Emphasis should be directed towards well balanced cultural practices to maintain the current equilibrium.

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