ESTIMATION OF YIELD LOSS IN SUGARCANE (*SACCHARUM* SPP.) DUE TO EFFECTS OF SMUT DISEASE IN SOME SELECTED SUGARCANE GENOTYPES UNDER SUDAN CONDITIONS

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ABSTRACT

This study was conducted at Sugarcane Research Centre, Guneid, (Latitude 15^0 N, longitude 33^0 E) in 2008/2009 cropping season. The objective was to estimate the amounts of losses (field and factory) incurred on sugarcane by the effects of smut disease of sugarcane caused by *Ustilago scitaminea* (Syd.). Replicated cane stalk samples were taken from each of three cane categories namely, whip-bearing canes from diseased stools (WBC-DS), apparently healthy looking canes from diseased stools (AHC-DS) and healthy canes from healthy stools (HC-HS) from some selected sugarcane genotypes. Results showed significant reductions of 5%, 4%, 5% and 40% for brix, sucrose content (pol %), estimated recoverable sugar (ERS) and stalk weight at (P=0.05), respectively in comparison to healthy canes. Fibre content of whip bearing cane stalks was significantly higher by 7% to that of HC-HS and AHC-DS; this is detrimental and responsible for losses in ERS. Moisture content and purity were however, found to be unaffected by the disease. This study has showed that, smut disease incurs losses to most cane yield parameters both in the field and factory. Therefore, cane growers need to properly manage this disease, the most feasible would be through the propagation and use of resistant/ tolerant sugarcane genotypes to the disease augmented by crop sanitation to maintain low levels of inoculum.

Key words: Yield loss; estimation; sugarcane; smut; *Ustilago scitaminea*; brix, sucrose content.

1. INTRODUCTION

Sugarcane, inter-specific hybrids of *Saccharum* spp. is grown in several countries and is the major source of global sugar it supersedes both sugar beet and other artificial sweeteners; and provides about to 70% of the world's sugar; and is the backbone of economies of many developing countries (CIRAD, 2005). Currently, sugarcane contributes substantially to the national economy in Sudan. However, productivity of this crop is affected by a variety of diseases caused by biotic and abiotic factors worldwide and a variety of pests, (Solomon *et al*. 2000; Ricaud *et al.* 1989). Waraitch (1995) reported a 15% loss in sugar recovery under Indian conditions. Elsewhere, other workers indicated that, losses due to diseases and pests could be total (Patil and Jain, 2000). Karla (1967) simply indicated that yield losses could be enormous depending on the crop cultivar, crop age, and type of disease involved and suitability of the temporal prevailing epiphytotic factors at the specific time. Nasr and Ahmed (1974) recorded smut disease which is incited by the basidiomycete fungus *Ustilago scitaminea* Syd. (Ustilaginales: Ustilaginomycetes) in Sudan in early sixties following its discovery in South Africa in 1897 (McMartin, 1945; Antoine, 1961). Thereafter, the disease spread quickly throughout the world and, it now occurs in all sugarcane producing countries except for a few islands in Polynesia, Fiji islands and Papua New Guinea (Steiner *et al.*, 1975). The disease is now endemic in Sudan following serious epidemics in late sixties and early seventies in which several superior varieties were lost (Abu Gideiri, 1965; Nasr and Ahmed, 1974). Field symptoms of culmicolous smut include the formation of a characteristic long, sometimes curved terminal sorus that is whip-like, (hence, the name whip smut disease); in which millions of diploid, airborne teliospores are produced thus perpetuating the disease. The disease affects both qualitative (mill loss) and quantitative (field loss) yield components of sugarcane, severity is often dependent on the climatic conditions age and variety of cane grown (Akalach and Touil, 1996; Croft *et al.*, 2000). However, no detailed studies have been carried out in Sudan on the extent of loss incurred by smut disease; therefore, this study was incepted to elucidate these loses attributable to smut disease in sugarcane under Sudan conditions.

2. MATERIALS AND METHODS

2.1 Yield loss assessment (field loss)

Quantitative field losses were estimated by collecting four bundles containing about 10-15 sugarcane stalks each from the selected sugarcane genotypes namely, BJ 84111, ROC-10, Kn 93-14, BJ 7451, BBZ 95681, B 79136, FR 9682, BJ 83125 and BT 83339. And the following parameters of; namely, Cane height (CHt), Cane thickness (CTh) and Cane weight (CWt) were determined from whip-bearing canes in diseased stools (WBC-DS), apparently healthy canes in diseased stools (AHC-DS) and healthy canes from healthy stools (HC-HS) which served as a control.

2.2 Assessment of quality losses (factory loss)

Quality losses were determined from cane stalks sampled as above. The total soluble solids (brix), sucrose content (pol), estimated recoverable sugar (ERS), purity and fiber were determined from each of: (a) whip bearing-canes in diseased stools (WBC-DS); (b) apparently healthy canes in diseased stools (AHC-DS) and healthy canes from healthy stools (HC-HS) to serve as control.

2.3 **Statistical analysis**

Data collected were subjected to analysis of variance by the statistical software MSTAT-C and Duncan's Multiple Range Test was used to locate differences between the treatment means.

3. RESULTS AND DISCUSSION

The combined ANOVA of mean squares for the effects of smut disease on some sugarcane genotypes is given in Table 1 and the parameter means are given in Table 2. Sugarcane genotypes ROC-10, BBZ 95681 and B7 9136 exhibited the highest brix (total soluble solids); sucrose content (pol %) and estimated recoverable sugar (ERS). The effects of smut disease on the various sugarcane quality and yield parameters are annotated in Table 3. Results showed that, whip bearing cane stalks had significantly lower brix, pol % and ERS values and stalk weight compared to healthy cane stalks at (P=0.05). Meanwhile, the fibre content of whip bearing cane stalks was significantly higher than that of healthy and apparently healthy cane stalks obtained from smut infected stools. However, cane parameters of moisture content and purity were not affected by the disease. Furthermore, Table 4 showed significant reductions (P=0.05) of most of the yield parameters as affected by the different levels of disease present. Sucrose content or pol (%) and cane weight were reduced by about 4% and 40% from that of healthy cane stalks. Also, brix and ERS followed a similar trend and were reduced each by 5% from that of healthy canes. Table 4 further showed that, fiber content in cane increased significantly (P=0.05) from that of healthy cane stalks by about 7%. It should be critically noted that high fibre content is detrimental in cane sugar processing and is known to reduce sugar recovery (ERS) at the factory (=mill loss). However, high fibre content is favored, in some countries where cane fibre is burned as an energy source to generate electricity or used in paper or hard-board making. These findings agree with the work of *Raga et al*., 1972; Misra and Ram, 1993; Alexander, 1995 and Solomon *et al*., 2000 who showed that smut could cause reductions of up to 3-20% sugar losses (mill loss) and 10-30% for cane (field loss). Lee-Lovick (1978) further showed that, losses can reach above 50%. Nevertheless, in our work moisture and purity remained un-affected at the levels of disease tested. The reductions in ERS and Pol are most detrimental to the sugar industry as they are directly affecting the economic aspect of the cane sugar production system.

Table 1. Combined ANOVA mean squares for the different yield and quality parameters as affected by the smut disease in selected sugarcane varieties.

Source of variation	df	MS								
		BRX	POL	MOIS	ERS	FB	SW (kg)	CT (cm)	CH (cm)	NON
Replicates	2	94.04	1.48	18.04	1.67	17.37	0.63	0.08	124.60	8.49
Treatments	8	7.77	4.78	5.88	5.49	01.78	2.27	0.21	798.40	12.24
Disease levels	2	12.68	3.63	4.69	4.12	16.93	7.87	0.10	4019.55	16.18
Error	16	0.69	0.71	3.343	0.81	1.59	0.71	0.04	192.34	3.84

BRX= brix; POL= pol %; MOIS= moisture; ERS= estimated recoverable sugar; FB= fibre; NON = number of nodes/ stalk; CT= cane thickness (cm); CH= cane height (cm); SW= stalk weight (kg); MS = mean square for characters.

Table 2. Sugarcane quality and yield parameters as affected by the smut disease in some selected sugarcane varieties.

Sugarcane genotypes	Sugarcane yield and quality parameters									
	Qualitative parameters						Quantitative parameters			
	BRX	POL	MOIS	ERS	FB	PTY	CT (cm)	CH (cm)	NON	SW (kg)
BJ84111	17.83 bcd	12.96 ab	66.68	10.88 ab	16.04	88.02	2.009 b	92.74 ab	15.31 ab	2.62
ROC-10	19.86 a	14.42 a	65.11	12.45 a	16.67	88.60	2.327 ab	83.02 b	15.61 ab	2.87
Kn93-14	17.28 d	12.07 b	67.27	09.93 b	16.03	85.10	2.338 ab	89.91 ab	16.39 ab	2.71
BJ7451	17.59 cd	12.90 ab	66.80	10.82 ab	16.40	89.05	2.132 ab	109.2 ab	15.09 ab	2.88
BBZ95681	19.47 a	14.15 a	65.00	12.16 a	15.88	88.89	2.319 ab	96.17 ab	16.40 ab	3.14
B79136	19.65 a	13.95 a	65.84	11.95 a	15.61	87.25	2.096 ab	101.6 ab	16.92 ab	2.78
FR9682	19.58 b	13.54 ab	66.42	11.51 ab	16.01	89.86	24.32 a	113.8 a	16.68 ab	4.25
BJ83125	18.26 bc	13.17 ab	66.89	11.10 ab	16.20	88.41	2.207 ab	99.32 ab	14.07 b	3.08
BT83339	18.50 b	13.59 ab	65.72	11.56 ab	17.09	89.75	24.41 a	98.42 ab	18.02 a	3.44
GM	18.56	13.42	66.19	11.37	16.21	88.44	2.26	98.24	16.05	03.09
S.E. ±	0.28	0.49	NS	0.52	NS	1.72	0.11	08.01	01.13	NS
C .V. (%)	5	6	3	8	8	3	8	14	12	27
$LSD_{0.05}$	0.79	1.46	2.33	1.56	2.18	5.14	0.35	24.01	3.39	0.79

Means in a column followed by the same letter(s) are not significantly different at (P=0.05) according to DMRT; BRX= brix (total soluble solids); POL= pol % (sucrose content); MOIS= moisture; ERS= estimated recoverable sugar; FB= fibre; NON= number of nodes/ stalk; CT= cane stalk thickness (cm); CH= cane stalk height (cm); SW= stalk weight (kg); NS= not significant.

Table 3. Sugarcane quality and yield parameters as affected by different levels of smut disease.

Disease levels	Character Means						
	BRX	POL	MOIS	PTY	ERS	FB	SW (kg)
A	19.20 a	13.76 a	66.44	88.59	11.76 a	15.54 b	3.69 a
B	18.65 b	13.43 ab	66.45	88.42	11.39 ab	16.02 b	2.89 b
C	17.84 c	13.12 b	66.10	88.30	10.98 b	17.09 a	2.65 b
GM	18.56	13.42	66.19	88.44	11.37	16.21	03.09
S.E. ±	0.22	0.12	NS	NS	0.13	0.17	0.12
C .V. (%)	5	7	3	4	9	7	19

Means in a column followed by the same letter(s) are not significantly different at (P=0.05) according to DMRT; BRX= brix (total soluble solids); POL= pol % (sucrose content); PTY = purity; ERS= estimated recoverable sugar; MOIS= moisture; FB= fibre; SW= stalk weight (kg); A= Healthy cane; B= apparently healthy cane from diseased stools; C= whip bearing canes from diseased stools; NS= not significant.

Table 4. Losses in sugarcane quality and yield parameters as affected by different levels of smut disease.

Disease levels	Character Means						
	BRX	POL	MOIS	PTY	ERS	FB	SW (kg)
A	19.20	13.76	66.44	88.59	11.76	15.54	3.69
B	18.65	13.43	66.45	88.42	11.39	16.02 (+0.48)	2.89
C	17.84	13.12	66.10	88.30	10.98	17.09 (+1.55)	2.65
DSA	18.25	13.27	66.28	88.36	11.18	16.56 (+1.02)	2.22
DICH	0.95	0.49	0.16	0.23	0.58	+1.02	1.47
PLDS	5	4	0.2	0.3	5	+7	40

BRX= brix; POL= pol % (sucrose content); MOIS= moisture; ERS= estimated recoverable sugar; FB= fibre; NON = number of nodes/ stalk; CT= cane thickness (cm); CH= cane height (cm); SW= stalk weight (kg); CM = character means; A= Healthy cane; B= apparently healthy cane from diseased stools; C= whip bearing canes from diseased stools; DSA= diseased samples average; DICH= decrease in comparison to healthy; PLDS= percentage of loss due to smut disease.

4. CONCLUSION

The results of this study indicated that, smut disease if left uncontrolled is detrimental to the sugar industry as it affects both the quantity (as high as 40% of cane weight- field loss) and quality namely, brix, ERS and pol% (up to 5% each – factory loss) of sugarcane. Subsequently, due to the difficulty encountered by sugar industries in the control and management of this disease the study suggests the rigorous screening of cane varieties and maintenance of a wide spectrum of resistant and tolerant cane genotypes to the disease by Institutions or other agencies that support cane growers/ industries to minimize the effects of this disease.

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