

ESTIMATION OF SUGAR LOSS DUE TO INFESTATION BY THE STEM BORER, *CHILO SACCHARIPHAGUS*, IN MAURITIUS

By A. RAJABALEE, L. C. Y. LIM SHIN CHONG and S. GANESHAN

Sugar Industry Research Institute, Rédiut, Mauritius

Abstract

To justify the cost effectiveness of sex pheromones for the control of the stem borer *Chilo sacchariphagus* Bojer in sugarcane, the relationship between the per cent internodes bored and the various yield parameters, i.e. pol % cane, purity, fibre % cane, industrial recoverable sugar % cane (IRSC) and weight had to be determined. Analyses were made on cane samples, with varying degrees of infestation, in each of the four climatic regions of Mauritius. Simple regression analyses were carried out between each of the yield components and the per cent internodes bored. Multiple regressions for loss in relation to degree of stem borer infestation and climatic regions were obtained for the per cent mass, IRSC and sugar loss. The multiple correlation coefficients were 0,95, 0,94 and 0,96 respectively.

Introduction

Chilo sacchariphagus Bojer was first recorded in Mauritius in 1850, probably introduced with cane cuttings from Java (Vinson,¹⁹). Although generally of no economic importance, except in a few localised regions, it has remained a chronic pest and a challenge to conventional biological control. No insecticide treatments are carried out in Mauritius, and control has been attempted through importation of natural enemies, of which eight species have become established.

In an attempt to improve existing control, studies on the use of sex pheromones were initiated in 1975 (Anon¹ Nesbitt *et al.*,¹⁶) and it was shown that total control through mating disruption was possible (Anon²). Determination of economic loss due to stem borer attack was a prerequisite to justify the cost effectiveness of any control method through the use of sex pheromones.

In 1953, Martorell and Bangdiwala¹¹ obtained different regression equations relating sucrose content to per cent infestation by *Diatraea saccharalis* (F) for tops, centres and bases of canes and also for whole canes. They concluded that whole cane samples gave better estimates of the loss sustained. Mathes *et al.*¹³ studied losses caused by *D. saccharalis* over a 23-year period and estimated the crop loss for that period to be 12%. Studies have also been carried out in Louisiana by artificially creating different levels of infestation with chemical treatments such as sulphur and cryolite. Samples taken from these plots were analysed for per cent joints bored, brix, sucrose content, weight per stalk and per cent juice extracted. Difference in losses between highly infested plots (62% joints bored) and plots with lower infestation (40% joints bored) were estimated at 1,22% in sucrose, 2,8% in purity and 5,0% in juice extraction (Mathes *et al.*^{14,12,15}).

Analyses (Ellis *et al.*⁹) made on 40 kg-cane samples with different degrees of infestation showed a decrease in (i) pol % normal juice, (ii) purity of normal juice and (iii) normal juice extraction % cane and an increase in fibre % cane in canes damaged by borers. An average decrease of 0,854%

in available sucrose % cane was observed in samples with a damage intensity of 20,17% compared with borer-free samples. It was suggested that damage per unit weight could give a better basis for estimating loss of sugar % cane caused by *D. saccharalis* damage. Similar results have been obtained by David and Ananthanarayana⁷ with *Proceras indicus* Kapur in India. Charpentier *et al.*⁶ working with *D. saccharalis* in Louisiana, found that different varieties suffered different degrees of losses for the same degree of infestation, and studies made over a 6-year period showed an average of 10% crop loss for an average infestation of 13% internodes bored (range 6-19%). Perez-Gonzalez *et al.*¹⁷ found significant correlation between infestation index and brix, pol, purity and sugar content for ratoon cane, but not for plant cane. However the influence on cane weight was insignificant.

David and Ranganathan⁸ found a high correlation ($r = 0,99$) between length of cane affected by stem borers and loss in quality. Significant loss in quality was noted, but only when infestation was high (exceeding 10% of the total length of cane).

Studies have also been conducted to determine the effect of the borer-rot disease complex on various parameters affecting yield of sugar. Brix and pol % cane were significantly lower in stalks attacked by borer - micro-organisms complex, while the reducing sugar content and fibre % cane were higher in damaged stalks. (David and Ranganathan,⁸ Silva and Moraes,¹⁸ Ayquipa *et al.*⁵).

In 1982 in Mauritius, a sampling method was devised for establishing a relationship between per cent canes bored and per cent internodes bored (Lim Shin Chong and Rajabalee¹⁰), and in 1984 and 1985 island-wide surveys were conducted to determine damage levels (Anon^{3,4}). In 1986 an attempt was made to correlate damage with loss of sugar sustained, which is described in this paper.

Materials and Methods

The study was conducted in ratoon fields over different climatic regions: five fields in each of the sub-humid non-irrigated and humid zones; and four fields in each of the superhumid and sub-humid irrigated regions. For each climatic region fields of the most common variety were selected (Table 1).

Samples consisting of whole stalks, with varying number of internodes bored, were cut from the smallest area of each field as was practically possible (about 0,10 ha) in order to obtain a sufficient number of bored and healthy stalks. Care was taken to choose stalks of comparable length and girth.

Stalks with the same number of internodes bored were grouped together as follows: Groups 0,1,2,3,4,5 and 6 with 0,1,2,3,4,5 and six or more internodes bored respectively. Canes with more than 6 internodes bored were not common enough to provide a sufficient number of samples.

Each group was divided to give approximately 10 or more samples of five stalks each. Percentage internodes bored and

Table 1
Most common varieties per climatic region

Climatic region	Average annual rainfall (mm)	Variety
Sub-humid non-irrigated	< 1500	M 555/60
Sub-humid irrigated	< 1500	M 555/60
Humid	1500 – 2500	M 13/56
Super-humid	> 2500	M 93/48

weight were then recorded for each sample. The samples were analysed for determination of pol % cane, juice purity, fibre % cane and brix. From these data, the industrial recoverable sugar % cane (IRSC) and % mass of sugar loss (compared to healthy canes) were computed.

Results and Discussion

Results are given in Tables 2 to 5. Simple regression analyses were carried out. The correlation coefficients are given in Table 6 and the regression equations corresponding to the cases when correlation coefficients were significant are given in Table 7. Borer infestation does not seem to affect the juice purity. For the other characters, there is high correlation in

Table 2
Mean values of % internodes bored and results of sugar analyses – Super-humid region

% internodes bored	Pol % cane	Purity	Fibre % g	IRSC	Mass of sample (kg)	% sugar loss
0,0	16,0	91,4	14,3	12,65	9,84	0,0
5,15	15,9	90,9	14,0	12,50	9,51	4,8
10,19	15,6	89,7	14,1	12,20	9,03	11,2
14,86	15,6	90,2	14,0	12,30	9,35	8,0
18,45	15,8	89,7	14,4	12,40	9,01	10,4
26,0	15,7	89,9	14,0	12,30	9,78	3,2

Table 3
Mean values of % internodes bored and results of sugar analyses – Humid region

% internodes bored	Pol % cane	Purity	Fibre % g	IRSC	Mass of sample (kg)	% sugar loss
0,0	15,4	88,8	13,3	12,2	8,42	0,0
4,0	15,4	89,3	13,5	12,1	7,95	5,88
7,73	15,4	89,4	13,6	12,0	8,14	3,92
11,22	15,5	90,2	13,6	12,2	7,81	6,86
14,90	15,3	90,0	13,5	12,0	7,29	14,71
18,24	15,3	90,2	13,7	12,0	7,16	17,65
24,19	15,2	89,2	14,0	11,9	6,99	15,69

Table 4
Mean values of % internodes bored and result of sugar analyses – Sub-humid irrigated region

% internodes bored	Pol % cane	Purity	Fibre % g	IRSC	Mass of sample (kg)	% sugar loss
0,0	16,4	92,2	14,2	12,9	5,89	0,0
5,68	15,6	92,2	14,2	12,9	5,74	2,63
11,29	16,2	92,2	14,8	12,8	5,42	11,84
16,89	16,0	92,3	14,5	12,6	4,93	18,42
21,53	16,2	92,1	14,3	12,8	5,46	7,89
24,18	15,5	90,1	15,0	12,1	4,87	15,79

Table 5

Mean values of % internodes bored and results of sugar analyses – Sub-humid non-irrigated region

% internodes bored	Pol % cane	Purity	Fibre % g	IRSC	Mass of sample (kg)	% sugar loss
0,0	17,1	92,4	13,1	13,6	6,17	0,0
5,41	16,9	92,1	13,8	13,4	5,73	6,10
11,09	16,8	91,7	13,4	13,4	5,49	9,76
16,15	16,7	90,0	13,6	13,0	5,36	15,85
21,47	16,2	90,5	13,9	12,8	5,17	19,51
26,07	16,0	90,1	14,0	12,6	5,03	23,17
34,22	15,7	88,9	14,1	12,3	5,24	23,17

Table 6

Correlation coefficients between % internodes bored and yield parameters by climatic region

Limatic region	Pol % cane	Purity	Fibre % cane	Mass of sample (kg)	IRSC	% Mass sugar loss
Super-humid	-0,6032	-0,791	-0,1895	-0,1645	-0,655	+0,792
Humid	-0,7320	+0,448	+0,885	-0,955	-0,7657	+0,973
Sub-humid irrigated	-0,3841	-0,5815	+0,6045	-0,8301	-0,7298	+0,926
Sub-humid non-irrigated	-0,9803	-0,00147	+0,8548	-0,8735	-0,988	+0,988

Table 7

Regression equations between % internodes bored (X) and yield parameters (Y) by climatic region

Climatic region	Pol % cane	Fibre % cane	Mass of sample	IRSC	% mass sugar loss
Super-humid	-	-	-	-	Y = 0,3896X
Humid	-	Y = 13,338 + 0,228X	Y = 8,386 - 0,615X	-	Y = 0,7837X
Sub-humid irrigated	-	-	Y = 5,893 - 0,0368X	-	Y = 0,6773X
Sub-humid non-irrigated	Y = 17,2 - 0,0403X	Y = 13,27 - 0,0258X	Y = 5,920 - 0,028X	Y = 13,68 - 0,0403X	Y = 0,8122X

the sub-humid non-irrigated region and low correlation in the sub-humid region. The positive correlation between fibre % cane and % internodes bored, except in the super-humid region, is to be noted. The highest correlation coefficients are obtained in the case of % sugar loss; the value corresponding to the super-humid region is the only one which is not significant. All the regression equations are given for this particular case (Fig 1-5).

Multiple regressions were carried out for the dependent variables % IRSC loss (IL), % weight loss (WL) and % sugar loss (SL). The independent variables are the % internodes bored (IB) and the dummy variables X₁, X₂, X₃ and X₄ where

- X₁ = 1, X₂ = 0, X₃ = 0, X₄ = 0 for super-humid region
- X₁ = 0, X₂ = 1, X₃ = 0, X₄ = 0 for humid region
- X₁ = 0, X₂ = 0, X₃ = 1, X₄ = 0 for sub-humid irrigated region
- X₁ = 0, X₂ = 0, X₃ = 0, X₄ = 1 for sub-humid not irrigated region

The equations obtained are:

$$IL = 0,21 IB - 0,65 X_1 - 1,69 X_2 - 1,29 X_3 + 1,15 X_4 \quad (1)$$

WL =
 $0,36 IB - 0,25 X_1 + 5,44 X_2 + 4,56 X_3 + 6,65 X_4$ (2)
 SL =
 $0,48 IB + 0,34 X_1 + 4,35 X_2 + 3,66 X_3 + 7,08 X_4$ (3)
 and the multiple correlation coefficients are 0,94, 0,95 and 0,96 respectively.

The negative signs in equation (1) show that for the super-humid, humid and sub-humid irrigated regions, the % IRSC loss is attenuated by the moisture content present. The regression equations show that only slight losses are obtained in the super-humid region and the biggest losses are obtained in the sub-humid non-irrigated region. The losses

obtained in the humid and sub-humid irrigated regions are similar, indicating that the loss in sugar due to borer infestation can be reduced by irrigation.

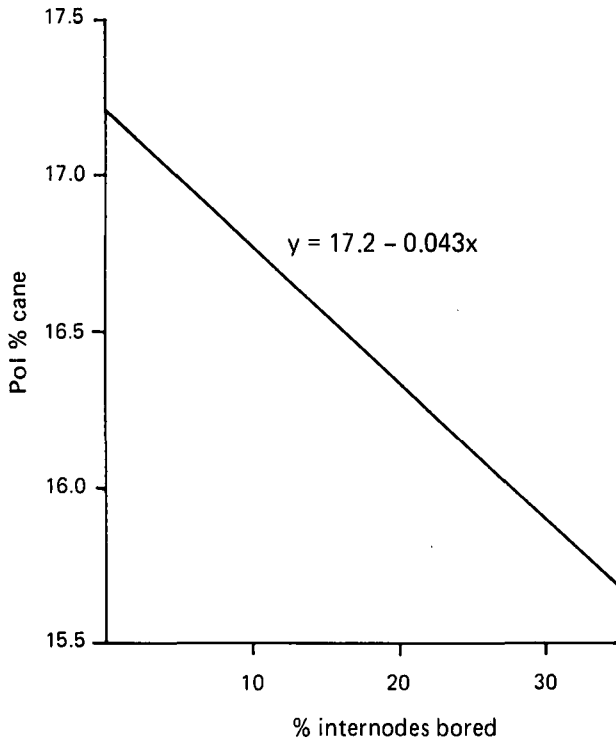


FIGURE 1 Losses in Pol % cane caused by stem borer infestation – Sub-humid non-irrigated zone.

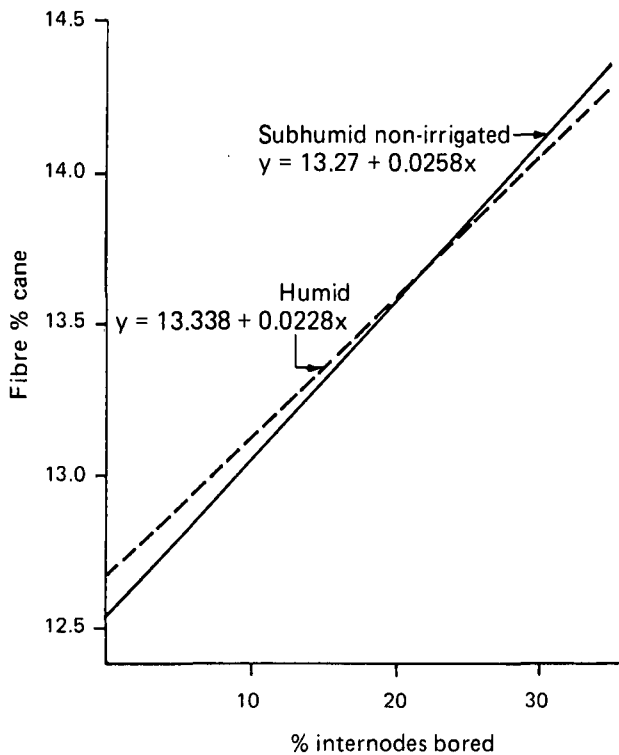


FIGURE 2 Effect of borer infestation on fibre % cane.

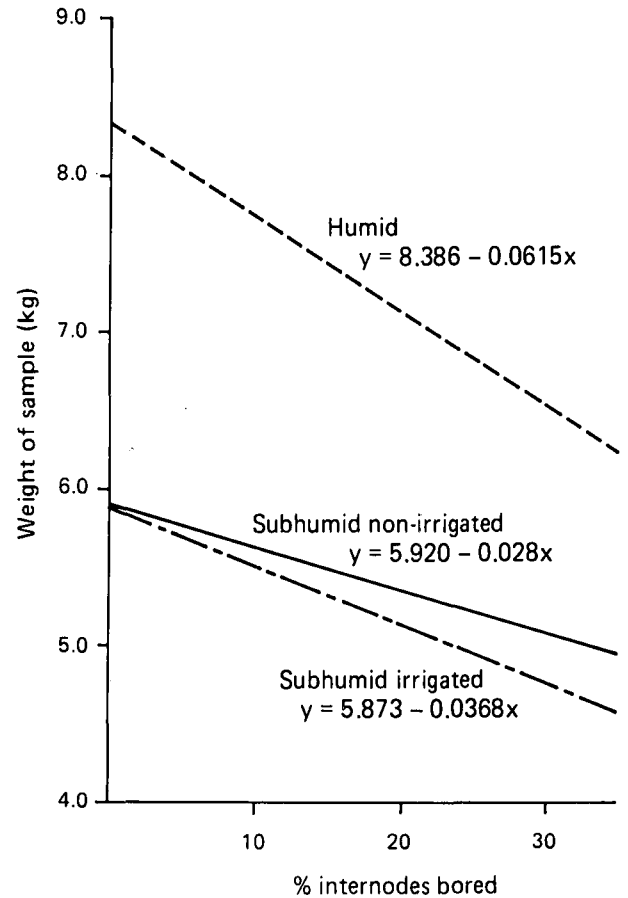


FIGURE 3 Losses in weight caused by stem borer infestation.

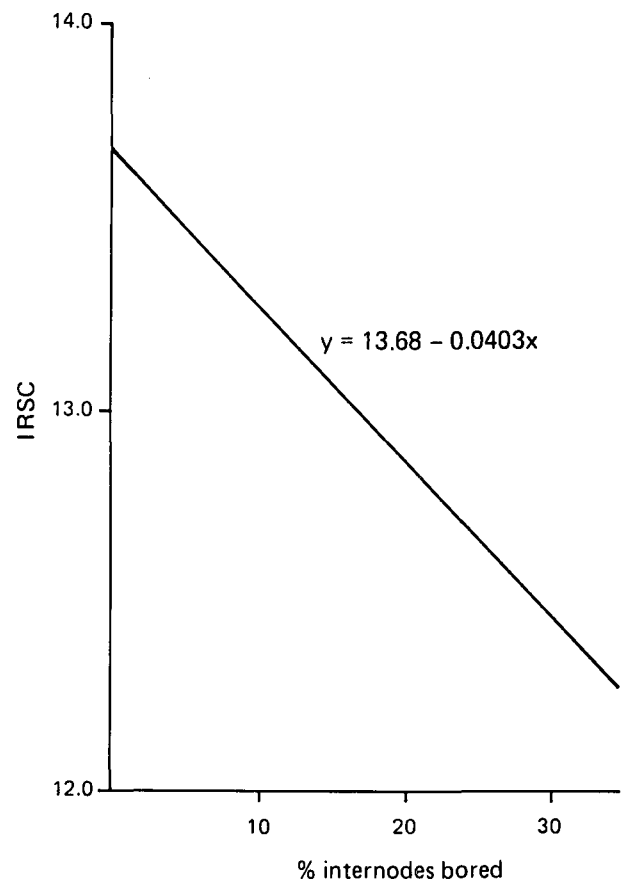


FIGURE 4 Losses in IRSC caused by stem borer infestation. Sub-humid non-irrigated region.

The study should be continued to include, especially, cases with higher infestation, and to investigate the effect of borer infestation on weight of stalks.

The equation (3) can be used provisionally as a model to predict, in future, the amount of sugar lost through borer infestation, provided the per cent internodes bored is estimated properly.

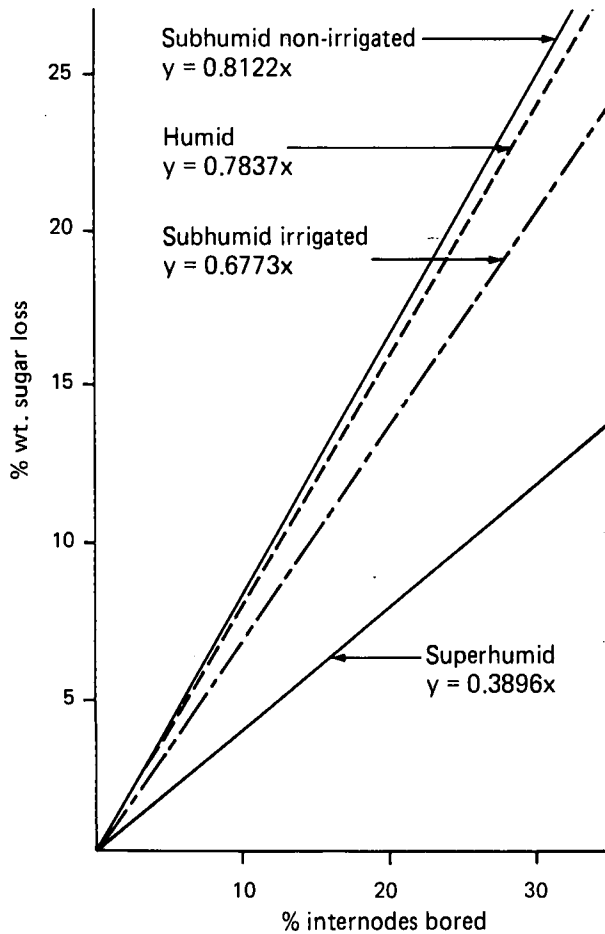


FIGURE 5 % weight sugar loss due to stem borer infestation by climatic region.

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