

SUSCEPTIBILITY OF SUGARCANE TO THE BORER *Eldana saccharina* Walker AND SELECTION FOR RESISTANCE

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Abstract

Eldana saccharina, an indigenous insect, is a pest of sugarcane. Factors that affect larval numbers and which have to be considered in breeding, are water stress, age, soils and nitrogen application. Resistant varieties have been selected and resistance in a sample of 200 varieties was associated with low values of brix % dry matter.

Introduction

The sugarcane stalk borer, *Eldana saccharina* Walker, was first observed in sugarcane in South Africa in 1939 when it attacked the variety POJ2725 in the Umfolozi area. The disappearance of the borer coincided with the change of variety to Co281 (Dick¹⁰). Eldana borer reappeared in sugarcane in 1970 in variety NCo 376 in the Hluhluwe area. Since then the pest has spread to many areas of the South African sugar industry (Atkinson *et al*⁵).

Eldana is an indigenous insect and is found in riverine vegetation along the Natal Coast as well as other parts of East and West Africa (Atkinson⁴). Its spread in sugarcane in South Africa has probably been due to the widespread distribution of the insect in its natural hosts adjacent to sugarcane rather than by migration of the moth or by the use of infested seed cane. At present eldana is endemic in more than 80 % of the sugarcane region and it is absent only in high altitude areas. Eldana has been found in all commercial varieties and the intensity of infestation is affected by growing conditions of the cane as well as by varieties. This paper concerns some factors which should be considered when selecting for resistance of sugarcane to attack by eldana, and the progress that has been achieved so far with breeding for resistance.

Factors affecting the selection of resistant varieties

Effect of eldana on yield of cane

The conventional method that is used to estimate crop loss in replicated trials has not been possible because there is at present no effective method for the prevention of an infestation by eldana. One estimate showed that eldana caused 0,1 % loss in recoverable sugar for every 1 % of the stalks damaged (Smaill and Carnegie¹⁷) while another indicated that some mills lost up to 20 % of the cane in the 1981/82 season (Anon¹). A third estimate of loss was a comparison of the yields of 20 varieties in two trials where one was more heavily infested with eldana than the other was and it was found that for every one eldana/100 stalks (1E/100) the loss in yield of cane was 0,45 % (Anon³). Finally, a similar value has been obtained by comparing the loss of cane yield in a trial with 160 varieties. The loss in yield of sucrose could be even greater, so the loss caused by eldana can be serious.

Conditions of sugarcane growth

Since the recent outbreak of eldana in 1970, emphasis has been placed on the factors that contribute to a high infestation. To plan selection procedures for obtaining resistant

varieties, the effect of these factors on larval numbers has to be known.

Age of cane was one of the first factors recognized to have an influence on eldana numbers (Carnegie and Smaill⁸). Field survey results showed that eldana numbers were much lower in 12 to 15 month old cane than in 20 month old cane. (See Fig. 1)

Water stress also has a marked effect on eldana numbers (Anon²). In a trial where cane was grown in drums, greater numbers and heavier larvae were recovered from stressed plants than from well-watered plants. The larval biomass in stressed cane was three to five times greater than that in unstressed cane. In a separate trial, the life cycle of eldana (eggs to moths) was 54 days in stressed cane and 84 days in well-watered cane. Virtually all the moths had emerged from stressed cane before the first moth had emerged from the watered cane.

Soil type affects eldana because of differences in water holding capacity. Most eldana damage to cane has been found in soils derived from Middle Ecca, Lower Ecca and Dwyka (Paxton¹⁵). These soils are shallow, so they have a low water holding capacity and the cane has a shallow rooting system.

Nitrogen application influences eldana numbers recovered from cane (Anon³, Carnegie⁷, Paxton¹⁵). With low applications of N, eldana numbers were fewer and their masses lower than those where higher rates of N had been applied. The effect of N-fertilization on eldana survival and growth is greatly increased if the cane is stressed and in some trials the larval biomass was increased up to ten-fold.

Varieties vary in their reaction to eldana. In one set of trials, moths did not show any varietal preference in their choice of site for oviposition. However, when eldana eggs were placed on different varieties of cane growing in drums there were differences between varieties both in the numbers of larvae recovered and the total biomass recovered per 100 eggs placed (Nuss and Atkinson¹⁴). A summary of all the results (Table 1) suggests that N11 is more susceptible than is NCo 376, and that N12, in which larval weights were low, is moderately resistant. A variety trial was used to monitor on a monthly basis the pressure of eldana larvae. When the trial was terminated after 13 months, there were up to 80E/100 in variety N52/219 and only 19E/100 in variety N7 (Fig. 1). Larvae were recovered at five months in N11 but only at 11,5 months in N7.

Table 1
Mean eldana numbers, mass and biomass in three varieties grown in drums

	Varieties		
	NCo 376	N11	N12
No. of eldana/drum	2,2	5,0	2,1
Mean mass of larvae (mg)	19,2	34,0	9,2
Larval biomass (mg)	42,2	170,0	19,3

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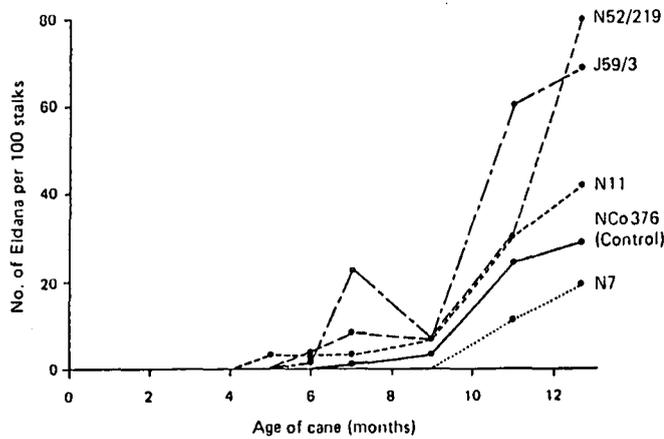


FIGURE 1 Eldana numbers in five varieties determined at monthly intervals

Breeding for resistance to eldana

Response to selection

Initial observations to determine the range in varietal resistance to eldana were not encouraging. From the results of several trials it appeared that the majority of varieties were more susceptible than the widely grown NCo 376 and that no varieties were completely free from the pest.

The Experiment Station farm at Mtunzini represents the area in the sugar industry where eldana numbers have been greatest and as the level of eldana on the farm has been high for many years, it was possible to exert selection pressure against varieties that are highly susceptible to eldana attack. Samples were taken from the third stage of the selection programme and the amount of internode damage was assessed for each variety. The distribution of varieties in the various classes of internode damage is shown in Fig. 2. In this trial more than 50% of the varieties were damaged less than NCo 376 was.

The first and second selection stages, from which these varieties were selected, were grown under conditions where eldana was prevalent, and it appears that an increase has been obtained in the proportion of varieties which are more resistant to attack than is NCo 376.

Varieties emanating from all the selection sites are evaluated together in the fifth selection stage. It was therefore possible to compare the reaction of eldana on these varieties at two sites, Mtunzini and La Mercy. The borer incidence at La Mercy was lower than at Mtunzini but the implications were similar (Table 2).

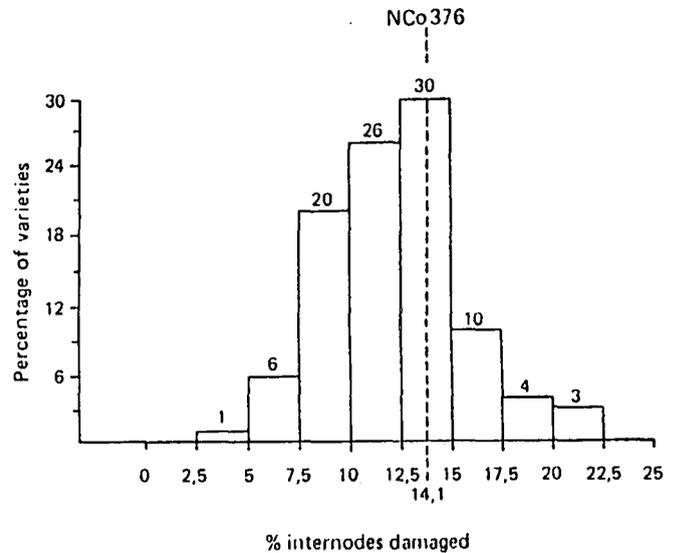


FIGURE 2 Distribution of stage III varieties from Mtunzini in different classes of internode damage

Varieties selected at Mtunzini had approximately one third as many E100 as varieties selected at Pongola and the Pongola-derived varieties had about twice as many eldana damaged stalks as those from Mtunzini.

NCo 376 showed less damage than the average for the selections from CFS, Shakaskraal or Pongola, but was more damaged than the average of the Mtunzini selections. The worst affected variety had 90E/100 while the least affected variety had only 11E/100.

Association of cane quality and eldana levels

In many variety trials, the correlations between eldana numbers and fibre and sucrose levels were low and variable. These comparisons were made with data obtained from trials affected by eldana. Recently a comparison was made in 13 variety trials in which the eldana infestation values (log E/100) were compared with quality traits of the same varieties grown in areas where little or no eldana occurred. The total number of varieties was more than 200 and the range of eldana infestation was between 1E/100 and 69E/100. The coefficients of correlation were significant for fibre % cane, brix % cane, brix % dry matter and pol % cane (Table 3). The factor most consistently associated with eldana numbers was brix % dry matter, the correlations with log E/100 being significant in all but one comparison. Fewer correlations with fibre were significant than would have been expected from previous comparisons.

Table 2
Eldana damage and numbers in two trials in varieties from different selection sites

Selection site	Mtunzini variety trial		La Mercy variety trial	
	Damaged stalks (%)	Eldana per 100 stalks	Damaged stalks (%)	Eldana per 100 stalks
Mtunzini	66	23	37	5
CFS	91	51	65	9
Shakaskraal	90	58	71	12
Pongola	90	64	68	11
NCo 376 (control)	79	39	51	4
N55/805 (control)	93	46	45	10

Table 3

Coefficients of correlation of the log of eldana numbers per 100 stalks (E/100) and cane quality traits in cane of various ages.

Age of cane	Comparison	No. of observations	Mean E/100	Fibre % cane	Brix % cane	Brix % dry matter	Pol % cane
Long season (18 months)	1	23	62,0	-0,33	0,23	0,40*	0,20
	2	22	66,7	-0,38	0,42*	0,52**	0,40*
	3	33	9,9	-0,31	0,32	0,44**	0,30
	4	32	48,9	-0,41*	0,47**	0,61**	0,48**
	5	25	46,7	-0,53**	0,43*	0,57**	0,42*
Short season (12-15 months)	6	26	1,5	-0,57**	0,15	0,55**	0,00
	7	24	10,7	-0,20	0,12	0,27	0,15
	8	30	11,2	-0,29	0,19	0,39*	0,16
Long season PHS+	9	29	28,9	-0,20	0,49**	0,51**	0,45*
	10	21	41,6	-0,53*	-0,03	0,48*	-0,01
Short season PHS+	11	24	18,6	-0,35	0,29	0,52**	0,28
	12	15	11,7	-0,36	0,46	0,75**	0,44
	13	27	1,5	-0,46*	-0,05	0,43*	-0,12

*** Significant at the 1% and 5% level of significance, respectively.

+ PHS = pre-harvest sample for cane quality determinations taken 1,5 to 3,0 months before harvest.

Discussion

The effect of eldana damage on the yield of sugarcane appears to be variable and the estimates are about 0,45% damage for every 1% stalk damage or 1E/100. These values are similar to estimates recorded in other countries. In Egypt, the borer *Chilo agamemnon* apparently caused a decrease in sugar yield of 0,65% per 1% infestation (Kira and El-Sherif¹²) while in India, another *Chilo* borer caused a loss of 0,1% pol for every unit increase in borer intensity (Verma¹⁸).

Eldana borer numbers are influenced by the conditions in which the crop grows. Age of cane, application of nitrogen and varieties are all factors that can be manipulated to control eldana. Cane is now harvested at a younger age in areas prone to eldana and reduced applications of nitrogen have been advocated. Excessive amounts of N should be avoided.

Water stress has been associated with higher borer numbers in Trinidad (Schaff¹⁶) and this is probably the most important factor in the eldana/sugarcane plant relationship (Anon³). Plants affected by water stress have higher amounts of nitrogen in the stalk which probably accelerates both the growth of the borer and its life cycle. Borer numbers in sugarcane crops have been reduced in several countries through the use of resistant varieties (Hensley, *et al*¹¹, Bastos, *et al*⁶ and David and Joseph⁹). In a detailed study of the inheritance of resistance to *Diatraea saccharalis*, a borer of sugarcane, the heritability was found to be high, which indicates that selection for resistance should be successful (Macedo, *et al*¹³). Also the present results are encouraging in showing that a shift towards a greater proportion of resistant varieties in breeding material can take place when the selection is performed in an area such as Mtunzini farm which is fairly heavily infested with eldana. Screening of varieties planted in drums has been introduced in the programme (Nuss *et al*¹⁴) to supplement observations in field trials because levels of infestation can vary between plots as well as from year to year.

The correlation between eldana numbers and brix % dry matter was positive and significant and indicated that varieties with high sucrose tend to be susceptible to eldana. However, the values of the correlation were generally only moderate ($r = 0,39$ to $0,75$) and a proportion of varieties which are both resistant to eldana and moderately high in sucrose can be expected in material under selection. For

example N7, N12 and N17 are relatively resistant to eldana and have sucrose contents similar to or better than that of NCo 376. Indeed, some promising seedling varieties such as 75L1463, 77F637 and 79M1235 have high sucrose levels as well as reasonable resistance to eldana.

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