

METHODS USED TO MEASURE THE SUSCEPTIBILITY OF SUGARCANE VARIETIES TO ATTACK BY *ELDANA SACCHARINA* WALKER

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Abstract

A quick method is needed to determine the susceptibility of sugarcane to attack by eldana borer. Plants of three varieties and of differing ages of cane were tested for attractiveness of the plant to an ovipositing moth and for the performance of the larva when feeding. The preference of moths for certain varieties was studied by releasing moths into a large cage containing potted plants of the three varieties, and the number of eggs laid on each plant was counted. To measure larval performance, about 100 eggs were placed on each plant. After a period during which 500 day-degrees above 15°C had accumulated (the minimum duration of one larval stage in sugarcane), the survivors were counted and weighed. The methods used and the problems encountered are described and results from initial trials are presented.

Introduction

The borer, *Eldana saccharina* Walker reappeared as a pest of sugarcane in 1970 (Carnegie³) and has since spread to most areas of the South African sugar industry (Paxton⁷). Numerous research programmes have been initiated to study and control the pest (Carnegie^{4, 5}).

Research on the susceptibility of varieties to attack by eldana has received little attention apart from the assessment of the presence of eldana in variety trials. Some information (Atkinson¹; Carnegie^{3, 4, 5}) has been published and is being used as a guide when varieties are recommended. However, the wide variation in eldana numbers in the trials has made it necessary to assess several trials before the results can be used. Infestation by eldana is affected by the age of cane, variety, soil type, soil moisture content and chemical ripeners (Carnegie^{4, 5}). Methods that can be repeated and that are not affected by other factors are required to enable the reaction of eldana borers to different varieties to be determined.

The two aspects of cane susceptibility to eldana infestation which were investigated were differences due to the variety and to the age of the cane. Both the attractiveness of the plant to an ovipositing moth and larval performance, measured by the number and biomass of larvae, were assessed.

Methods

Cane plants

Two budded setts of cane were planted in a mixture of sand, soil and compost in 25 drums (surface area 0,07 m²) on 4 December 1981. The drums were kept in a glasshouse for the first month until the plants were established. Thereafter they were moved onto a terrace where they were watered regularly and fertilized with 30 g 5.1.5(47) fertilizer on 5 February, 9 March, 27 April and 5 May.

Three varieties were planted: NCo 376, the standard commercial variety, N11, which appeared to be more susceptible to eldana attack than NCo 376, and N12 which, in some trials, appeared to be less susceptible than NCo 376. No attempt was made to prevent natural infestation by eldana and other borers, and all drums received the same treatment.

Moth preference

At the start of each experiment, drums containing the three cane varieties were placed under a frame covered with 40% plastic shade cloth through which no moths could enter or escape. The drums were spaced 30 cm apart and the floor was lined with black plastic sheets. Newly emerged moths were released into the cane each afternoon for the duration of the four experiments. The experiment lasted four days in summer, and nine days in winter, which is the duration of the egg stage. Details of the experiments are contained in Table 1.

TABLE 1

Moth preference trial; details of Experiments 1 to 4

	Experiment No.			
	1	2	3	4
Age of cane (months)	3,8	7,7	8,0	10,3
Date experiment started	29/3	26/7	7/8	15/10
No. of replications	4	7	6	12
No. of drums per replication	5	1	3	2
Duration - number of nights	4	9	9	5
No. of moths released per night:				
Males	25	50	50	50
Females	25	50	50	50
Total number of moths released	200	900	900	500

On the predetermined date, the cane in each drum was searched thoroughly for eldana eggs. To avoid any bias, each worker searched three drums. In Experiments 1, 2 and 3 experienced staff searched for and counted the eggs. In Experiment 4, some of the staff were inexperienced, and the eggs were placed in vials and counted later with the aid of a dissecting microscope. The dry leaves and trash from each drum in Experiments 2 and 3 were weighed and in Experiment 4, the dry leaves, which were attached to the stalks, were weighed separately from the loose trash. The number of eggs found in the dry leaves and loose trash were recorded separately. A sucrose analysis was carried out on cane stalks from Experiments 2, 3 and 4.

Larval performance

The details of three experiments conducted in the plant breeding glasshouse to measure larval performance are contained in Table 2. In Experiment 5 the drums of one variety were placed together in a replication and in Experiments 6 and 7 the drums were placed in a randomized latin square design. Plants were placed in the glasshouse two weeks before they were artificially infested so that any larvae from natural infestations could emerge as moths. In addition, light traps were used in the glasshouse so that the emerging moths would not re-infest the plants.

Known numbers of eldana eggs which had been laid on tissue paper in an artificial culture and which were about to hatch, were placed between the leaf sheaths and stalks in each drum on three or four consecutive days until there were approxi-

TABLE 2

Details of larval performance trials; Experiments 5 to 7

Experiment No.	Age of cane at start (months)	Starting date	Duration of trial (days)	No. of replications	No. of drums per replication
5	3,8	29/3	32	3	6 or 7
6	8,0	19/7	32	8	3
7	11,0	1/11	28	8	3

mately 100 eggs per drum. The cane was watered daily during the trial.

The experiments were conducted until 500 day-degrees above 15°C had accumulated, which is the minimum duration of the larval stage in sugarcane (Atkinson²). The cane was cut at soil level, the leaves removed carefully and the stalks split open. All eldana larvae and pupae from each drum were counted and placed in small vials to prevent desiccation, and weighed after each drum had been searched.

Results and Discussion

Condition of cane

The cane which had been growing in small drums for up to 11 months was uniform in appearance, and sucrose analyses of the cane from Experiments 2, 3 and 4 confirmed the uniformity. The coefficients of variation (CV) for estimated recoverable sugar (ers) were low, ranging between 4,6% and 6,6%.

The CV for ers mass per stalk, which is a variable trait, were 20,4%, 15,6% and 16,3% in Experiments 2, 3 and 4, respectively. The ers percentage in cane changed little with age between eight and 11 months (Table 3), but the average mass of ers per stalk was 30,5 g, 27,7 g and 41,8 g in Experiments 2, 3 and 4 respectively.

TABLE 3

Ers % cane and grams ers per stalk in Experiments 2, 3 and 4

Trait	Variety	Experiment No.		
		2	3	4
Ers % cane	NCo 376	10,13	10,60	10,98
	N11	10,53	10,61	11,14
	N12	11,07	10,32	10,87
	Mean LSD (0,05)	10,58 0,946	10,51 0,720	11,00 0,675
Ers g/stalk	NCo 376	29,9	25,3	37,8
	N11	38,5	36,4	53,5
	N12	23,1	21,3	34,1
	Mean LSD (0,05)	30,5 7,24	27,7 5,54	41,8 5,78

Moth preference

The preference of a moth for a variety is indicated by the number of eggs laid on it. The number of eggs was variable in each of the four experiments and the CV ranged from 31% to 73%. In Experiment 1, most eggs were found on variety N11 (Table 4), but in the subsequent experiments there were fewer eggs on N11 than on NCo 376 or N12.

Experiment 1 had the most eggs per drum despite the release of fewer moths than in subsequent experiments. This experiment was conducted in March when temperatures were higher than those in Experiments 2 and 3, which were conducted in July/August, and that in Experiment 4 which was done in October. The cooler weather during Experiments 2, 3 and 4 may have reduced moth activity.

Cane in Experiment 4 had produced more dry leaves than that in Experiment 2 because it was older. The difference in

TABLE 4

Number of eggs and weight of trash in Experiments 1 to 4 (Note: Results of Experiments 3 and 4 are from more drums than Experiments 1 and 2)

Trait	Variety	Experiment No.			
		1	2	3	4
No. of drums/replication		1	1	3	2
No. of moths/drum		3,3	42,8	16,7	6,9
No. of eggs	NCo 376	264	231	548	459
	N11	522	182	337	356
	N12	354	337	736	499
	Mean LSD (0,05)	380 182,8	250 210,1	541 379,1	438 272,2
Trash mass	NCo 376	-	119	441	401
	N11	-	152	421	504
	N12	-	130	358	455
	Mean LSD (0,05)	-	134 32,8	407 110,7	454 89,8

the amount of trash was smaller than the difference in the number of eggs. N11 produced more dry leaves and trash than did NCo 376 or N12 (Table 4). It was found that more eggs per unit weight of dry leaf material were laid on trash close to the soil, than on dry leaves attached to the main stalk (Table 5). In N11 particularly, few eggs were found on dry leaves attached to the stalk. Predation, mainly by ants, occurred in all the experiments and this must have affected the results, so their control should be considered in future.

TABLE 5

Number of eggs and weight of trash in Experiment 4 (Dry leaves attached to stalk = S, trash in drum = D)

Trait	Variety			Mean	LSD (0,05)
	NCo 376	N11	N12		
Weight of trash (g) on S	293	430	323	348	81,7
Weight of trash (g) on D	108	75	132	105	30,2
No. eggs on S	278	207	204	230	163,7
No. eggs on D	181	149	295	208	162,1
No. eggs/100 g trash on S	95	48	158	100	-
No. eggs/100 g trash on D	167	200	223	196	-

In the field N11 had appeared to be susceptible to attack by eldana and it was considered that moths might prefer laying their eggs on this variety. The results from these experiments did not clearly indicate a preference for cane variety or for plants of a particular age. The large number of eggs on N11 in Experiment 1 may represent normal variation but may also indicate that a moth finds N11 especially attractive while the cane is short. Eggs were frequently found on the soft tissue of the trash near the base of the stalk, the amount of which varies with age and the variety. More information is required before any preference by moths can be established.

Larval performance

There was large variation in larval numbers, mass, biomass and width of the head capsule of the borer, and precision was not greatly increased when the number of replications was increased from three to eight. Significant differences were, however, obtained for these traits in Experiments 6 and 7 (Table 6). Differences of similar magnitude were obtained in Experiment 5, but these were not significant because of insufficient replication. The mean number of eldana recovered in all the experiments was similar to those reported previously (Carnegie⁵), and to those obtained from field trials where infestation was

natural. In the field trials, larval biomass was not measured. In the present trials larval biomass differed markedly between varieties. The mean biomass of larvae from N11 was 3,6 times that of larvae from NCo 376 and 7,2 times that of larvae from N12. The width of the head capsules, which is a measure of larval size, was greater in N11 than in the other varieties.

TABLE 6

Number of larvae recovered, weights, biomass and width of head capsules as a percentage of NCo 376 values in larval performance Experiments 5 to 7

	Experiment No.	Variety			Mean	LSD (0,05)
		NCo 376	N11	N12		
No. eldana recovered	5	100(1,7)*	219	86	135	248,2
	6	100(2,0)	150	75	108	61,7
	7	100(3,0)	307	127	178	89,1
	Mean	100	225	96	-	-
Mean weight of larvae	5	100(14,4)†	190	60	117	147,2
	6	100(25,3)	175	33	103	101,1
	7	100(17,8)	167	51	106	51,1
	Mean	100	177	48	-	-
Biomass of larvae	5	100(24,3)†	356	53	170	253,0
	6	100(72,6)	204	23	109	110,8
	7	100(61,0)	526	73	233	208,6
	Mean	100	362	50	-	-
Mean width of capsule	5	100(1,23)‡	129	89	106	36,3
	6	100(1,04)	139	94	111	39,8
	7	100(1,16)	127	87	105	18,8
	Mean	100	132	90	-	-

* actual values of NCo 376

† actual values of NCo 376 (mg)

‡ actual values of NCo 376 (mm)

The average number of eggs placed per drum was 92, 127 and 151 for Experiments 5, 6 and 7 respectively. The biomass per 100 eggs (Table 7) was greatest with N11 plants, and least with N12 plants. Biomass appears to be better than numbers only as a measure of varietal susceptibility, and it could be used to obtain susceptibility ratings in the plant breeding programme. Results could be obtained within about twelve months whereas the results of field trials may take between three and six years to obtain.

TABLE 7

Larval biomass (mg) per 100 eggs placed in Experiment 5, 6 and 7

Experiment No.	Age of cane (months)	Variety			Mean
		NCo 376	N11	N12	
5	3,8	25,7	91,2	12,8	43,2
6	8,0	57,1	117,7	13,1	62,6
7	11,0	40,6	214,5	29,3	94,8
Mean		41,1	141,1	18,4	66,9

The effect of age of cane on larval performance, measured by biomass, was to have been investigated in this trial, but larvae of *Sesamia calamistis* Hampson and *Chilo* sp. were found in cane which had not been inoculated, and eldana might therefore also have been present before starting the trials, particularly Experiments 6 and 7. No statistical comparisons were therefore made between assessments done at different ages of plants.

Variability was large in both moth preference and larval performance trials. These results could be improved if the cane was grown in insect-proof cages, the drums were placed in holes in the ground so that the base of the plant was approximately at ground level, the trash was placed at the base of the cane and predation by ants was controlled with insecticides. Insects obtain all their nutrients from their host plants and they can therefore be expected to react to small differences in the anatomy and physiology of the plants (Maxwell and Jennings⁶), that would not necessarily be detected in analyses of major components such as sucrose. It is therefore important that the cane plants be treated as well as possible.

Conclusion

The moth preference trial did not show any consistent varietal differences in attractiveness to ovipositing moths. Several refinements to the experimental procedure could be implemented to enable the effect of variety and age of the cane on the ovipositing of eldana moths to be tested. For example, trash could be placed around potted plants. The method employed to assess larval performance appears to be a useful means of determining varietal susceptibility because significant differences between varieties were obtained and these confirmed previous observations in field trials. In all the experiments, the variation in egg numbers and the performance of larvae was great. Predators and unwanted moths which lay eggs on the cane must be controlled to improve the precision of assessments.

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