FIELD SCREENING OF SUGARCANE VARIETIES FOR RESISTANCE TO THE STALK BORER, *ELDANA SACCHARINA* (LEPIDOPTERA: PYRALIDAE)

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To date, routine screening of unreleased varieties (from stages 4 and 5 of the sugarcane selection programme) for resistance to *Eldana saccharina* Walker has been conducted in shade house trials where cane is artificially inoculated with *E. saccharina* eggs (Nuss, 1991; Nuss and Atkinson, 1983). Although this screening method ensures equal exposure of all test varieties to larvae of the borer, and excludes many uncontrolled environmental variables inherent in field trials, it also precludes moth choice of varieties for oviposition, as a potential resistance mechanism (e.g. Sosa 1990). Thus the total field resistance of test varieties should include information on their performance against *E. saccharina* in the field as well as in shade house trials. Field performance data are currently obtained from surveys for damaged stalks in observation, primary and secondary plant breeding trials at the Experiment Station's Mtunzini, Shakaskraal and La Mercy research farms. However, low to mild *E. saccharina* infestations, such as those experienced over the past three years, do not provide an adequate test of resistance, throwing doubt on the value of the data obtained.

In light of the above, two field trials, each containing 36 varieties, were established to test: (a) discrimination of varietal differences in resistance to *E. saccharina* under field conditions, (b) repeatability of resistance ratings between successive crops, and (c) whether field and shade house screening of varieties produced comparable resistance ratings. Trial 1, containing 24 unreleased clones and 12 commercial controls, was planted at La Mercy research farm in August 1993 and harvested annually over four crops. Trial 2, containing 28 unreleased clones and eight commercial controls, was planted at the Mount Edgecombe research farm in December 1995 and consisted of one 18 month old crop. This trial and a shade house trial performed during the same year contained the same varieties.

For Trial 1, *E. saccharina* infestation levels were enhanced through inoculating sorghum and/or maize, intercropped with the cane, with eggs when the cane was seven months old. Moths emerging from the intercrop subsequently oviposited in the adjacent rows of cane when the latter was approximately nine months old. White and Legendre (1991) used similar methods to intensify the level of borer (*Diatraea saccharalis*; Lepidoptera: Pyralidae) pressure in sugarcane in Louisiana. Trial 2 was infested through direct inoculation with 500 eggs per stool when the crop was 15 months old. Higher damage levels were achieved using the inoculated intercrop method than through direct inoculation (10,8% vs. 2,8% internodes damaged, respectively). Each crop in Trial 1 was harvested at 12 months and Trial 2 was harvested at 19 months. Data collected included length of stalk bored and internodes bored, and numbers and mass of *E. saccharina* larvae and pupae. Length of stalk bored and borer mass were not recorded for the third ratoon of Trail 1.

Discrimination of varietal differences (i.e. Degree of Genetic Determination or DGD) in resistance was high in both trials (Table 1), except for the third ratoon of Trial 1, where damage and borer numbers were reduced, probably due to the poor nutritional status of the crop. Borer numbers and damage increased in Trial 1 from the plant crop to the second ratoon (Table 1). Ratings were the same between at least two crops for 86% of varieties in Trial 1. Broad resistance categories (i.e. susceptible, intermediate, resistant) were matched between Trial 1 and Plant Breeding (PB) records for 76% of 34 varieties for which PB records were available. Exact resistance ratings on a 1-9 scale differed between the Trial 1 mean (n=4 crops) and PB records by two units for only eight of the 34 varieties; ratings for the remaining 26 varieties were either the same or differed by one unit. Broad resistance categories were matched between 69% of the 26 test clones included in Trial 2 and the 1995 shade house trial; exact ratings differed by two or more units for eight of the latter.

The results indicate that field trials, using either direct inoculation with *E. saccharina* eggs or infestation from an inoculated intercrop, can incur adequate borer infestation and crop damage to allow for reliable estimation of resistance levels in test clones. However, it is clear that ratings derived from at least three successive crops were required to produce satisfactory agreement with resistance ratings established over several years of shade house testing and/or PB field surveys for *E. saccharina*. Observed differences in the resistance rating for the same variety from field and shade house trials may be due to the effect of antixenosis acting on moth varietal choice in field trials, a mechanism for which there is no allowance in shade house trials.

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Table 1. Trial means and degree of genetic determination for variables measured in *Eldana saccharina* field Trial 1 (La Mercy) and Trial 2 (Mount Edgecombe).

Trial & crop	Borer numbers per plot (CV%)	Per cent stalks damaged (CV%)	Per cent internodes damaged (CV%)	Degree of Genetic Determination (DGD)*			
				Length damaged	Internodes damaged	Borer numbers	Borer mass
Trial 1:							
Plant	6,5 (64,3)	53,6 (21,9)	10,8 (30,2)	0,62	0,64	0,51	0,52
R1	12,2 (51,1)	78,0 (12,7)	17,8 (30,5)	0,89	0,86	0,64	0,56
R2	78,8 (45,5)	85,0 (10,4)	22,0 (28,6)	0,82	0,82	0,75	0,71
R3	6,6 (91,3)	45,1 (25,7)	5,8 (39,5)	-	0,71	0,56	-
Trial 2:							
Plant	7,4 (79,9)	26,0 (42,6)	2,8 (60,9)	0,83	0,88	0,85	0,82

*DGD (selections only) = (F-1)/F. The closer the DGD value is to 1,0, the higher the discrimination of heritable varietal differences.

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GLASSHOUSE TESTS FOR OVIPOSITIONAL ANTIXENOSIS OF SOUTH AFRICAN SUGARCANE VARIETIES TO *ELDANA SACCHARINA* (LEPIDOPTERA: PYRALIDAE)

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Plant resistance is an important management strategy for stalk borers in several sugarcane growing areas of the world (Meagher *et al.*, 1996). Antixenosis is one of three resistance mechanisms employed by plants, which prevents or reduces colonisation by adult and immature insects. In the case of antixenosis to oviposition, resistance may derive from plant characteristics that either fail to stimulate or inhibit oviposition (Panda and Khush, 1995).

Glasshouse experiments were conducted to test for ovipositional antixenotic resistance of six commercial sugarcane varieties to the stalk borer *Eldana saccharina* Walker. Three trial designs (multiple-variety, paired-variety, and no-choice) using plants and moths placed in mesh cages measuring 2 m x 2 m x 2 m, provided data on number of eggs laid by female moths on each variety. In the multiple-variety choice tests, four plants of each of the sugarcane varieties N11, N14, N20 and N21 (two susceptible and two resistant, respectively) were placed in a cage in randomised positions. Fifteen newly emerged female and five male moths were released from the centre of the cage and egg laying allowed to proceed for 72 hours (three days).

In the paired-variety choice experiments, four plants of each of two varieties in the combinations N21+N14, N12+N14, N21+N16 and N12+N16 were placed in randomised positions in a cage. In each combination, a resistant variety was paired with a susceptible variety, giving the moths a simpler (binary) choice than that presented to them in multiple-variety trials. Numbers of moths released and period for oviposition were as for multiple-choice trials. In the no-choice tests, eight plants of the same variety (each of N11, N12, N14, N16, N20, N21) were presented to the moths for 72 hours; five newly emerged females and five males were released in the cage.

All experiments were replicated four times. For each trial, plants with a similar quantity of trash were used and their green leaves trimmed to produce similar plant height. At harvest the following measurements were taken: number of egg batches, positions of egg batches, number of eggs per batch, stalk lengths, internode diameters (10 cm above the stalk base) and trash mass (after oven drying at 60°C for 48 hours). Stalk length and internode diameters were measured as estimates of plant size which, together with quantity of trash (Leslie, 1990), may influence the numbers of eggs laid. Other than on a single plant, where eggs were laid on green leaf material, all eggs in all experiments were laid on dead leaves and especially on curled dead leaf blades (Table 1).

In all three experiments, numbers of eggs and egg batches did not differ significantly between varieties at the 5% level. However, in no-choice experiments the mean number of eggs per batch differed significantly between varieties ($H=12,4$; $p<0,03$; Kruskal-Wallis ANOVA). In multiple-variety choice experiments, a significant correlation was obtained, using pooled data across varieties, for number of eggs versus internode diameter ($r=0,993$; $p<0,01$). This suggests that number of eggs laid may be related to plant size, although egg number and stalk length were not significantly correlated ($r=0,803$; $p>0,05$). Number of eggs and trash mass were not significantly correlated ($r=0,538$; $p>0,05$), suggesting that additional trash did not stimulate oviposition in the young plants used in this study.

Of the sugarcane varieties offered to the moths for oviposition, N21 received the highest number of eggs in all three experiments (Table 2), contrary to expectation as this is a resistant variety. In multiple-variety choice tests, the resistant variety N20 received the second highest number of eggs (25% of the total; Table 2), while in no-choice tests it received the least. Varieties N11, N12, N14 and N16 had variable numbers of eggs in the experiments where they were used. In general, the results show that for the varieties tested there was no consistent trend in egg-laying preference of *E. saccharina*, whether the moth had a choice or not. Moreover, coefficients of variation (CV) were high for egg numbers and egg batches in all three experiments (Table 2). The number of eggs within replicates was also inconsistent for all varieties, although N21 had the highest number of eggs when replicates were combined in all three experiments. In the paired-variety and no-choice experiments there was probably heavy predation by ants and spiders, as these were frequently seen on the plants and some plants carried no eggs at all. Predator exclusion is an important consideration for future experiments.

Ovipositional (antixenotic) resistance was not correlated with smaller stalk borer (*Diatraea saccharalis*; Lepidoptera: Pyralidae) populations in sugarcane (Kyle and Hensley, 1970); and work by Tucker (1933) and Fuchs and Harding

Table 1. Number of *Eldana saccharina* eggs found on different parts of the sugarcane plant and percentage (in parentheses) of total number of eggs laid on each plant part, in each experiment.

Experiment	Egg positions							Total
	Curled leaf blade	Midrib	Between stalk and sheath	Crevices on leaves	Curled leaf sheath	Rotten leaf sheath	Leaf ligule	
Multiple choice	1 883 (34)	313 (77)	319 (14)	0	268 (19)	75 (22)	31 (72)	2 889
Paired choice	1 219 (22)	43 (11)	637 (28)	23 (24)	73 (5)	121 (36)	0	2 116
No choice	2 443 (44)	51 (13)	1 337 (58)	72 (76)	1 097 (76)	142 (42)	12 (28)	5 154
Total	5 545	407	2 293	95	1438	338	43	10 159

Table 2. Mean number of *Eldana saccharina* eggs and egg batches found on each variety, coefficients of variation (CV), and percentage of total number of eggs and egg batches laid in each experiment.

Experiment	Variable	N11			N12			N14			N16			N20			N21			Total eggs
		Mean	CV	% of total eggs	Mean	CV	% of total eggs	Mean	CV	% of total eggs	Mean	CV	% of total eggs	Mean	CV	% of total eggs	Mean	CV	% of total eggs	
Multiple-choice	No. of eggs	31,9	186	19	-	-	-	40,7	161	23	-	-	-	45,4	123	25	62,6	110	35	2 889
	No. of egg batches	1,0	150	-	-	-	-	1,7	124	-	-	-	-	1,1	136	-	2,9	80	-	
Paired-choice	No. of eggs	-	-	-	31,2	195	21	34,2	147	27	20,1	192	18	-	-	-	14,8	223	34	2 116
	No. of egg batches	-	-	-	1,2	158	-	1,0	130	-	0,5	160	-	-	-	-	0,7	200	-	
No-choice	No. of eggs	30,8	169	24	21,5	220	13	25,8	160	16	17,8	256	11	14,4	190	5	40,3	162	31	5 154
	No. of egg batches	1,2	142	-	0,8	213	-	1,0	160	-	0,7	257	-	1,0	150	-	1,6	138	-	

Dashes indicate variety was not used in that experiment and/or value not applicable (number of batches).

(1978) indicated no ovipositional preference of this species among sugarcane varieties in the USA. More recently, however, leaf pubescence was found to be associated with both ovipositional and larval antixenotic resistance against *D. saccharalis* (Sosa, 1988; 1990; Sosa *et al.*, 1997). Meagher *et al.* (1996) performed choice and no-choice tests on different cultivars (NCo310, CP 70-321 and CP 70-324) of Texas sugarcane against *D. saccharalis* and *Eoreuma loftini* (Lepidoptera: Pyralidae). In their no-choice tests, individual comparisons showed no significant differences in number of eggs laid between cultivars. However, there were trends for NCo310 to carry more eggs per plant than CP 70-321 and CP 70-324, and CP 70-324 to carry more eggs than CP 70-321.

Results of the present study using South African varieties indicate that ovipositional antixenosis to *E. saccharina*, at least in young sugarcane (5 months old), is probably not an important resistance mechanism.

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