SHORT, NON-REFEREED PAPER

EFFECT OF SELF-TRASHING ON *ELDANA SACCHARINA* WALKER DAMAGE IN SUGARCANE AND IMPLICATIONS FOR RESISTANCE BREEDING

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Abstract

Eldana saccharina is a major pest of sugarcane in South Africa, which causes losses estimated at R900 million per annum. Genetic resistance remains an important component of an integrated eldana control strategy. The objectives of this study were to determine the relationship between levels of self-trashing and eldana damage, and evaluate implications for resistance breeding. Self-trashing is expected to reduce oviposition sites thus, exposing eggs and larvae to predators. Data on the number of bored stalks per genotype were collected from the mini-lines trial (TML14) at SASRI's Empangeni Research Station. There was a 7.76% decrease (P<0.0001) in number of bored stalks with every unit increase in self-trashing. The number of bored stalks decreased significantly from 68% (clinging leaves) to 52% (highly self-trashing) (P=0.0008), indicating that self-trashing was associated with a reduction in eldana damage. There were highly significant (P=0.001) family effects for self-trashing, significant variability (σ^2=0.016, P=0.002) and moderate broad sense heritability of 0.58, suggesting breeding for self-trashing was possible. Best Linear Unbiased Prediction analysis showed significant female (P<0.0001) and male (P<0.0001) parental effects, and suggested that selecting high self-trashing parents will increase trait levels in breeding populations. Female (σ^2=0.005, P=0.0542) and male (σ^2=0.022, P=0.0003) parental variance components suggested that the choice of male parent is more important for increasing self-trashing when considering these specific parents. The results indicated that self-trashing was a trait offering an additional resistance mechanism to combat eldana in sugarcane. Quantitative genetic parameters highlight the potential to indirectly breed for eldana resistance using the self-trashing trait.

Keywords: *Eldana saccharina*, resistance, sugarcane, self-trashing, breeding mechanism

Introduction

Eldana saccharina Walker (Lepidoptera: Pyralidae) (eldana) is a stalk borer indigenous to Africa and a major pest of sugarcane. In South Africa, it causes losses estimated at R900 million per annum (Horton *et al*, 2002; Rutherford, 2015). Eldana has spread from coastal areas into the Midlands and northern irrigated regions of KwaZulu-Natal (Assefa *et al*., 2008; Zhou, 2015). Integrated Pest Management (IPM) practices which include chemical and biological control and cultivation of resistant varieties reduces yield losses.

Sugarcane varietal resistance is a significant component of IPM eldana control and breeding for eldana resistance started in the 1980s (Nuss and Atkinson, 1983). Several defence and tolerance mechanisms provide plant resistance. The objectives of this study were to determine the relationship between levels of self-trashing and eldana damage, and evaluate implications for resistance breeding.

Materials and Methods

Data were collected from Stage 1 TML14 Mini-lines trial planted at The South African Sugarcane Research Institute's (SASRI's) Empangeni Research Station (103 m.a.s.l; 28°45'S, 31°54'E) in 2015. A randomised complete block design with three replications per family was used. Each family plot was made up of several genotypes, each planted to 1 row of 1 m length in a tramline set-up. At crop maturity, the first 20 genotypes in each family plot were examined and scored for self-trashing, and then the total number of stalks and the number of stalks with eldana entry and exit holes were counted. Self-trashing was scored from 0 to 3 with 0 representing clinging leaves, 1 representing slight self-trashing, 2 representing intermediate self-trashing and 3, representing highly self-trashing.

A simple linear regressing was used to determine the relationship between eldana damage and self-trashing using the equation:

$$Y_i = a + bx_i + e_i \qquad \text{Equation 1}$$

where Y_i was the eldana damage in the ith genotype, a was the intercept, b was the coefficient or slope, x_i was the self-trashing score and also the independent variable, and e_i was the error.

Data were analysed for family effects of eldana damage and self-trashing scores and to estimate variance components using the linear mixed model:

$$Y_{ijk} = \mu + R_j + Fk + RF_{jk} + E_{jkl} \qquad \text{Equation 2}$$

Y_{ijk} is the damage recorded on the lth genotype in the jth replication in the kth family.
Data were analysed for the effect of self-trashing on borer damage using the linear mixed model:

$$Y_{ijk} = \mu + S_i + R_j + F_k + RF_{jk} + E_{ijkl} \qquad \text{Equation 3}$$

where Y_{ijk} is the ith self-trashing score in the jth replication of the kth family measured on the lth genotype, μ is the overall mean, S_i is the fixed effect of the ith self-trashing level, R_j is the random effect of the jth replication, F_k is the random effect of the kth family, RF_{jk} is the random interaction effect the $_j$th replication by the $_k$th family, E_{ijkl} is the residual error. Mean comparisons were performed using least significant differences.

Results and Discussion

There were significant differences (F=25.77, P<0.0001) among families for eldana damage. Significant variance (σ^2=3.86, P<0.0001) suggested family genetic variability for eldana damage (Zhou, 2015).

There was significant negative linear association representing a 7.76% (P<0.0001) decrease in bored stalks with every unit increase in self-trashing (Figure 1). The number of bored stalks decreased significantly from 68% (clinging leaves) to 52% (highly self-trashing) (F=5.61, P=0.0008). Significant differences (P<0.05) were present among self-trashing levels in general, but a pairwise approach showed non-significant differences between self-trashing levels 2 and 3 (P=0.1984). These results suggest that even low levels of self-trashing reduced eldana damage (Carnegie and Smaill, 1982). Studies by Carnegie and Smaill (1982) and Leslie (1989) showed a reduction in eldana infestation after manual pre-trashing by reducing ovipositional sites and exposing larvae to predators. Self-trashing varieties are expected to behave similarly.

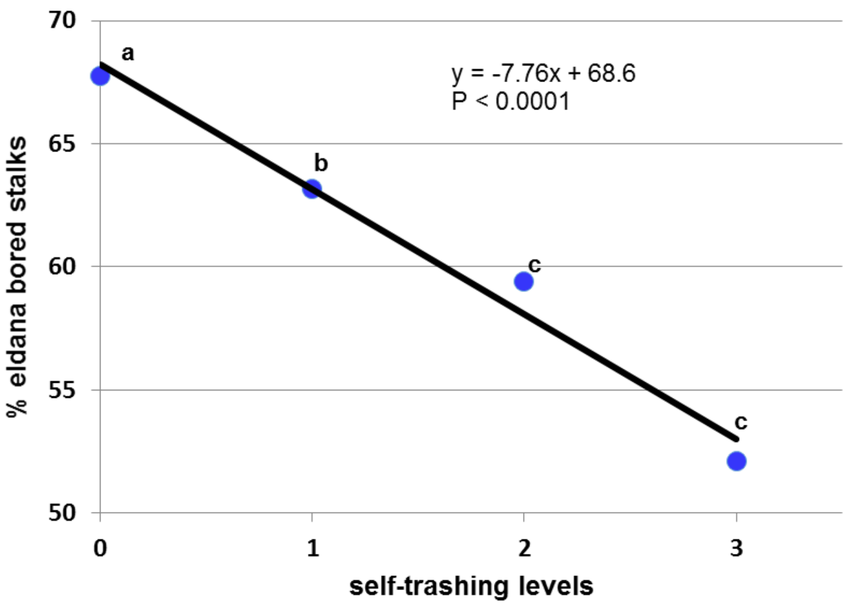

Figure 1. Figure showing the relationship between percentage *Eldana saccharina* Walker (Lepidoptera: Pyralidae) bored stalks and various self-trashing levels.

There were highly significant (F=2.25, P=0.0001) family effects and significant family variance (σ^2=0.016, P=0.002) (Table 1), indicating high genetic effects for self-trashing. Moderate broad sense heritability of 0.58 suggested selection for self-trashing is possible.

Table 1. The random and fixed effects for self-trashing. SE = standard error, Z-value = Z distribution statistic, P>Z = probability of obtaining a larger value of the Z statistic, F-value = F distribution statistic, P>F = probability of obtaining a larger value of the F statistic.

Random effects				
Covariance parameter	**Variance**	**SE**	**Z-value**	**P>Z**
Family	0.016	0.005	2.88	0.0020
Female	0.005	0.003	1.58	0.0566
Male	0.022	0.006	3.43	0.0003
Fixed effects				
Effect	**F-value**	**P>F**		
Family	2.25	0.0001		
Female	2.84	0.0001		
Male	5.75	0.0001		

Significant female (F=2.84, P<0.0001) and male (F=5.75, P<0.0001) (Table 1) parental effects suggest selecting high self-trashing parents at crossing will increase trait levels in progenies. Female (σ^2=0.005, P=0.0566) and male (σ^2=0.022, P=0.0003) (Table 1) variance components suggested that when considering these specific parents, the choice of male parent was more important for increasing self-trashing during breeding.

In conclusion, results indicated that self-trashing reduces damage caused by eldana. However, further studies are required to validate the relationship between self-trashing and eldana damage and to determine the genetic control of self-trashing.

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