

SHORT NON-REFEREED PAPER

RELEASES OF IRRADIATED MOTHS TO SUPPRESS WILD POPULATIONS OF *ELDANA SACCHARINA* WALKER (LEPIDOPTERA: PYRALIDAE)

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Abstract

Pilot shade house trials were conducted to measure the impact of sustained releases of partially sterile adult males of the stalk borer *Eldana saccharina* Walker (Lepidoptera: Pyralidae) at an over-flooding moth ratio of 10T:1U (treated to untreated). Their efficacy in stopping *E. saccharina* incursions and suppressing wild populations was measured prior to testing under true season-long and area-wide conditions. Results from the current study demonstrated that releasing partially irradiated (200 Gy) adult male moths at the above-mentioned release rate significantly reduced sugarcane stalk damage, and also reduced the number of fertile progeny from F₁ to succeeding generations in a stable *E. saccharina* population initiated in a cage-house. There were more damaged internodes per stalk in the control than in the sugarcane receiving regular releases of partially sterile male moths. Overall, there were significantly more undamaged stalks in the treated sugarcane than the untreated control. Furthermore, there were significantly more larvae per stalk retrieved from the control than from the treated sugarcane, suggesting that the sustained release of steriles was efficacious in reducing emergence of fertile larvae in the succeeding generations. The results of this study indicate that there is considerable scope for the Sterile Insect Technique (SIT) against this damaging pest of sugarcane.

Keywords: Sterile Insect Technique, *Eldana saccharina*, pilot field release, inherited sterility

Introduction

Releases of irradiated moths in pilot studies to suppress wild populations can be done by the conventional system approach (Bloem and Bloem, 2000; Walters *et al.*, 2000) or the green/shade house approach (Rosca and Barbulescu, 1993; Sutrisno and Hoedaya, 1993; Calvitti *et al.*, 1997; 1998; 2000; Hofmeyr *et al.*, 2005). In the former, pilot releases of the sterile insects are conducted in an isolated site where native populations are monitored closely over a defined period that depends on the phenology of the pest species, in order to measure the impact of the initial SIT releases. The latter evaluates efficacy of the SIT in a confined environment (Calvitti *et al.*, 1997; 1998; 2000). In the case of *E. saccharina* this approach is novel but has been implemented on other related species such as *Cactoblastis cactorum* (Berg) (Lepidoptera: Pyralidae) (Hight *et al.*, 2005) and *Thaumatotibia leucotreta* (Lepidoptera: Tortricidae) (Hofmeyr *et al.*, 2005).

The study tested the capacity of *E. saccharina* male moths sub-sterilised at 200 Gy to suppress an existing stable 'wild' population under cage-house conditions. The hypothesis that continuous releases of sterile moths into an existing stable population will reduce the level of crop damage (indicating pest control) compared to a scenario where a natural *E. saccharina* population is allowed to build up in the absence of any control intervention was also tested.

Material and Methods

Trial location and cage-house design

The study was conducted at the Agricultural Research Council Plant Protection Research Institute (ARC-PPRI) Vredenburg Quarantine Station at Stellenbosch in the Western Cape province of South Africa. Three hundred potted sugarcane plants sourced from the South African Sugarcane Research Institute (SASRI) were placed into a large greenhouse (25 x 10 x 7 m) fitted with an extractor fan and wet-wall system pre-set to reduce the temperature to $26\pm 1^{\circ}\text{C}$, as well as a drip irrigation system. The greenhouse was partitioned into three equal blocks/cages of 7 x 7 x 4 m, each containing 100 plants. This represented three treatments: (i) control: uninterrupted *E. saccharina* population build-up, (ii) buffer zone: to isolate or prevent cross infestation between the control and test cages, and (iii) SIT: test cage for measuring the impact of steriles on an existing stable *E. saccharina* population.

Study populations

Due to the difficulty in sourcing sufficient quantities of moths as well as the high variability in development and adult emergence of wild strains, laboratory reared *E. saccharina* supplied by SASRI were used for this study. A comprehensive description of the origin of the insects as well as their handling protocol is given in Walton (2011).

Moth releases

This pilot cage/greenhouse release trial was based on protocols of similar trials by other researchers (Calvitti *et al.*, 1998; 2000; Nguyen Thi and Nguyen Thanh, 2001; Hight *et al.*, 2005; Hofmeyr *et al.*, 2005). Modifications were made where necessary. The initial *E. saccharina* infestation was established by releasing 100 pairs of mated laboratory reared moths into each of the cages.

Population size and sterile moth release rate determinations were done by inspecting 100 stalks in each cage for signs of damage (i.e. exit holes) after 898 day-degrees (DD). This is the estimated number of DD required for complete development of *E. saccharina* from egg to adult emergence (Way, 1994; 1995) following introduction of the initial infestation. The DD model was also used for predicting and monitoring insect developmental life stages and synchronizing adult emergence with sterile male releases. Three sterile male moth releases were conducted in the test cage every 898 DD following the first infestation establishment. The sterile moth quantity and release rate was fixed in all three releases and was based on a treated (T) to untreated (U) adult over-flooding ratio of 10T:1U (Nguyen Thi and Nguyen Thanh, 2001; Hight *et al.*, 2005; Hofmeyr *et al.*, 2005).

Evaluation of the impact of sterile male releases on an existing stable E. saccharina population and crop damage

The sugarcane crop was harvested at age 31 months to assess the impact of the three sterile male *E. saccharina* moth releases on the existing stable population initially established on the crop. In both the control and the test cages, 100 mature sugarcane stalks (i.e. randomly

selected parent stalks or tillers) from each of the cages were cut down from the root zone to assess damage and presence of F₃ *E. saccharina* progeny.

Data analyses

The non-parametric Mann-Whitney U test was performed in Statistica 10.0 (Statsoft Inc., Tulsa, Oklahoma, USA) to test the hypothesis that the median amount of crop damage (i.e. per cent internodes damaged) in the control is not significantly different from that in the test cage.

To test the hypothesis that the number of damaged sugarcane stalks in both cages is independent of treatment administered (i.e. there are no differences in numbers of damaged stalks between the control and the treatment), the empirical logistic transform for comparing two samples was used (Cox, 1970).

Results

Cross infestation between cages

There was neither damage nor were there any *E. saccharina* eggs, larvae, pupae or moths on any of the sugarcane stalks in the buffer cage.

Efficacy of sterile male releases in suppressing population growth and crop damage

There were significantly less F₃ larvae per sugarcane stalk recovered from the treated cage (SIT) than from the untreated (control) cage (Mann-Whitney U test: $U=4139.5$; $P=0.036$) after the final sampling. With regards to effect of sterile male *E. saccharina* releases on the incidence of internode damage, the differences in median per cent damaged internodes per sugarcane stalk between the control and treatment were highly significant (Mann-Whitney U test: $U=3999.5$; $P=0.015$; Figure 1). There were significantly more damaged internodes per stalk in the control than in the treatment group. In both cases, damage was concentrated mainly on the bottom third of the sugarcane stalk.

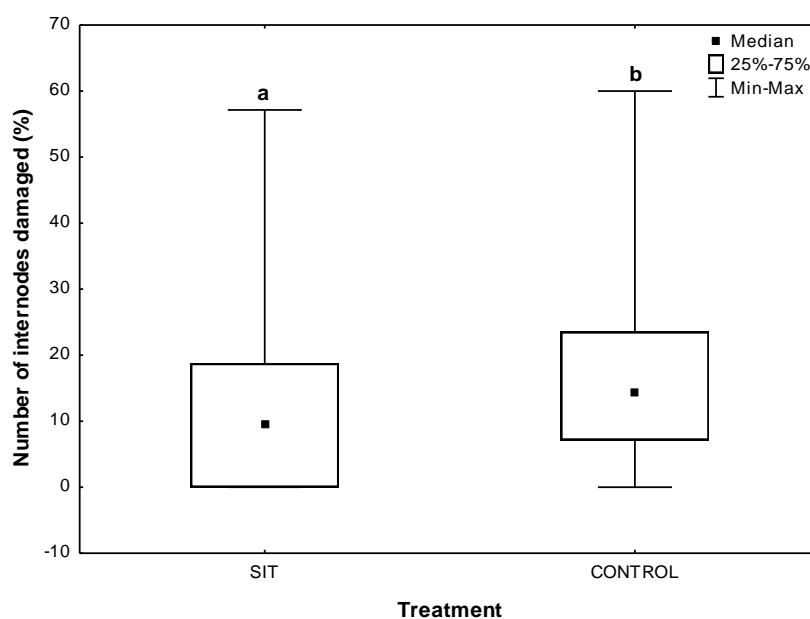


Figure 1. Efficacy of three sterile male releases maintained at a sterile (T) to untreated (U) adult *Eldana saccharina* over-flooding ratio of (10T:1U) in lowering levels of stalk damage (% internodes damaged).

The empirical logistic transform complemented the results of the Mann-Whitney U test by showing that the amount of damage in a given plot is dependent on the treatment. There was a significant difference in the total number of damaged sugarcane stalks between the control and the SIT treatment ($Z=2.494$; $P=0.013$; Figure 2). From the 100 stalks sampled in each of the cages, 30 and 15 were undamaged in the treated (SIT) and untreated (control) sugarcane, respectively (Figure 2).

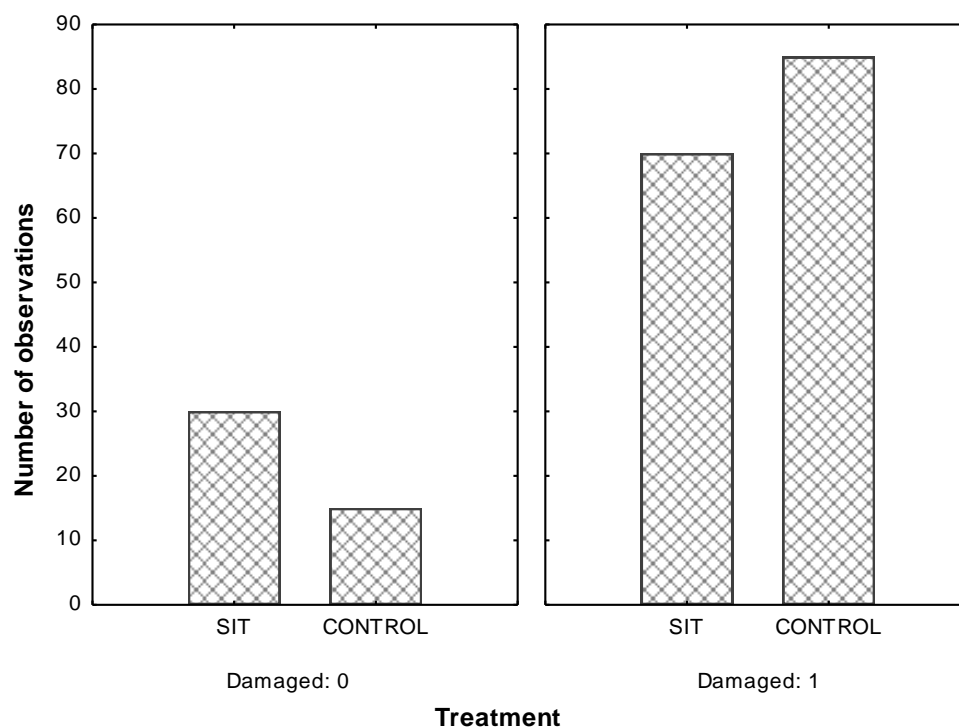


Figure 2. Histograms of overall total number of undamaged (0) and damaged (1) sugarcane stalks in the untreated (control) and treated (SIT) cages, where the sugarcane was aged 31 months at the time of final sampling and total number of stalks sampled (n)=100.

Discussion and Conclusions

Results from the current study demonstrated the efficacy of irradiated and released *E. saccharina* adults in reducing stalk damage as well as in lowering the number of fertile progeny under semi-controlled cage house conditions. Compared with sugarcane in the control group, the test group had significantly less damaged sugarcane stalks, suggesting that the fertility of the F_1 adults was significantly reduced. This also indicated that the treated males had competed successfully with their untreated counterpart males for untreated females, and hence pest population growth could be significantly impacted by the release of irradiated conspecifics (Hofmeyr *et al.*, 2005).

While data on sizes of the F_1 and F_2 populations were not collected in order to accurately calculate the rates of population increase or decrease, the fewer F_3 larvae per stalk obtained from the treated sugarcane (SIT) compared to the control indicates that the fertile population was in decline from P_1 to the succeeding generations.

Results of the current study support findings reported by Hight *et al.* (2005), who showed that sustaining an over-flooding ratio as low as (5T:1U) or the optimum (10T:1U) was adequate to

bring about a significant reduction in the 'wild' population under field cage conditions, irrespective of whether treated males only or both sexes were used in the release.

No efficient technique currently exists for separating males and females in Lepidoptera. Consequently, simultaneous release of treated male and female *E. saccharina* moths is unavoidable at this stage. Nevertheless, experimental evidence on other species has demonstrated the role of sterile females and the benefits of releasing mixed genders in SIT enterprises (Hight *et al.*, 2005).

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