Trichogramma chilonis (Hymenoptera : trichogrammatidae) as a biological control agent of Chilo sacchariphagus (Lepidoptera, Crambidae) in Reunion Island : initial field trials

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TRICHOGRAMMA CHILONIS (HYMENOPTERA : TRICHOGRAMMATIDAE) AS A BIOLOGICAL CONTROL AGENT OF *CHILO SACCHARIPHAGUS* (LEPIDOPTERA : CRAMBIDAE) IN REUNION ISLAND : INITIAL FIELD TRIALS

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Abstract

The spotted stalk borer, *Chilo sacchariphagus* Bojer, is a major pest of sugarcane in southern Asia, the Indian Ocean islands and Mozambique in southern Africa. Since 1999, a biological control programme has been developed on this pest in Reunion Island through a partnership between research and development organisations. *Trichogramma chilonis* Ishii has been shown to be the most naturally efficient parasitoid of the borer in Reunion, following a comparison of the bionomics of different strains of *T. chilonis*, and one strain was selected for mass production and field release testing. In 2002, two distinct sites, Savannah (SAV) and Sainte-Marie (SMA), were chosen for field experiments. At each site, plots were treated with releases of 150 000 *T. chilonis* per hectare and compared with untreated plots. In both plots, efficacy of these releases was assessed through damage to sugarcane internodes and mass of millable stalks at harvest. In treated plots, the percentage of bored internodes at harvest was 45% less than the controls at SAV and 36% at SMA. The mean stalk mass was 14% higher in treated plots at SAV, and 12% at SMA, corresponding to increases of 15 and 12 tons of cane per hectare, respectively. These results are presented and improvements in a new trial are suggested.

Keywords: sugarcane, biological control, *Chilo sacchariphagus*, *Trichogramma chilonis*, parasitoids, stalk borer, Reunion Island

Introduction

Chilo sacchariphagus Bojer (Lepidoptera: Crambidae), is a key pest in southern Asia and the Indian Ocean islands, and recently in Mozambique. In Reunion and Mauritius, this borer has been a serious pest since it was introduced with sugarcane during the 19th century (Williams, 1983). In Reunion Island, *C. sacchariphagus* can cause important yield losses, particularly in the susceptible variety R579, where 10-30 tons cane/ha can be lost (Goebel, 1999).

During the 1960s in Reunion and Mauritius, several attempts were made to control *C. sacchariphagus* using exotic parasitoids, with variable results. Various parasitoid species were introduced and mass releases made, and some, for example *Trichogramma chilonis* Ishii (Hym: Trichogrammatidae) and *Cotesia flavipes* Cameron (Hym: Braconidae), were successfully established in sugarcane fields (Etienne, 1971; Williams, 1983). However, the natural densities of these parasitoids were not sufficient to control *C. sacchariphagus*.

In order to improve and optimise the use of such natural enemies in biological control programmes, a better knowledge of the bio-ecology of *C. sacchariphagus* and its natural enemies is needed.

On Reunion Island, a new biological programme using *Trichogramma chilonis* began in 2000, through a partnership between the Centre de coopération internationale en recherche agronomique pour le developpement (CIRAD), the Institut national de recherches agronomiques (INRA) and the Fédération départementale des groupements de défense contre les ennemis des cultures (FDGDEC). This parasitoid was chosen because (i) it is the most naturally frequent parasitoid of *C. sacchariphagus* in Reunion island, (ii) it is an egg parasitoid and kills the pest before it can damage cane, (iii) the past 20 years have seen considerable use of this biological control agent on a very large scale on corn, sugarcane, cotton, fruit trees and vegetables in more than 30 countries (Li, 1994), and (iv) in sugarcane, *Trichogramma* sp. are considered to be effective egg parasitoids of many lepidopteran stalk borers (Metcalfe and Brenière, 1969; Nagarkatti and Nagaradja, 1977; Browning and Melton, 1987; Pham *et al*., 1995).

Inventory and selection of egg parasitoids were completed in 2000 (Goebel et *al*., 2001). The adults were collected in the field with egg-traps of *C. sacchariphagus* or *Galleria mellonella* Linnaeus (Lep : Pyralidae), a factitious host of *Trichogramma* in the laboratory. Each *Trichogramma* strain found in selected areas was reared separately in the laboratory and samples of adults were identified, using morphological (male genitalia) or molecular (RAPD) techniques. Only *T. chilonis* was identified (Goebel et *al*., 2001).

In 2001, bionomics of three geographically distinct strains of *T. chilonis* were compared on the basis of their functional response to host density, the time of development and several demographic parameters of the adults (Reay-Jones, 2001). The strain from St-Benoit (a hot and rainy region in the north-east of Reunion) presented the best performances and was chosen for mass production and augmentative release programmes. This production was done on *G. mellonella*, which is easier to rear than *C. sacchariphagus*.

This paper summarises the first season of results from inundative releases of *T. chilonis* against *C. sacchariphagus*. Future research ideas and developmental perspectives are also presented.

Methods and Materials

In 2002, field experiments were conducted at two sites: Savannah (SAV) and Sainte-Marie (SMA) with dry and wet climates, respectively (Figure 1). Both sites are planted with the susceptible variety R579, and experiments during previous years showed high borer infestation (Goebel, 1999). Goebel (1999) and Goebel *et al*. (1999, 2001) showed that predation of borer eggs mostly by the ant *Pheidole megacephala* Fabricius (Hym : Formicidae) was high (80-90%) during late growth stages of sugarcane, especially after six months old. Inundative releases were therefore planned for the early growth stage (about two months old), when predation is low and sugarcane is most susceptible to the borer. Unfortunately, the tropical cyclone Dyna occurred in January and delayed the trials, which began in February on cane aged three and four months at SAV and SMA, respectively.

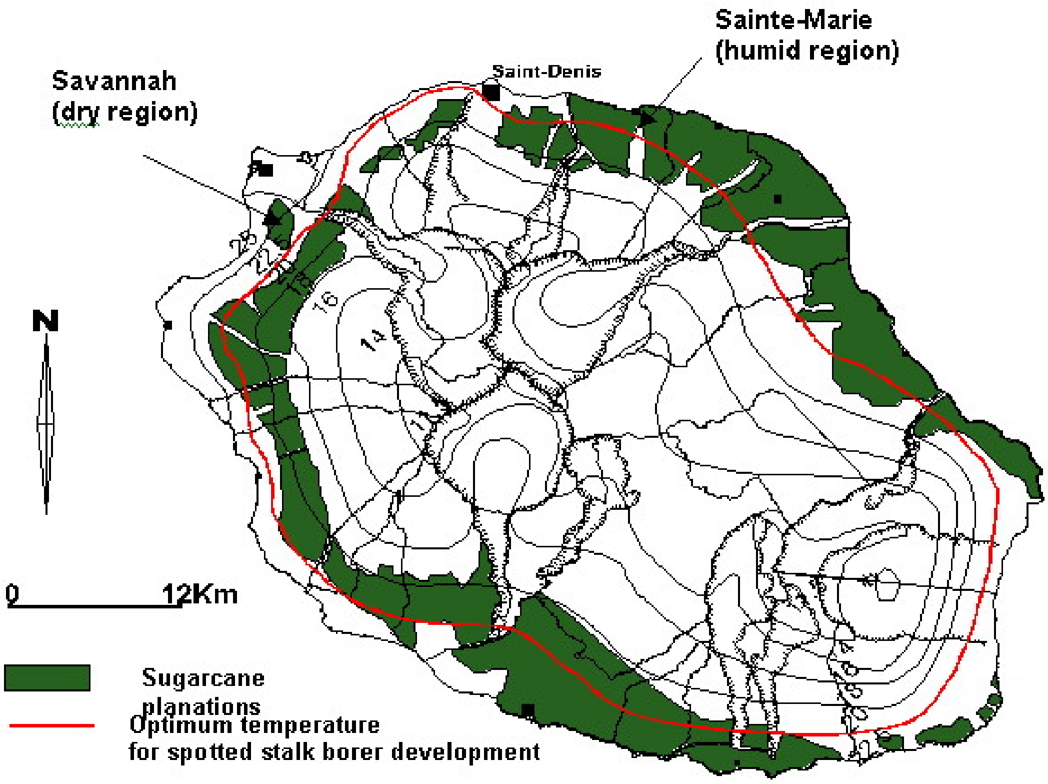

Figure 1. Location of the two sites in Reunion Island used for field releases of *Trichogramma chilonis* in biological control experiments against *Chilo sacchariphagus*.

At each site, eight plots of 500 m^2 were set up, and half of them were treated with releases of 150 000 *T. chilonis* per hectare, each week over a period of four months. Treated plots were set up at least 20 m apart from the control ones (minimum 20 m) to avoid any migration of adults after releases.

In both treated and control plots (untreated check), infestation of *C. sacchariphagus* and parasitism levels were studied through damage to stalks and internodes. Each month during releases (from February to May) a sample of 400 stalks (100 per plot chosen randomly) was dissected carefully to assess the borer damage. At harvest, crop loss was estimated by weighing the same number of stalks.

Results

At SMA, the percentage stalks damaged increased from 10% at the time of first release to 88% (treated plots) and 100% (control) at harvest, but these results were not significantly different. Results were similar at SAV, although overall infestation was lower (53% and 66% in treated and control plots respectively). At harvest, the percentage of bored internodes, which is an accurate measure of damage, decreased dramatically in treated plots at both sites (Figure 2) which could be due to a lower number of larvae. Similarly, the mean stalk weights were 17% (SMA) and 14% (SAV) higher in treated plots (Figure 3). Yield estimations in cane production have shown a gain of 17 tons/ha at SMA (from 102 to 119 t/ha) and 15 tons/ha at SAV (from 107 to 122 t/ha).

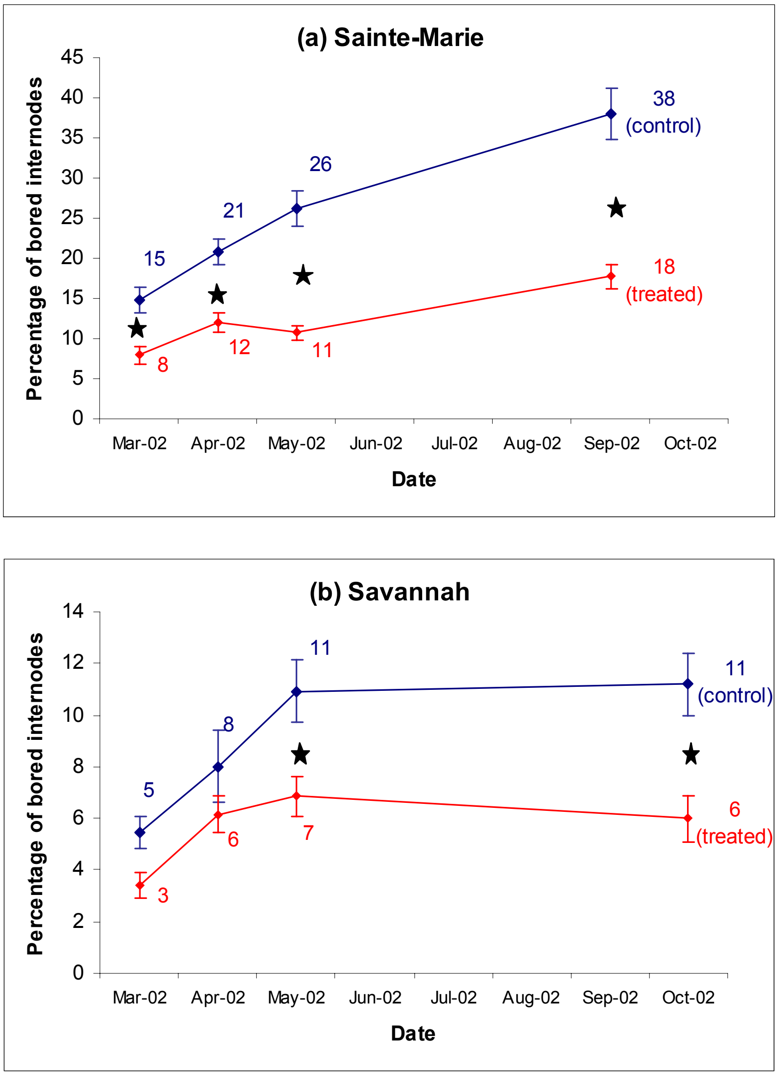

Figure 2. Percentage internodes bored in check and treated plots at Sainte-Marie (a) and Savannah (b) during 2002. Black stars indicate significant differences (*P*<0.05).

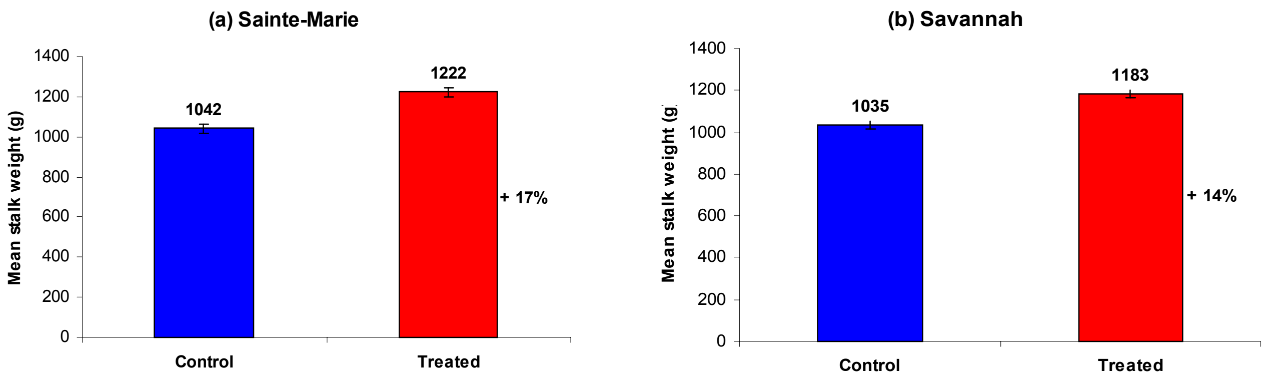

Figure 3. Mean stalk weights at harvest at Sainte-Marie and Savannah in control and treated plots. At both sites, mean values differed significantly (*P*<0.05).

Discussion and Future Prospects

The results of these first experiment trials allow efficient biological control of stalk borer populations in Reunion Island to be envisaged. Although inundative releases were delayed by cyclone Dyna, encouraging results were obtained. In late 2002, new releases were initiated, taking account of the previous experiments. The first releases were made earlier (one month old cane) than in 2002, to coincide with the infestation of sugarcane leaves by young larvae in the initial trials. Moreover, the number of *T. chilonis* released was modulated (100 000 or 200 000 per ha), according to variations in borer density. The effectiveness of these new releases will be estimated at harvest in late 2003. To date, results based on internodes bored and *Trichogramma* efficiency (presence in egg traps) show that the treated plots are about 50% less infested than the check plots.

In 2003, studies on bionomics will continue in the laboratory using two hosts (*C. sacchariphagus* and *G. mellonella*), especially on the strain originating from the region of Sainte-Marie, which is highly infested by the stalk borer. Further studies on pest-parasitoid population dynamics are also needed to optimise the field releases with parameters such as time, frequency and duration of releases, and number and distribution of release points. Knowledge of the influence of climatic and agronomic factors on population dynamics is also essential, and is being studied with the aim of modelling these interactions. Finally, the likely success of this biological control programme could lead to the generalisation of *T. chilonis* releases in most coastal sugarcane areas. Different parameters concerning quality of production and logistics (holding/storage/transport) should then be investigated. These parameters will be increasingly important as *T. chilonis* releases become commercially viable.

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