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Monitoring and scale pest control

Biological control of *Saccharicoccus sacchari* (Coccoidea: Pseudococcidae) on sugar cane in Egypt using imported and indigenous natural enemies

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Abstract: The pink sugarcane mealybug, *Saccharicoccus sacchari* (Cockerell) (Hemiptera: Pseudococcidae) is one of the most important pests attacking sugar cane in Egypt. Natural enemies play an important role in controlling this species. The present work deals with (a) the seasonal abundance of indigenous natural enemies in sugar cane fields during 2005-2006. *Anagyrus saccachricloa* Timberlake (Hymenoptera, Encyrtidae) is considered the most abundant parasitoid on this pest. This work also deals with (b) the imported predator, namely, *Hyperaspis trilineata* Mulsant (Coleoptera: Coccinellidae). A total 200,000 adult beetles were reared on *Saccharum officinarum.* The predator was released 12 times at the rate of thirty nodes (each 60cm) from one square meter. These results indicated that *H. trilineata* increased, while the population of *S. sacchari* consequently decreased during the period of experiment.

Key words: pink sugarcane mealybug, *Anagyrus saccachricloa, Hyperaspis trilineata.*

Introduction

The pink sugarcane mealybug, *Saccharicoccus sacchari* (Hemiptera: Pseudococcidae) is widespread on sugarcane globally. *S. sacchari* infests the above-ground storage tissue as it develops, feeding on the phloem and producing honeydew. When present in large numbers, it causes stunting, yellowing of the plant, death the young shoots and impaired growth. The mealybug also causes severe problems in the filtration and clarification of sugar syrups in affected factories. Recently, virus and bacteria have been isolated from this mealybug (Cooper & Zhang, 1992; Franke-Whittle *et al.*, 1999).

Due to the drastic effects of *S. sacchari* on sugarcane plants, the mealybug is considered one of the most important pests attacking this plant in Egypt (Abd-Rabou, 2000). Peak populations are present in August and September, when the average monthly temperatures are around 27^{0}C. The mealybug has four generations a year (Hafez & Salama, 1969). Several studies have been conducted on this pest, looking at: damage (Atiqui & Murad, 1992, 1993); bionomic (Allsopp, 1991; Allsopp *et al.*, 1993; Bonnett & Hewitt, 2005; Borah & Dutta, 1995; De Barro, 1991; Rae & De'ath, 1991), biological control (Alam, 1972; Kapadia *et al*., 1995), plant resistance and chemical control (Kapadia & Mittal, 1994), microbial control (Franke-Whittle *et al*., 2004), agricultural control (Parsana *et al.*, 1994; Rae & Jones, 1992) and mechanical control (Jayanthi *et al.*, 1994). *Anagyrus saccachricloa* Timberlake (Hymenoptera:

Encyrtidae) has been found in *S. sacchari* populations in Australia and Cuba (Carver *et al.*, 1987; Hernandez *et al.*, 1993). Dorge *et al.* (1972) studied the predatory coccinellid beetle, *Chilocorus nigritus* Fab., feeding *S. sacchari* in Australia, while De Barro (1990) studied the natural enemies in the Bundaberg area of Southeast Queensland.

In India, Kapadia & Mittal (1994) recorded *Anagyrus punctulatus* Agarwal, as a parasitoid of *S. sacchari*. Nine parasitoids and hyperparasitoids have been recorded in Egypt (Abd-Rabou, 2000). These are *Anagyrus greeni* Howard, *A. pseudococci* (Girault), *Chartocerus subaenus* (Foerster), *Leptomastidea abnormis* (Girault), *Microterys* sp., *Paraphaenaodiscus* sp., *Prochiloneurus* sp., *Rhopus nigriclavus* (Girault) and *Rhopus* sp. Abd-Rabou (2002) introduced, reared and evaluated the parasitoid *Anagyrus saccachricloa* in the highly infested areas in five governorates in Egypt. Pruett & Colque (1984) found the predacious coccinellid *Hyperaspis trilineata* Mulsant (Coleoptera: Coccinellidae) to be an effective predator of *S. sacchari* in Bolivia. Alam (1972) also recorded this predator associated with *S. sacchari* in Barbados.

The objective of this research was to evaluate the biological control potential of imported and indigenous natural enemies on sugar cane in Egypt.

Materials and methods

During 2005-2006, a survey of *S. sacchari* parasitoids and predators was conducted. The mealybug colonies were kept in a well-ventilated container until emergence of any natural enemies. Identification of natural enemies was made by examining the adults mounted in Hoyerõ s medium (slide) and on card (Noyes, 1982). A survey of natural enemies of *S. sacchari*, particularly their abundance, was carried out between June 2005–June 2006 on sugar cane in three localities, namely, Aswan, Qena and Sohag. Three locations heavily infested by 1st, 2nd, 3rd nymphal instars and non-ovipositing females of *S. sacchari* were chosen for the study and were sampled monthly. No chemical control was performed on these sites during the period of the study.

Thirty nodes (each 60 cm long) were collected at each of the sites and transferred to the laboratory. The number of 1st, 2nd, 3rd nymphal instars and non-ovipositing females of *S. sacchari* were recorded per node. Susceptible stages were stored in well-ventilated emergence glass tubes and monitored daily for parasitoid emergency. Percentages of parasitism were calculated according to the methods of Abd-Rabou (1997). The predators were examined and counted in the field.

In addition, the coccinellid predator, *Hyperaspis trilineata* was introduced from India during 2005. In the laboratory, the predator was successfully mass reared on *S. sacchari* reared on sugarcane seedlings (*Saccharum officinarum*, "C9/45 variety"). A total 200,000 adult coccinellid individuals were released monthly on *S. officinarum* infested plants in Qena and Aswan governorates. Each of the two sites had 4 replicates, giving a total of 8 plots, each of 0.12 hectare. Before release, the number of *S. sacchari* were estimateed, by collecting 30 from each replicate and transferring them to the laboratory (25-27°C and 60-65% R.H.).

Statistical analyses of the data were conducted using ANOVA procedures in SAS (1989). Mean separation was by using Duncan Multiple range test.

Results and discussion

Ten species of encyrtids and a signophorid emerged from sampled material: *Anagyrus greeni* Howard, *A. pseudococci* (Girault), *A. saccharicola* (Hymenoptera, Encyrtidae), *Chartocerus*

subaenus (Foerster), *Leptomastidea abnormis* (Girault), *Microterys* sp., *Paraphaenaodiscus* sp., *Prochiloneurus* sp., *Rhopus nigriclavus* (Girault) and *Rhopus* sp. In addition, five predators were collected from sampled material of *S. sacchari*: *Coccinella undecimpunctata* L.; *Scymnus syriaca* Mars.; *Paederus alfierii* Koch; *Orius* sp. and *Chrysoperla carnea* (Steph.) (Table 1).

Table 1. Natural enemies of *Saccharicoccus sacchari* in Egypt.

Natural enemies	Order	Family	Principal and Occasional natural enemies
I. Parasitoids			
Primary parasitoids			
1. *Anagyrus greeni* Howard	Hymenoptera	Encyrtidae	Principal
2. *A. pseudococci* (Girault)	Hymenoptera	Encyrtidae	Principal
3. *A. saccharicola*	Hymenoptera	Encyrtidae	Principal
4. *Leptomastidea abnormis* (Girault)	Hymenoptera	Encyrtidae	Occasional
5. *Microterys* sp.	Hymenoptera	Encyrtidae	Occasional
6. *Paraphaenaodiscus* sp.	Hymenoptera	Encyrtidae	Occasional
7. *Prochiloneurus* sp.	Hymenoptera	Encyrtidae	Occasional
8. *Rhopus nigriclavus* (Girault)	Hymenoptera	Encyrtidae	Principal
9. *Rhopus* sp.	Hymenoptera	Encyrtidae	Occasional
Secondary parasitoids			
10. *Chartocerus subaenus* (Foerster)	Hymenoptera	Signophoridae	Occasional
II. Predators			
1. *Chrysoperla carnea* (Steph.)	Neuroptera	Chrysopidae	Principal
2. *Coccinella undecimpunctata* L.	Coleoptera	Coccinellidae	Principal
3. *Orius* sp.	Hemiptera	Anthocoridae	Occasional
4. *Paederus alfierii* Koch			Occasional
5. *Scymnus syriaca* Mars.	Coleoptera	Coccinellidae	Occasional

In Aswan, *S. sacchari* was parasitized by *A. saccharicola*, *R. nigriclavus*, *Rhopus* sp. and *C. subaenus*, with average parasitism rates of 12.3, 5.2, 2.3 and 0.3% respectively, with peak percentages of 31, 16, 7 and 2 respectively (Fig. 1). *S. sacchari* was also attacked in Aswan by the predators *C. carnea* and *P. alfierii,* with an average 4.9 and 1.5 individuals/30 nodes, respectively and with peak populations of 16 and 5 individuals/30 nodes (each 60 cm).

In Qena, *S. sacchari* was parasitized by *A. pseudococci*, *A. saccharicola*, *L. abnormis* and *Microterys* sp., with average parasitism rates of 4.1, 5.1, 3.5, and 0.2% respectively. Parasitism peaks were 15, 17, 11 and 1% respectively (Fig. 2). *S. sacchari* also attacked in Qena by the predators *C. undecimpunctata* and *S. syriaca,* with an average 3.9 and 1.3 individuals/30 nodes respectively, and with peak populations of 12 and 4 individuals/30 nodes.

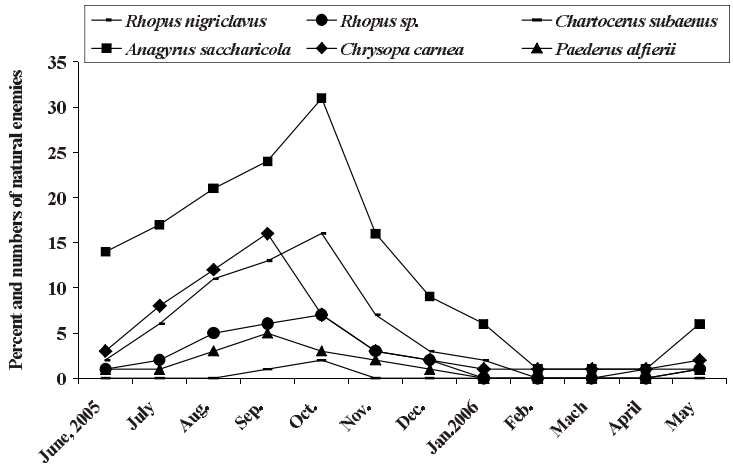

Figure 1. Population trends of parasitoids (%) and predators (numbers) of *Saccharicoccus sacchari* in Aswan governorate during 2005-2006.

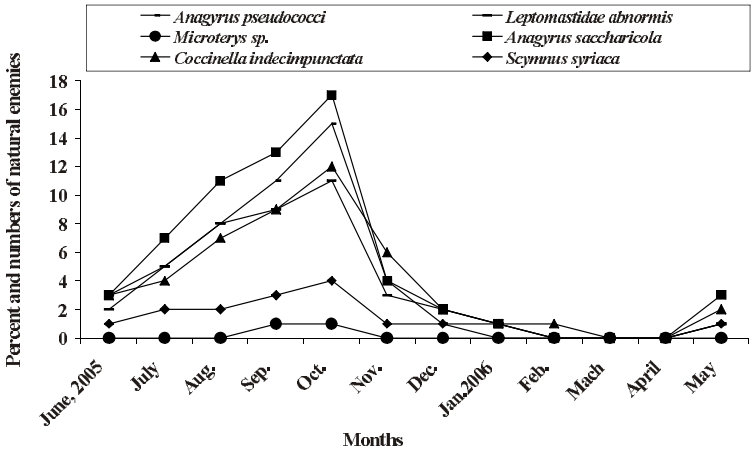

Figure 2. Population trends of parasitoids (%) and predators (numbers) of *Saccharicoccus sacchari* in Qena governorate during 2005-2006.

In Sohag, *S. sacchari* was parasitized by *A. greeni*, *A. saccharicola*, *Paraphaenaodiscus* sp. and *Prochiloneurus* sp., with average parasitism rates of 4.8, 8.8, 0.8 and 0.45 respectively. Parasitism peaks were 13, 23, 5 and 3% respectively (Fig. 3). *S. sacchari* also attacked at Sohag by the coccinellid predator *C. undecimpunctata* with an average 5.4 individuals/ 30 nodes, and with a peak of 14 individuals/30 nodes.

The three governorates surveyed were distinctive in their locations as well as in their prevailing weather factors. Apart from the parasitoid *A. saccharicola*, which was the dominant parasitoid in all locations in this study, the parasitoid species collected from Aswan were not reported from Qena and Sohag nor vice versa. In India, Alam (1972) stated that *A. saccharicola* became established. It was recovered soon after its release and, augmented

by additional releases, spread rapidly. By January 1972, the levels of parasitism in the dry, intermediate and high rainfall areas were: 8.3, 9.0 and 9.7%. Later Pruett & Colque (1984) recorded this parasitoid in Bolivia and it has also been recorded as an effective parasitoid of the pink sugarcane mealybug in Australia (Carver *et al.*, 1987). *A. saccharicola* has also been recorded from *S. sacchari* in Cuba by Hernandez *et al.* (1993).

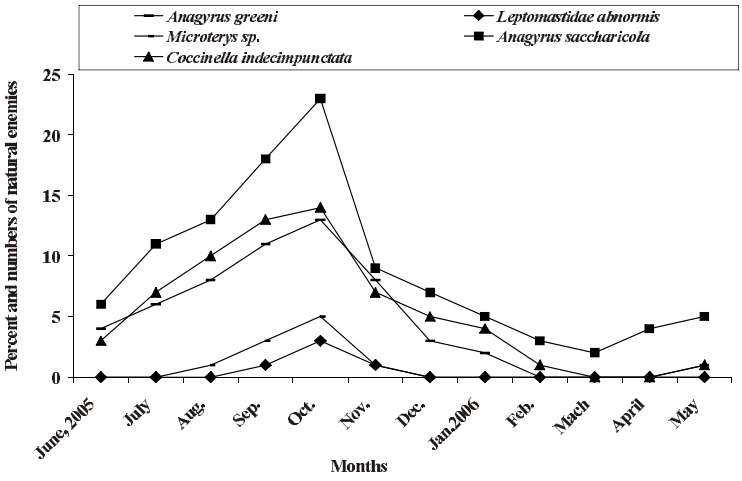

Figure 3. Population trends of parasitoids (%) and predators (numbers) of *Saccharicoccus sacchari* in Sohag governorate during 2005-2006.

Abd-Rabou (2000) undertook a survey of the parasitoids of *S. sacchari* and their abundance in various locations in Egypt. Nine parasitoids and hyperparasitoids were recorded: *Anagyrus greeni* Howard, *A. pseudococci* (Girault), *Chartocerus subaenus* (Foerster), *Leptomastidea abnormis* (Girault), *Microterys* sp., *Paraphaenaodiscus* sp., *Prochiloneurus* sp., *Rhopus nigriclavus* (Girault) and *Rhopus* sp. The abundance of these species was evaluated at three localities. *L. abnormis* was the dominant parasitoid, showing maximum parasitism rates of 14 and 21% during October 1998 in Assiut and Qena governorates, respectively, whilst at the third locality it was not active. Later Abd-Rabou (2002) released about between 146 163 parasitoid adults of *A. saccharicola* in five governorates in upper Egypt during March 1999 and May 2000. Surveys to evaluate the effectiveness of the parasitoid were conducted between June 2000 and June 2001. *A. saccharicola* established readily and spread rapidly. The rate of parasitism increased gradually from 0.5 to13.2% in Sohag, 3.7-19.95 in Qena, 4.4-24.4% in Assuit, 0.8-26.6% in Beni-Suef and 8.9-50.0% in El-Minya. Climatic conditions seemed to play an important role in promoting the establishment of the parasitoids. Table (2) shows simple correlation and partial regression values between the monthly mean numbers of natural enemies and the population of *S. sacchari* on sugar cane in different Governorates during 2005 and 2006.

Individuals of the predator, *H. trilineata* were released monthly between June 2005 and May 2006 on infested sugar cane in Aswan and Qena The total number released was 200,000 individuals (Fig.4). The highest densities later recorded were 64 and 41 individuals/ 30 nodes (each 60cm) in October in Qena and Aswan, respectively (Fig. 5). These results

were recorded after 4 months from the time of introduction, showing that *H. trilineata* became established in these governorates. These findings suggest that effective control of the mealybug may be achieved in the near future, as seen in Bolivia and Barbados (Colque, 1984; Alam, 1972).

Table 2. Simple correlation and partial regression values between the monthly mean numbers of natural enemies and the population of *S. sacchari* on sugar cane in different Governorates in Egypt during 2005 and 2006 years.

Governorate	Relation	Population	*R. nigriclavus*	*Rhopus* sp.	*C. subaenus*	*A. accharicola*	*C. carnea*	*P. alfierii*
Aswan	Correlation "r"	-	0.97	0.96	0.75	0.98	0.76	0.85
	Regression "b"	-	0.94	0.93	0.57	0.96	0.77	0.85
Qena	Relation	Population	*A. pseudococci*	*L. abnormis*	*Microterys* sp.	*A. saccharicola*	*C. undecimpunctata*	*S. syriaca*
	Correlation "r"	-	0.89	0.91	0.65	0.89	0.91	0.90
	Regression "b"	-	0.82	0.87	0.42	0.81	0.85	0.83
Sohag	Relation	Population	*A. greeni*	*Prochiloneurus* sp	*Paraphaenaodiscus* sp	*A. saccharicola*	*C. undecimpunctata*	-
	Correlation "r"	-	0.98	0.77	0.84	0.95	0.94	-
	Regression "b"	-	0.97	0.63	0.78	0.92	0.89	-

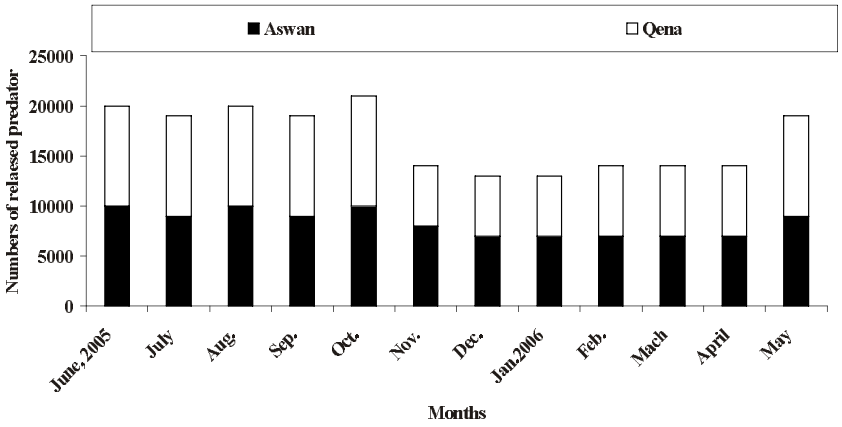

Figure 4. Numbers of individuals of the predator *Hyperaspis trilineata* released at each date in the Aswan and Qena governorates.

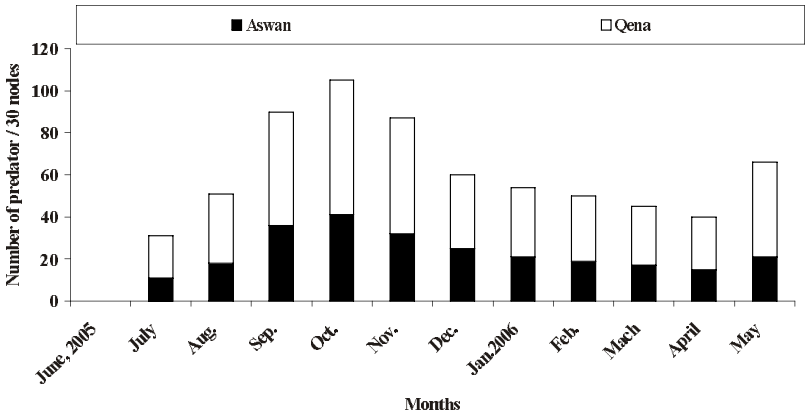

Figure 5. Numbers of the predator *Hyperaspis trilineata* collected 4 months after release during 2005-2006 in Aswan and Qena governorates.

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