

Research Article

Field efficacy of parasitoid, *Coccophagus scutellaris* (Hymenoptera: Aphelinidae) and the predator, *Exochomus flavipes* (Coleoptera: Coccinellidae) against *Pulvinaria psidii* (Hemiptera: Coccidae) in Egypt

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ABSTRACT: The aim of this study was to investigate the biological control of the green shield scale, *Pulvinaria psidii* Maskell (Hemiptera: Coccidae), on guava trees in Gahriya, Egypt, by the release of two of its natural enemies. For this purpose, 12 releases of larval *Exochomus flavipes* (Thunberg) (Coleoptera: Coccinellidae) and *Coccophagus scutellaris* (Dalman) (Hymenoptera: Aphelinidae) were carried out on guava trees between May 2007 and April 2008. These two beneficials were reared under defined climatic conditions (25–27°C and 65–75%) in a laboratory. A significant reduction in the number of *P. psidii* populations was recorded as compared with control plots. Six months after the release of *E. flavipes*, the average populations of *P. psidii* decreased from 1897/30 to 475/30 leaves in the treated plot. With regard to *C. scutellaris*, the number of parasitized *P. psidii* nymphs in the treated plots increased from 2% to 54% as compared to the control plots. The present study indicated that *C. scutellaris* and *E. flavipes* are potential biocontrol agents of *P. psidii* on guava.

KEY WORDS: Biocontrol, field efficacy, *Pulvinaria psidii*, Egypt, *Coccophagus scutellaris*, *Exochomus flavipes*

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INTRODUCTION

The green shield scale, *Pulvinaria psidii* (Maskell) (Hemiptera: Coccidae) attacks a large number of host plants such as guava, citrus and mango in Egypt (Mohammad and Nada, 1991; Abd-Rabou, 2000; Abd-Rabou and Ali, 2009) and in different parts of the world (Ben-Dov, 1993). It feeds on the phloem of leaves and tender young stems of the host plant. Damage due to the feeding of an individual scale is small. However, under severe infestation, feeding causes yellowing, defoliation, reduction in fruit set, and loss in plant vigor. It excretes honeydew, which serves as a medium for sooty mold. Sooty mold blackens the leaf, decreases photosynthesis and the fruit often becomes unmarketable or of a lower grade, because of the unappealing appearance (Hodgson, 1967; Salama and Salem, 1970; Elmer and Brawner, 1975).

The parasitoid, *Coccophagus scutellaris* (Dalman) (Hymenoptera: Aphelinidae) has been recorded attacking the pest in different locations in Upper Egypt (Abd-Rabou, 2002a). Many species of *Coccophagus* which are frequently encountered as parasitoids of soft scales have been used in biological control programs (Wilk and Kitayama, 1981). *C. scutellaris* attacks six species of soft

scale insects (*Ceroplastes floridensis* Comstock, *Coccus hesperidum* L., *Pulvinaria floccifera* (Westwood), *P. psidii* Maskell, *Saissetia coffeae* (Walker) and *S. oleae* (Oliver) and is considered an effective parasitoid of some of these pests with maximum parasitism rates reaching 26% in Egypt (Abd-Rabou, 2002b; Hendawy *et al.*, 2002; Abd El-Samea, 2003; El-Serwy and Guerrieri, 2005; Abd-Rabou and Abd.El-Samea, 2007; Abd-Rabou, 2008).

Exochomus flavipes (Thunberg) (Coleoptera; Coccinellidae) is reported as an effective predator of scale insects infesting different economic crops such as apple, citrus, pear and olive (Abd-Rabou *et al.*, 2003; Abd-Rabou and Badary, 2004; Famoosh, 2003; Iheagwam, 1981; Boussienguet, 1986; Samways, 1983; Tassan *et al.*, 1982; Selim, 1977; Barnes *et al.*, 1976). The objective of this research was to evaluate the biological control potential of *C. scutellaris* and *E. flavipes* against *P. psidii* on *Psidium guajava* in Egypt.

MATERIALS AND METHODS

Psidium guajava was used to mass rear *C. scutellaris* on *P. psidii*. Approximately 100,000 adults of this parasitoid were released (Table 1) in Gahriya governorate in Egypt

in a field of *P. guajava*, which was naturally infested with *P. psidii*. Releases were made during the year at monthly interval and 12 releases were made in consecutive months (May 2007 and April 2008). Within a given year, similar numbers of parasitoids were released each month. The parasitoids were released as adults from containers (vials or cups) which were attached to guava trees. One container of 80-100 parasitoids was released per tree by allowing the parasitoids to fly or walk from the containers. Each plot was approximately 0.21 hectares. Another at a plot distance of about 300 meters from the released plot was selected as control plot.

Evaluations of released parasitoid individuals were assessed through either rearing or dissection of recovered samples. Cardboard containers (0.5-liter) with ventilated tops were utilized to hold samples for two weeks at 25-29°C. This was achieved by holding 30 *P. guajava* leaves in each container. All materials found at the bottom of the rearing containers were examined for dead adult and larval stages of *P. psidii* and associated parasitoids. The parasitoids were identified by comparison with voucher specimens. Leaf samples were collected at the beginning of every month from June 2007 and April 2008. The samples were taken after each monthly release. For each month of sampling, 10 trees were sampled in the parasitoid release plot and 10 trees were sampled in the control plot. Dissection of second, third stages and adult instars of *P. psidii* obtained from the released location was used to detect prepupae and pupae of the parasitoids. Per cent parasitism was defined as: Per cent parasitism = [number of prepupae, pupae, and adult parasitoids / (number of *P. psidii*, excluding eggs and first instar + number of prepupae, pupae, and adult parasitoids)] x 100.

Table 1. Total numbers of adult *C. scutellaris* and *E. flavipes* released in fields of *P. guajava* in Gahrbiya Governorate in Egypt during May 2007 and April 2008

Month	Number released	
	<i>C. scutellaris</i>	<i>E. flavipes</i>
May 2007	9000	4000
June	8000	4500
July	8000	4000
August	9000	4000
September	8500	4500
October	8000	4000
November	9000	4000
December	8000	4000
January, 2008	8000	4000
February	8500	4500
March	8000	4000
April	8000	4500

Similar to this study, for the experiment with the predator, *E. flavipes* was mass reared on *P. psidii* which was reared on *P. guajava*. From May 2007 and April 2008, approximately 50,000 of the adult beetles were released (Table 1) in a different field of *P. guajava* located approximately 5 km far from the field of the parasitoid experiment. Releases of the predator were made in one half of the field and no releases were made in the other half of the field. Releases of the predators were made in governorate on *P. guajava* in a field that was naturally infested with *P. psidii*. Fifty thousand predators were released during the year, with a similar number released each month (Table 1). The predators were released as adults from vials as described above in the parasitoid experiment. Monthly releases were conducted. The evaluation of releases was assessed monthly from June 2007 and April 2008 by counting and recording the stages of *P. psidii* present and the total number of nymphs and adults of *P. psidii* and larvae, pupae and adults of *E. flavipes* present on a leaves of *P. guajava*. For each month of sampling, 10 trees were sampled and 10 trees were sampled in the control plot. As described above, a random monthly sample of 30 leaves were taken in each control plot and the release plot of *E. flavipes* trees. *P. psidii* counts for the control plots and the released plots were combined. The effect of maximum and minimum temperatures and relative humidity on percentage of parasitism and number of *E. flavipes* were analyzed by simple correlation and regression (SAS Institute, 1999).

RESULTS AND DISCUSSION

The release of approximately 100,000 *C. scutellaris* (Table 1) in the field on *P. guajava* resulted in increased parasitism from 2 to 54% during May 2007 and April 2008 as compared with the control plot where no releases were made, the parasitism ranged from 0 to 5%. (Fig. 3). The maximum rate of parasitism by *C. scutellaris* (54%) was attained in November 2007 in the release plot (Fig. 2). Parasitism gradually increased in July and peaked during November. The peak in parasitism was due to higher populations of *C. scutellaris* in the field, while in the control plot it was 8% (Fig. 3).

Simple correlation between the population of parasitoids, relative humidity (Fig.1) and the mean number of insects were non-significant ($r=0.57$ and 0.16) and significant ($r=0.78$ and 0.72) between maximum, minimum temperature and the mean number of insects during the May 2007 and April 2008, respectively (Table 2). Also, results in Table 2 based on the simple regression suggests that relative humidity had a non-significant relation ($b=0.52$ and 0.35), while maximum, minimum temperature had a

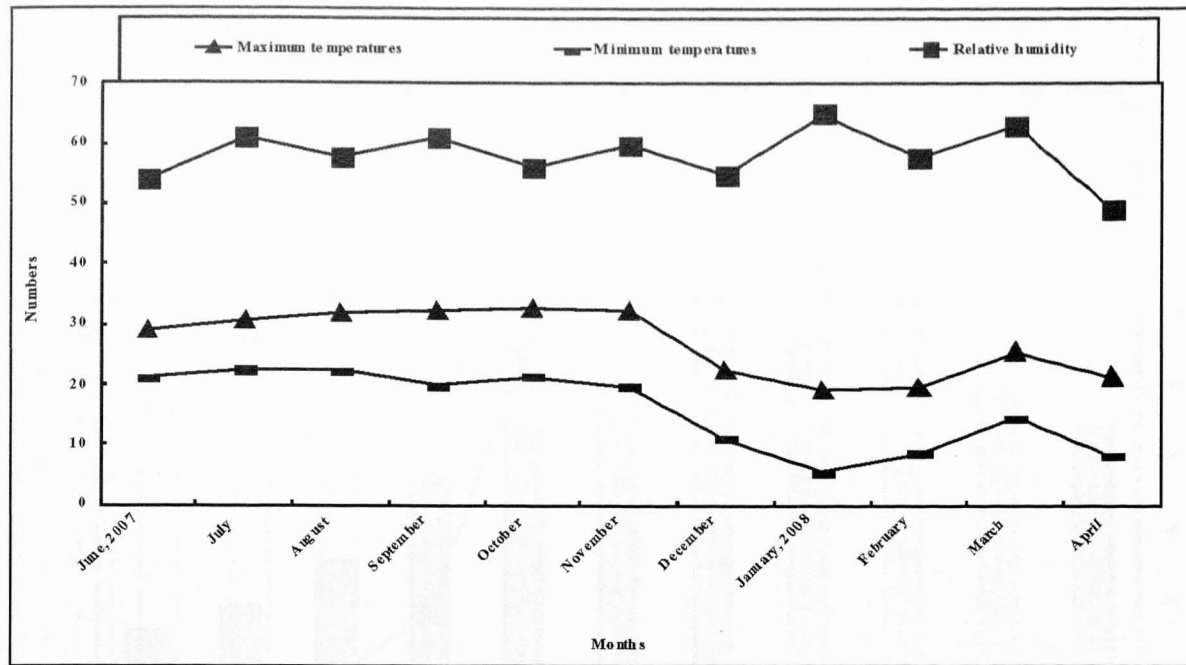


Fig. 1. Maximum, minimum temperatures and relative humidity during the period of study in Gahrbiya

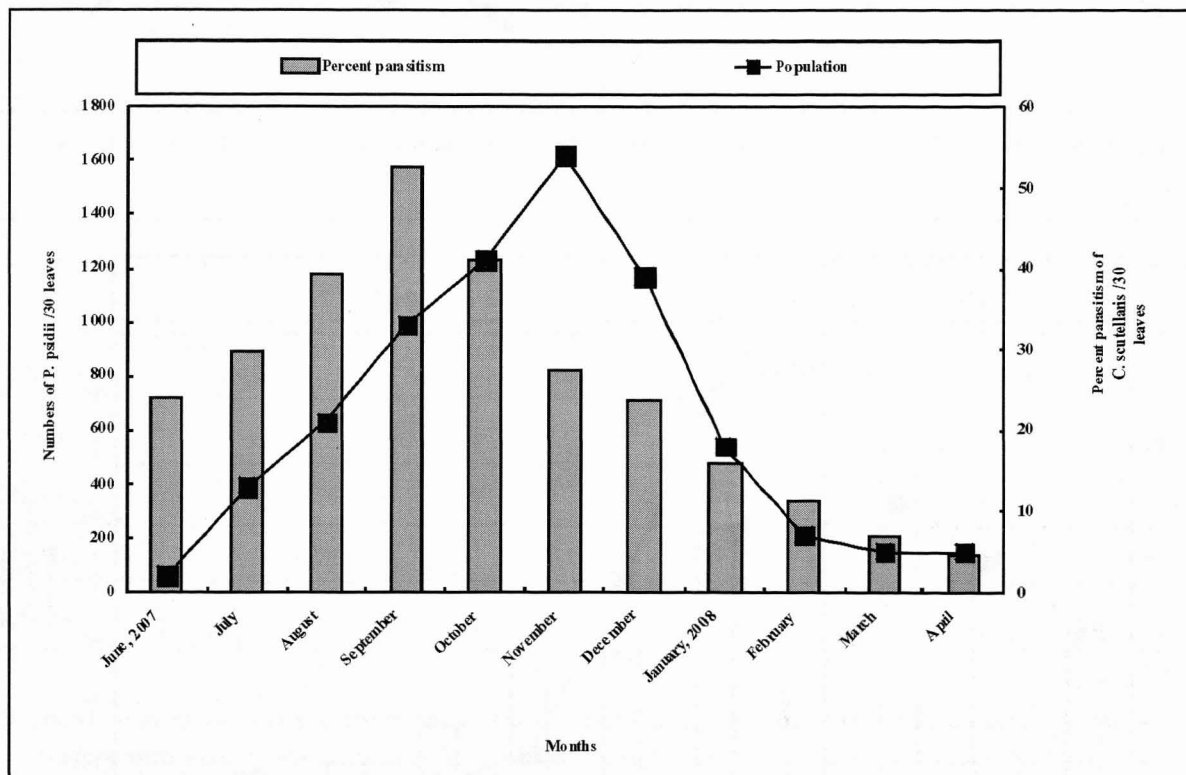


Fig. 2. Population of *Pulvinaria psidii* and per cent parasitism by *Coccophagus scutellaris* after releases

significant ($b=0.72$ and 0.57) relationship between and the mean number of insect during the May 2007 and April 2008, respectively.

In the predator released field plot, the population of *E. flavipes* ranged from 0 to 85 individuals per 30 leaves during the period of study (Fig. 4), while in control it

ranged from 0 to 35 predators per 30 leaves (Fig. 5). The data in Table 3 showed that the simple correlations between the population of predators, maximum, minimum temperature, relative humidity (Fig. 1) and the mean number of insect were significant and highly significant ($r=0.92, 0.74, 0.81$ and 0.84) during May 2007 and April 2008, respectively. Also, results in Table 3, show that

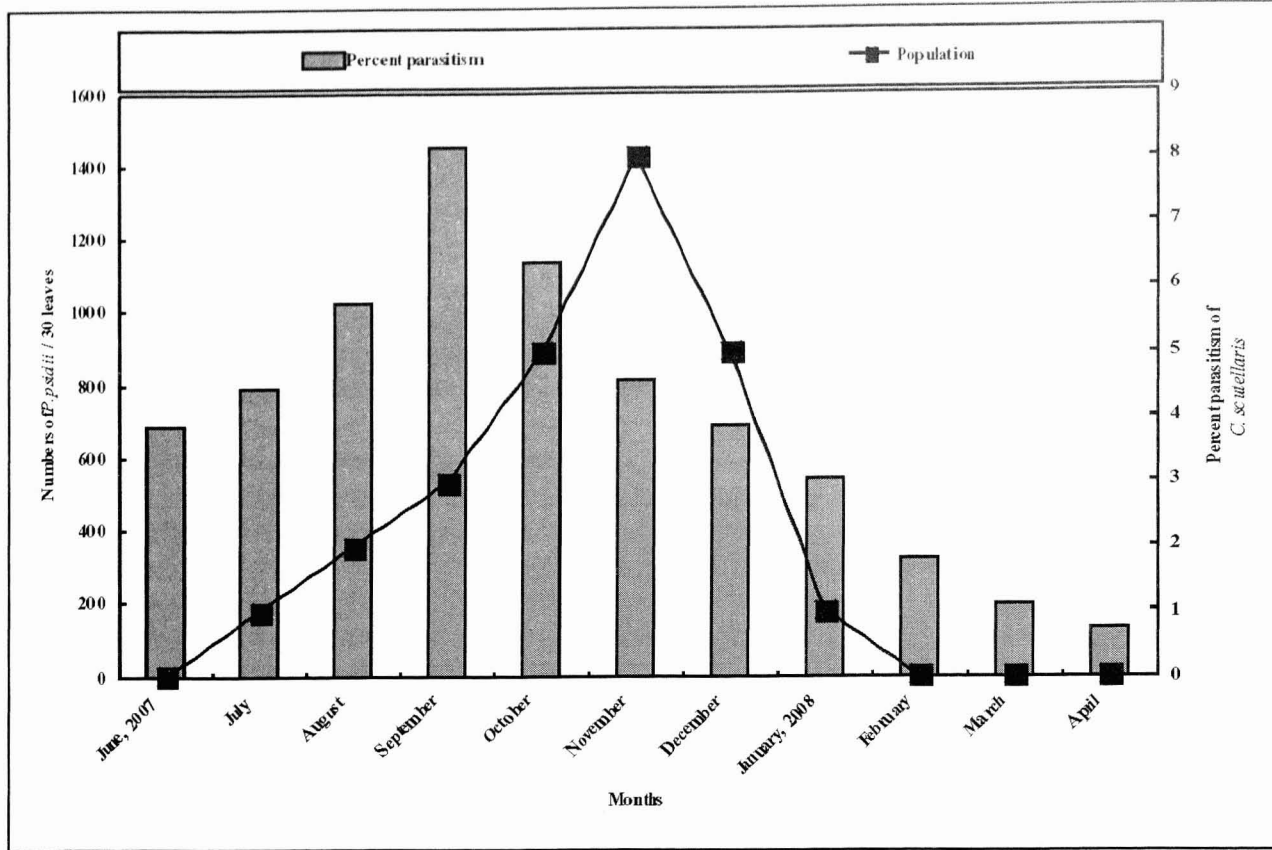


Fig. 3. Population of *Pulvinaria psidii* and per cent parasitism by *Coccophagus scutellaris* before releases

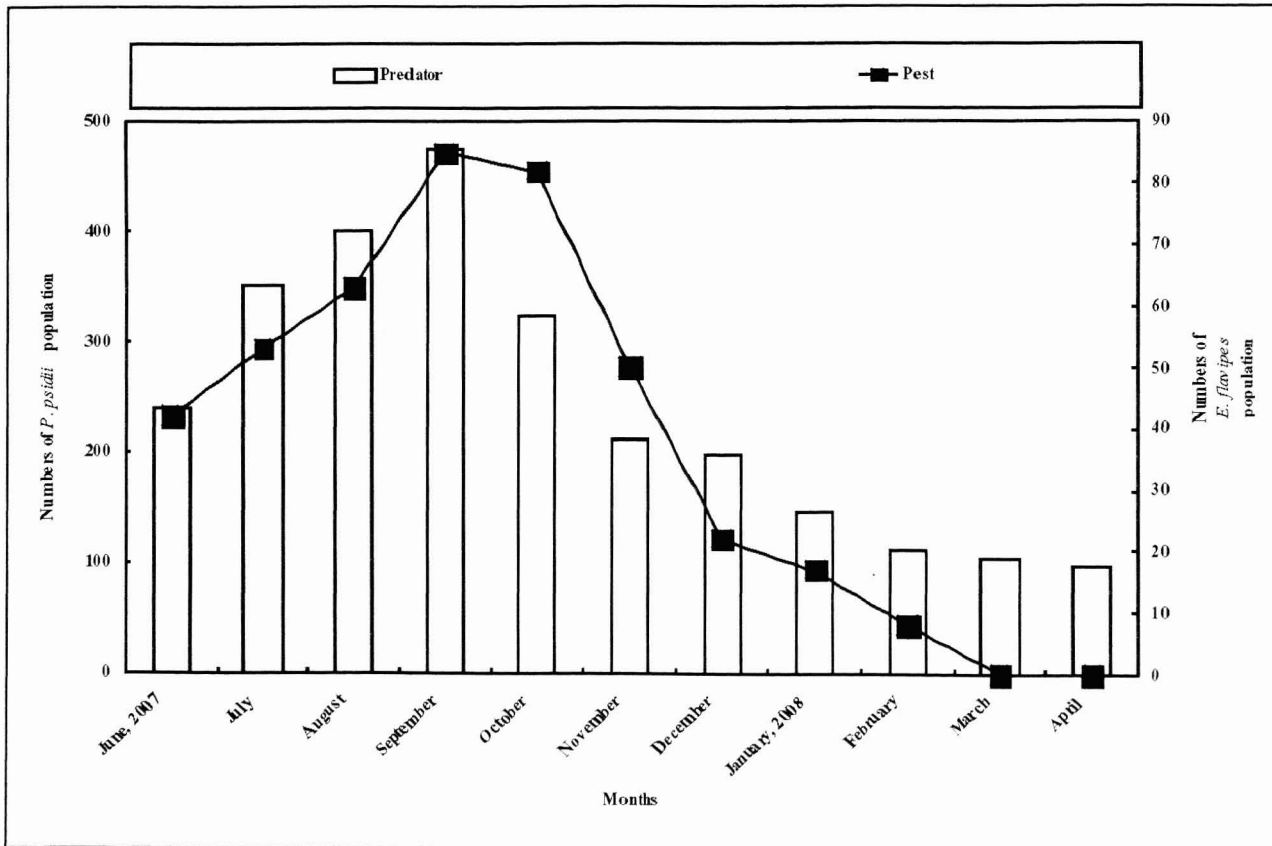


Fig. 4. Population of *Pulvinaria psidii* and *Exochomus flavipes* after releases

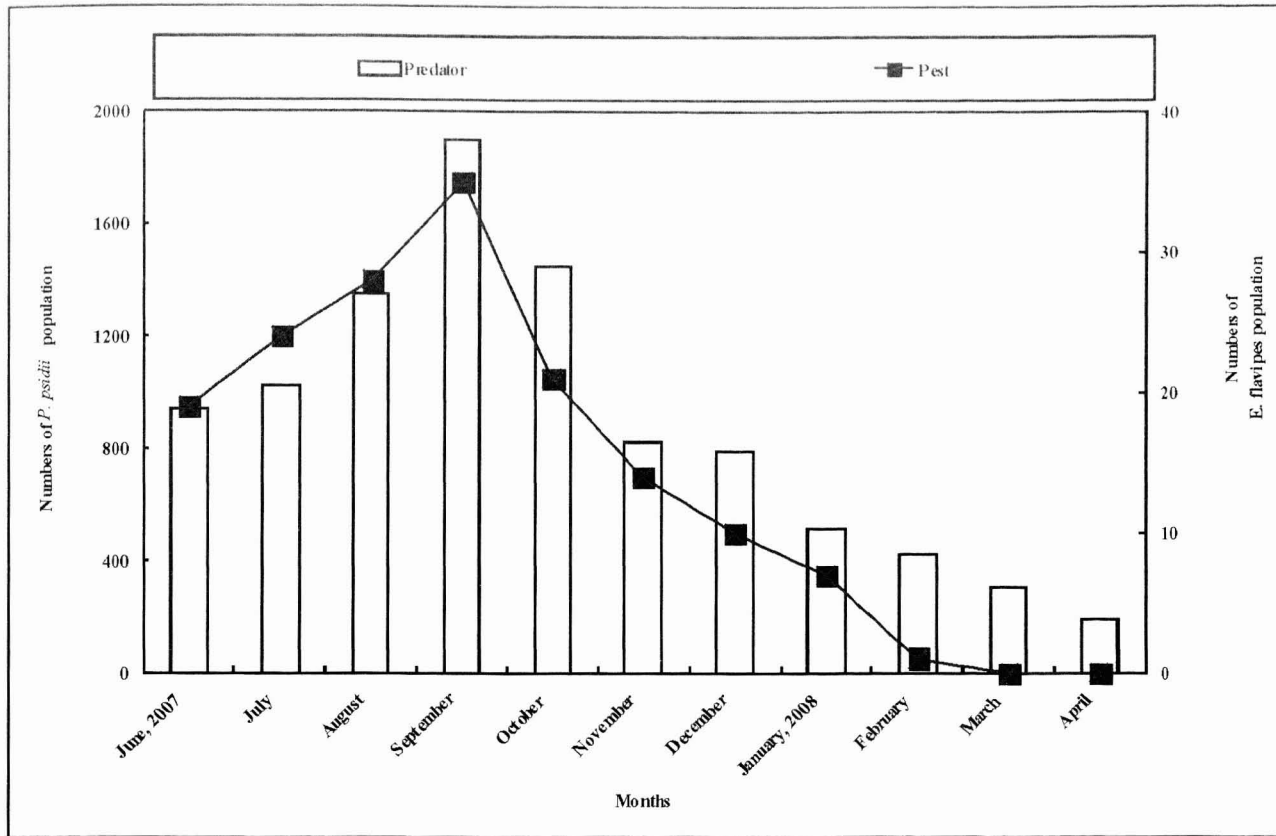


Fig. 5. Population of *Pulvinaria psidii* and *Exochomus flavipes* before releases

Table 2. Simple correlation and regression values for the population of *P. psidii* and its parasitoid, *C. scutellaris* on *P. guajava* with various abiotic factors in Gahrbiya Governorate during May 2007 and April 2008

Variable	Simple correlation "r"	Probability "P"	Regression	Probability "P"
Parasitoid	0.57	ns	0.52	Ns
Maximum	0.78	**	0.72	**
Minimum	0.72	*	0.54	*
R.H. %	0.16	ns	0.35	Ns

Table 3. Simple correlation and regression values for the population of *P. psidii* and its predator, *E. flavipes* on *P. guajava* with various abiotic factors in Gahrbiya Governorate during May 2007 and April 2008

Variable	Simple correlation "r"	Probability "P"	Regression	Probability "P"
Predator	0.92	***	0.86	***
Maximum	0.74	**	0.62	*
Minimum	0.81	**	0.74	**
R.H. %	0.84	***	0.76	**

the simple regression for changing the population of predators, maximum, minimum temperature, relative humidity and the mean number of insect were significant and highly significant ($r=0.86, 0.62, 0.74$ and 0.76) during May 2007 and April 2008, respectively.

Predators are recorded as effective bioagents attacking *P. psidii* in Egypt (Osman *et al.*, 1982). The predator, *E. flavipes* is the dominant coccinellid predator associated with the cottony camellia scale, *Pulvinaria floccifera* and a maximum of 65 individuals per 30 leaves was recorded during September, in El-Arish region (Abd-Rabou and Badary, 2004). However, Abd-Rabou *et al.* (2003) stated that *E. flavipes* was recorded at low populations in olive orchard infested by *Saissetia oleae* (Hemiptera: Coccidae). Tassan *et al.* (1982) recorded *E. flavipes* as an effective predator in controlling *Pulvinaria mesembryanthemi* (Vall.) and *Pulvinaria delottoi* Gill. (Hemiptera: Coccidae), infesting ice plant (*Carpobrotus* spp.). Argyriou and Katsoyannos (1977) considered *E. flavipes* as an effective bioagent in controlling *S. oleae* infested olive trees in Greece. The present study indicated that *C. scutellaris* and *E. flavipes* are potential biocontrol agents of *P. psidii* on guava.

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