J. Biol. Control, 23(1): 37-41, 2009

Evaluation of *Aphytis melinus* De Bach (Hymenoptera: Chalcidoidea: Aphelinidae) in citrus orchards as a biocontrol agent of black scale, *Parlatoria ziziphi* (Lucas) (Hemiptera: Coccoidea: Diaspididae) in Egypt

SHAABAN ABD-RABOU
Plant Protection Research Institute, Dokki, Giza, Egypt.

ABSTRACT: The black parlatoria scale, *Parlatoria ziziphi* (Lucas) (Coccoidea: Diaspididae), is one of the most important pests attacking citrus trees in different parts of the world including Egypt. This work deals with rearing, release and evaluation of the parasitoid, *Aphytis melinus* De Bach (Hymenoptera: Aphelinidae) to control *P. ziziphi* biologically. In all, 250000 adult parasitoid individuals were released monthly on citrus at five locations in Cairo, Giza and Qalyubiya governorates during 2006 and 2007. At Heliopolis (Cairo), where *A. melinus* was present prior to the augmentative release, the per cent parasitism in the control block was 15 and 75% while it was 73 and 87% in the treatment block during the two years under consideration. At Dokki (Giza) also, *A. melinus* was present prior to the augmentative releases and the peak of parasitism reached 18 and 82% in the control block, compared to 86 and 91% in the treatment block. At El-Qanater El-Khriya and Tukh in Qalyubiya, *A. melinus* was present prior to the augmentative releases. In El-Qanater El-Khriya, the peak of parasitism reached 41 and 67% in the treatment block, compared to 8 and 46% in the control block. In Tukh, the peak of parasitism reached 31 and 65% in the treatment block, compared to 4 and 35% in the check block. At Qalub, where the parasitoid was not present prior to the augmentative releases, the peak of parasitism reached 22 and 36% in the treatment block, compared to 0 and 22% in the control block during the two years, respectively.

KEY WORDS: *Aphytis melinus*, citrus, evaluation, orchards, *Parlatoria ziziphi*.

INTRODUCTION

The black parlatoria scale, *Parlatoria ziziphi* (Lucas) (Hemiptera: Coccoidea: Diaspididae) is one of the most important pests attacking citrus trees in Egypt (Coll and Abd-Rabou, 1998). Host range of the black scale has been recorded by many authors (Borchsenius, 1966; Dekle, 1976; Williams and Williams, 1988). It attacks vegetative growing, flowering, fruiting and post-harvest stages. The absorption of plant sap leads to reduced host vigor, and the foliage and fruit may be discolored with yellow streaking and spotting due to saliva toxicity. This species has two generations per year on sour oranges and three generations per year on grapefruit (Salama *et al.*, 1985). In China, *P. ziziphi* had three to four overlapping generations each year and overwintered in the adult stage (Huang *et al.,* 1988). Natural enemies of *P. ziziphi* have been recorded as effective in controlling it (Rosen, 1990). In Egypt, this species is attacked by four parasitoids (Abd-Rabou, 1997, 1999). Biological control of some species of armored scale insects by augmentative releases in Egypt was evaluated by Abd-Rabou (2001). *A. melinus* is a parasitoid that is effective on armored scale insects and is commonly used on citrus trees. The parasitoid has a narrow host range but its hosts are polyphagous (Morgan *et al.*, 1998).

The aim of this research was to rear, release and evaluate the parasitoid, *A. melinus* against the black scale, *P. ziziphi* biologically in Egypt.

MATERIALS AND METHODS

A preliminary survey of *A. melinus* was conducted in different locations of Egypt during November, 2005. In the laboratory, *A. melinus* was successfully mass reared on infestations of *P. ziziphi* on citrus plant. The infested trees were washed down before release to remove some of the honeydew secretions, making it easier for the parasitoids. In all, 250,000 adult parasitoid individuals were released monthly on citrus at five locations in Cairo, Giza and Qalyubiya governorates. For each of the five locations of the three governorates, the study was conducted on 0.13 ha of citrus. The population of *P. ziziphi* before releasing *A. melinus* was counted. Mortality releases were achieved throughout the periods of June to November, 2006 and 2007.

Sixty leaves of citrus were collected and then transferred to the laboratory (25-27C and 60-65% R.H.). *P. ziziphi* egg stage and other insects were eliminated under a stereoscopic microscope. The first, second nymphal instars and adult female were recorded per leaf. Each leaf was stored in a well ventilated glass tube for emergence and monitored daily for parasitism.

The same procedures followed in treatment experiments were followed in the control experiment too, which was separated from the treatment experiments by 300m. Multiple regression analyses were performed on the data to determine the relationships between population of armored scale insect and the effect of weather factors.

RESULTS AND DISCUSSION

A preliminary survey in the three governorates Cairo, Giza and Qalyubiya was conducted to investigate the presence of *A. melinus.* The parasitoid was abundant in five locations while in the remaining locations, there was no sign of the presence of the parasitoid (Table 1).

In Heliopolis, Cairo governorate, *A. melinus* was present prior to the augmentative release. About 50,000 parasitoid individuals were released. The releases more or less doubled the per cent parasitism from 15 and 75 % in the control block in November to 73 and 87% in the treatment block during the two years under consideration (Fig. 1). Simple correlation between the population of parasitoids and the mean number of scales was positive (r = 0.67 and 0.67) and non-significant during the 2006 and 2007 seasons, respectively. The simple regression for changing the population of parasitoids on the mean number of scales was positive (b= 0.44 and 0.58) and non-significant (Table 2) during the 2006 and 2007 seasons.

In Dokki, Giza governorate, *A. melinus* was present prior to the augmentative releases. Totally, 50,000 parasitoids were released and there was a big change in the per cent parasitism as a result. The peak of parasitism reached 86 and 91 % in the treatment block, compared to 18 and 82 % in the control block (Fig. 2). Simple correlation between the population of parasitoids and the mean number of scales was positive (r = 0.82 and 0.477) in both years, significant during the 2006 season and non-significant during 2007 season. The simple regression for changing the population of parasitoids on the mean number of scales was positive (b = 0.92 and 0.62) in both years, but significant during the 2006 season and non-significant during 2007 season.

In Qalyubiya governorate, at the locations El-Qanater El-Khriya and Tukh, *A. melinus* was present prior to the augmentative releases. In all, 50,000 parasitoids were released in each location and there was change in the per cent parasitism as a result. The peak of parasitism reached 41 and 67 in the treatment block, compared to 8 and 46% % in the control block during 2006 and 2007, respectively, in El-Qanater El-Khriya (Fig. 3). The simple correlation

Table 1. Number of individuals, per cent parasitism and locations of *Aphytis melinus* and population of *Parlatoria ziziphi* in the governorates of Cairo, Giza and Qalubiya during November 2005

Distribution		Population of scale	Parasitoid	
Governorate	Locations		Number	% parasitism
Cairo	Dar-Alsalam	1003	0	0
	Heliopolis	1220	240	19.7
	Helwan	954	10	1
	Maadi	1240	35	2.8
	Naser City	897	59	6.6
	Zamalk	1321	93	7
Giza	Aiyat El-	1324	0	0
	Abou-Kalb	1456	45	3.1
	Badrashin	1354	0	0
	Baharia Oasis	1220	0	0
	Beni-Salama	1854	19	1
	Dokki	1354	291	21.5
	El-Qata	1420	58	4.1
	El-Saff	1210	0	0
	Imbaba	1472	19	1.3
	Kirdasa	1394	110	7.9
	Manyal	1420	0	0
Qalyubiya	Benha	1102	34	3.1
	El-Qanatir El-Khairiya	1009	79	7.8
	Kafr Shokr	1145	0	0
	Qalyub	950	0	0
	Tukh	901	47	5.2

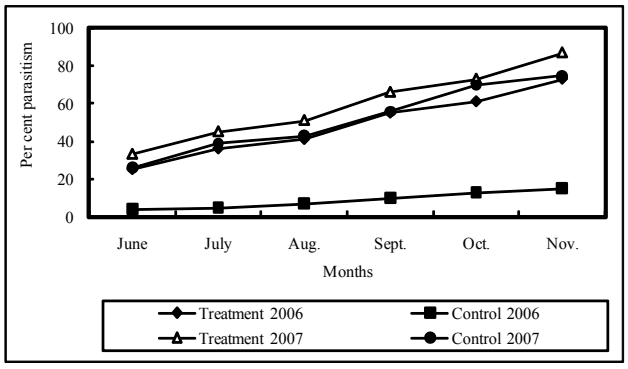

Fig. 1. Per cent parasitism of *Aphytis melinus* with *Parlatoria ziziphi* after release during 2006-2007 in Cairo (Hiliopolis)

between the population of parasitoids and the mean number of scales was negative (r = -0.016) in 2006 season, positive in 2007 season (r = 0.076), but non-significant during 2006 and 2007 seasons (Table 4). The simple regression for changing the population of parasitoids on the mean number of scales was positive (b = 0.48 and 0.73) and significant (Table 4) during 2006 and 2007 seasons, respectively.

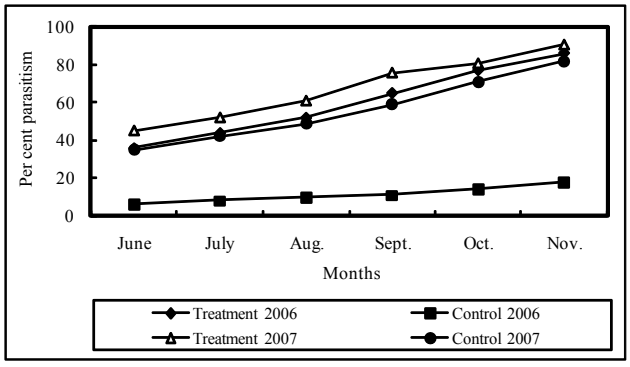

Fig. 2. Per cent parasitism of *Aphytis melinus* with *Parlatoria ziziphi* after release during 2006-2007 in Giza (Dokki)

In Tukh, the peak of parasitism reached 31 and 65 in the treatment block, compared to 4 and 35% % in the control block during 2006 and 2007, respectively (Fig. 4). The simple correlation between the population of parasitoids and the mean number of scale insects was negative during the two seasons, respectively (r = -0.12 and -0.26) and non-significant (Table 5). The simple regression for changing the population of parasitoids on the mean number of scales was positive (b = 0.83 and 0.95), but non-significant during 2006 season and significant during 2007 season, respectively (Table 5).

In Qalub, the parasitoid was not present prior to the augmentative releases. The peak of parasitism reached 22 and 36 in the treatment block, compared to 0 and 22% in the control block during 2006 and 2007, respectively (Fig. 5). Simple correlation between the population of parasitoids and the mean number of insect was negative during 2006 season and positive during 2007 season (r = -0.05 and 0.16, respectively)

(Table 6), but non-significant in both years. The simple regression for changing the population of parasitoids on the mean number of scales was positive (b = 0.95 and 0.84) in 2006 and 2007, respectively, but significant in 2006 and non-significant in 2007.

Aphytis melinus has been used for scale control in India and Pakistan. In Morocco, *A. melinus* is the most effective agent of biological control against the propagation of California red scale, *Aonidiella aurantii* (Maskell) (Coccoidea: Diaspididae), harmful to Moroccan citrus-fruit cultivation. Now, it is naturally present in the Tadla area, an important region for citrus cultivation in the centre of Morocco. Thus, the integrated protection of citrus fruits against *A. aurantii* could constitute a possibility of a promising control compared with methodical chemical control. This study was a precondition to the implementation of an integrated control strategy in citrus orchards in the Tadla area by the monitoring of *A. aurantii* and its principal parasite, *A. melinus*. The experiments were carried out in an untreated citrus orchard in Morocco, made up of a mixture of citrus fruit cultivars. In the Tadla area, the California red scale had four generations per year, a spring generation (April-May), a summer generation (June-July) and two autumnal generations (October and November-December). Pest stages that could be parasitized by *A. melinus* were observed throughout the

Table 2. Simple correlation and regression values of the population dynamics of *P. ziziphi* and its parasitoids in Cairo, Helipolis

Variable	Simple correlation "r"	Probability "P"	Regression	Probability "P"
2006	0.67	Ns	0.44	ns
2007	0.67	Ns	0.58	ns

Table 3. Simple correlation and regression values of the population dynamics of *P. ziziphi* and its parasitoids in Giza, Dokki

Variable	Simple correlation "r"	Probability "P"	Regression	Probability "P"
2006	0.82	*	0.92	*
2007	0.47	Ns	0.62	Ns

Table 4. Simple correlation and regression values of the population dynamics of *P. ziziphi* and its parasitoids in Qalyubiya, El-Qanater El-Khriya

Variable	Simple correlation "r"	Probability "P"	Regression	Probability "P"
2006	-0.016	Ns	0.48	Ns
2007	0.076	Ns	0.73	Ns

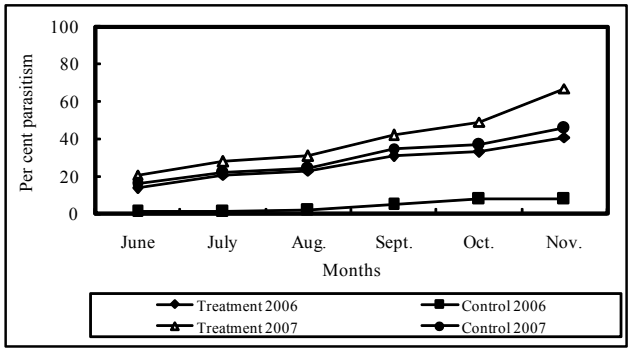

Fig. 3. Per cent parasitism of *Aphytis melinus* with *Parlatoria ziziphi* after release during 2006-2007 in El-Qanater El-Khriya (Qalyubiya)

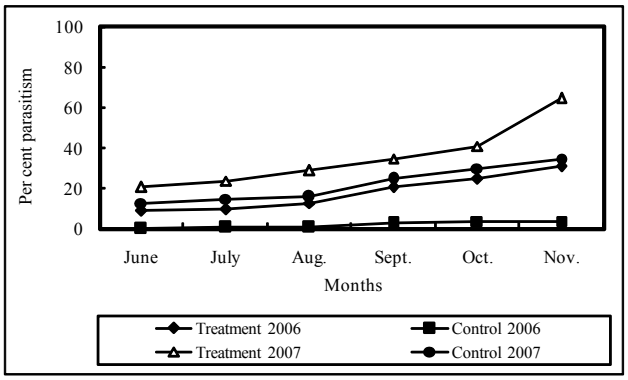

Fig. 4. Per cent parasitism of *Aphytis melinus* with *Parlatoria ziziphi* after release during 2006-2007 in Tukh (Qalyubiya)

year. Two periods (spring and autumnal) were found to be particularly suitable for the parasitoid female spawning. *A. melinus* populations appeared to be significant from the very start of the autumn and until the end of the following spring (El-Kaoutari *et al.*, 2004).

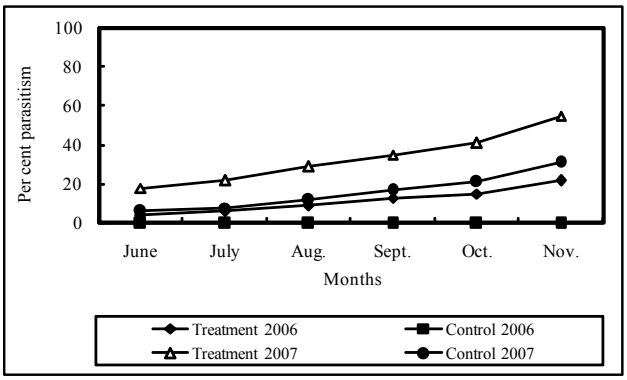

Fig. 5 . Per cent parasitism of *Aphytis melinus* with *Parlatoria ziziphi* after release during 2006-2007 in Qalub (Qalyubiya)

Mass rearing of this parasitoid, distribution and release was done in those sites where the parasitoid was not found during the summer. In the meantime, from those sites where the parasitoid was abundant, it was collected and transferred to the sites where it was not found or rare. Thus, the sites where *A. melinus* was absent were supplied with both native and laboratory reared parasitoids, during one whole year. Consequently, monthly collections were made from all these sites to estimate the new status of existence of the parasitoid. Due to the release and distribution of the parasitoids at the sites where it was absent, it became established in sites as evidenced by monthly collections.

The results showed that the methodology of transferring the reared and native parasitoids for distribution and release within the sites void of the parasitoid resulted in its establishment in these sites. The percentage of parasitism was satisfactory, showing good activity of the parasitoid and effective biocontrol of black parlatoria scale, *P. ziziphi,* which decreased in abundance.

Table 5. Simple correlation and regression values of the population dynamics of *P. ziziphi* and its parasitoids in Qalyubiya, Tukh

Variable	Simple correlation "r"	Probability "P"	Regression	Probability "P"
2006	-0.12	Ns	0.83	Ns
2007	-0.26	Ns	0.95	*

Table 6. Simple correlation and regression values of the population dynamics of *P. ziziphi* and its parasitoids in Qalyubiya, Qalub

Variable	Simple correlation "r"	Probability "P"	Regression	Probability "P"
2006	-0.05	Ns	0.95	**
2007	0.16	Ns	0.84	ns

REFERENCES

Abd-Rabou, S. 1997. Parasitoids attacking some species of scale insects (Homoptera: Coccoidea: Diaspididae) in Egypt. Proceeding of the First Scientific Conference of Agricultural Sciences, Faculty of Agriculture Assiut University, Vol. II, 727-736.

Abd-Rabou, S. 1999. Parasitoids attacking the Egyptian species of armored scale insects (Homoptera: Diaspipidae). *Egyptian Journal of Agricultural Research*, **77**: 1113-1129.

Abd-Rabou, S. 2001. The effect of augmentative releases of indigenous parasitoids on populations of *Parlatoria oleae* (Clovee') (Homoptera: Coccidea) in olive groves in Egypt. *Bollettino di Zoologia Agraria e di Bachicoltura*, **33**: 473-481.

Borchsenius, N. S. 1966. *A catalogue of the armoured scale insects (Diaspidoidea) of the world.* (In Russian.) Nauka, Moscow, Leningrad, Russia. 449 pp.

Coll, M. and Abd-Rabou, S. 1998. Effect of oil emulsion sprays on parasitoids of the black parlatoria, *Parlatoria ziziphi*, in grapefruit. *BioControl*, **43**: 29-37.

Dekle, G. W. 1976. *Florida armored scale insects. Revised edition. Arthropods of Florida and neighboring land areas, Volume 3.* Florida Department of Agriculture and Consumer Services, Gainesville, Florida, USA. 345 pp.

El-Kaoutari, I., Guirrou, Z., Chemseddine, M., Boumezzough, A. 2004. Role of *Aphytis melinus* (DeBach) in the natural control of *Aonidiella aurantii* (Maskell) in citrus orchards in Morocco. *Fruits*, **59**: 169-179.

Huang, L. L., Wang, D. W., Zhang, Q. B., Lei, H. D. and Yue, B. S. 1988. Study of bionomics and control of *Parlatoria ziziphus*. *Acta Phytophylactica Sinica*, **15**: 15-21.

Morgan, D., Hare, J. W. and Daniel, J. 1998. Volatile cues used by the parasitoid, *Aphytis melinus*, for host location: California red scale revisited. *Entomologia Experimentalis et Applicata*, **88**: 235-245.

Rosen, D. 1990. *Armoured scale insects, their biology, natural enemies and control. Vol. 4A. World Crop Pests*. Elsevier, Amsterdam, The Netherlands.

Salama, H. S., El Aherif, A. F. and Megahed, M. 1995. Soil nutrients affecting the population density of *Parlatoria ziziphus* (Lucas) and *Icerya purchasi* Mask. (Homomptera, Coccoidea) on citrus seedlings. *Zeitschrift für Angewandte Entomologie,* **99**: 471-476.

Williams, J. R. and Williams, D. J. 1988. *Homoptera of the Mascarene Islands - an annotated catalogue*. Entomology Memoir, Department of Agriculture and Water Supply, Republic of South Africa No. **72**: 1-98.

(Received: 24-09-2008; Revised: 29-10-2008; Accecpted: 06-12-2008)