Egyptian Journal of Biological Pest Control, 14(1), 2004, 31-35
Proceeding of 1st Arab Conference for Applied Biological Pest Control, Cairo, Egypt, 5-7 April 2004

Biological Control Utilizing *Trichogramma evanescens* (West.) and Agerin (B.T.) in Comparison to Ethion for Controlling *Prays citri* (Mill.) in Lime Orchards

M.A. Abo-Sheaesha [*] and E.A. Agamy [**]
[*] Plant Protection Research Institute, Agric. Res. Center Egypt
[**] Faculty of Agriculture, Cairo University

ABSTRACT

The effects of two biocontrol agents against *Prays citri* (Mill.), namely, the egg parasitoid *Trichogramma evanescens* West. and Agerin (*Bacillus thuringiensis*) were compared to the Ethion insecticide in lime orchards, at Middle Delta (Gharbia Governorate) during two successive seasons of 2002 and 2003. The results showed that the percent reductions in the larval infestation of *P. citri* (compared to the untreated trees) were 62.2, 76.4 and 78.3 in 2002 and 65.9, 80.4 and 75.9 in 2003 after application of *T. evanescens* , Agerin and Ethion, respectively. The statistical analysis showed no significant difference between the effectiveness of the three tested control methods in reducing infestation with this pest. Importantly, the obtained results revealed that the insecticide Ethion had highly significant side effect on *Bracon brevicornis* and *Chrysopa* larvae, compared to *Trichogramma* and *B.t.* It is suggested that Agerin (*B.T.*) or egg parasitoid *T. evanescens* are suitable candidates for the control of citrus flower moth *P. citri* in lime orchards within an IPM system.

Key Words: *Trichogramma evanescens*, Agerin, Ethion , *Prays citri*, Lime Orchards, Control, Egypt.

INTRODUCTION

Citrus crop represents one of the most important fruit crops in Egypt. The cultivated area of citrus has been rapidly expanded year after year. Citrus trees are infested with different species of insects causing serious damage with a noticeable reduction in the annual yield as well as the marketing income of the fruits. The citrus flowers moth *Prays citri* Mill. (Lep: Hyponomeutidae) is an important destructive pest of citrus flowers in many Mediterranean and Asian countries (Bodenheimer, 1951 and Sternlicht, 1974). It causes loss in yield particularly on lime trees. The larvae feed preferably on the reproductive organs and the interior petals. Moreover they feed on the mesocarp and seeds of the fruitlets causing premature dropping (Silayna, 1937 and Liotta & Mineo, 1963). In Egypt, this insect has 9-11 generations with two main peaks; the first is during April, May and June while the heaviest on lime trees occurred in September, October and November (Shehata, 1982 and El-Dessouki, *et al* 1987). Many parasitoids were recorded associated with *P. citri* in different countries, i. e. in Italy *Apantales laevigatus* (Rotz.), *Bracon laetus* (Wesm.), *Devorgilla canescens* (Grav.), *Nythobia (Angitia) tibialis* (Grav.), *Dichrogaster otacustes aestivalis* (Graw.), *Euderus* spp. and *Habrocytus* spp. (Mineo, 1966). In Egypt *Bracon brevicornis* (Wesm.) was recorded on *P. citri* larvae, (Abo-Sheasha 1994). Some predators such as predacious thrips, coccinellids and chrysopids, were recorded to attack this insect in the Mediterranean countries (Bodenheimer, 1951, Tawfik *et al* 1970 and Abo-Sheasha, 1994).

Different approaches were usually attempted to control this pest, among which the use of B.t., releasing the parasites such as *Trichogramma* and *Ageniaspis fuscicallis* Dalm. (var *praysimcola*) Silv. and chemical insecticides. However, highly effective insecticides create several problems such as undesirable chemical residues, environmental pollution, insecticide resistance and disturbance of the natural balance. To overcome these problems, search for alternative non–chemical methods are highly required. The present work aims to compare the biological control using *Trichogramma evenescens* and Agerin (*B.t.*) in comparison to the chemical control using Ethion insecticide against *P. citri* in lime orchards.

MATERIALS AND METHODS

Three lime orchards were selected at Zefta , Samannuod and Kotour Districts, Gharbia Governorate, in order to study efficacy of three control methods for suppressing infestation by *P. citri* during two successive years,2002 and 2003 :-

1- Releasing of *Trichogramma evenescens* (West.) at a rate of 90000 wasps/feddan/release. Six releases were applied from the beginning of April, then four times, from mid of September, with ten days intervals, in each year.

2- Agerin (*Bacillus thuringiensis*) B.t. at dose of 75 gm / 100 L. of water.
3- The synthetic organic insecticide, Ethion was used at dose of 150 cc / 100 L. of water, {Ethion (Common Name) = Endo 50% EC (Trade Name) according to the recommendations of Ministry of Agriculture and Land Reclamation 2001, Egypt}.

Both Agerin and Ethion were applied three sprays during each year; one at the beginning of April and the second on 21st of April, then the third at mid-September. Spraying was accomplished by a 7- horse power motor sprayer (Kobota) 600 L. and the sprayer pressure was 100 Lb. / inch^2.

Each orchard was about one feddan, the lime trees were 15 years old planted at 4m space. Each orchard was divided into 12 plots, (each contains about 15 trees) and every treatment was applied in randomly three plots and the other three plots were left untreated, as control.

Three deltoid sticky traps baited with *P. citri* sex pheromone were used, and randomly individually installed on a branch of lime tree, about 2m above the ground in each treatment. Weekly catches of moths were recorded. The data were subjected to analysis of variance using F-test.

A comparison was done using the following parameters:

Mean number of *P. citri* larvae in the lime flowers and /or fruitlets, mean number of males/sex pheromone trap and percentage reduction in the larval stage infestation.

A weekly sample of 100 flowers and 100 lime leaves was collected randomly from five trees and repeated three times as replicates. When flowers were scarce, only 50 flowers with 50 fruit lets were collected. The samples were examined carefully for recording number of *P. citri* larvae in the flowers and the fruit lets. Population densities of the predator, *Chrysoperla* sp. larvae and the parasitoid, *B. brevicornis* parasitizing larvae of *P. citri* were recorded per sample (lime leaves, flowers and fruitlets) in each plot. Percentages reduction of the larval stage infestation and the side effect of each method (as % reduction in the population densities of both the predator and the parasitoid) were calculated and recorded as follows:

$$\% \text{ Reduction} = (C - T) / C \times 100$$

Whereas: C = Mean number of larvae, moths, parasite or predator in control.
T = Mean number of larvae, moths, parasite or predator in treatment.

RESULTS AND DISCUSSION

Data in Table (1) show that the different three methods of *P. citri* control have highly significant effect in reducing the weekly mean number of larvae compared to untreated plots. However, the highest reduction in *P. citri* larvae was recorded with Agerin (*B.t.*) since the percent reduction reached 76.4 and 80.4 in 2002 and 2003 respectively. These results were in agreement with Giammanco *et al* (1966) in Italy, who obtained 77.8 , 91.2 and 100% mortalities in *P. citri* larvae on artificially infested trees treated with suspensions of *B.t.* containing $2.5x10^8$.$2.5x10^9$ and $3.3x10^9$ spores per ml. in the field, respectively.

On the other hand the lowest percent reduction in *P. citri* larval infestation was noticed with releasing *T. evanescens* (egg – parasite) since the percent reductions reached 62.2 and 65.9 in 2002 and 2003, respectively. The lower reduction values with releasing the *T. evanescens* in the lime orchard may be due to short incubation period of *P. citri*, hence there was a short period for the parasitoid to parasitize the egg before its development.

Mineo *et al* (1978) in Italy observed that *P. citri* larvae had high rates of parasitism (up to 80%) by releasing *Ageniaspis fuscicallis* Dalm. (var *praysimcola*) Silv. (Hym. Encyrtidae), while the rates were negligible with releasing *Trichogramma evanescens.*

As presented in Table (2), the percentage reduction in moths caught by sex pheromone traps in the treatments ranged between 62.1 and 78.3% in 2002 and between 65.9 and 80.4% in 2003. However statistical analysis showed that there were no significant differences between the tested three methods in reducing *P. citri* infestation.

Data in Tables (3&4) show the side effect of the biological control and the chemical control on the natural enemies of *P. citri* in lime orchards. Ethion caused high percent reduction in the population density of *P. citri* natural enemies reached 96.3 and 93.3 in 2002 and 93.7 and 94.1 in 2003 on *B. brevecornis* and *Chrysoperla* sp., respectively. Releasing *T. evanescens* had fewer side effects on the natural enemies, as the respective percent reduction of both *B. brevicornis* and *Chrysoperla* sp. were 82.8 & 0.3 in 2002 and81.2 & 0.0 in 2003. The treatment with Agerin (*B.t.*) had side effect values between the side effect values of both Ethion and *T. evanescens* since the reduction in population density of *B. brevicornis* and *Chrysoperla* sp. were

82.5, 27.7 % in 2002 and 87.5, 16.9 % in 2003 respectively. The data showed that reduction of *P. citri* larvae in the different three treatments reflected on the population density of its parasite.

The above results were in agreement with those reported by Shehata and Nasr (1998) who recommended the application of *B.t.* (Bactospeine) for reducing the population of *P. citri.*

Table (1): Weekly mean number of *P. citri* larvae/sample in treatments of *Trichogramma*, Agerin and Ethion at Gharbia Governorate during 2002 & 2003.

Season	Ex. Date	*T. evanescens*		Agerin		Ethion		Control	
		2002	2003	2002	2003	2002	2003	2002	2003
Spring	7 / 4	5.6	4.3	4.3	4.0	0.6	1.0	7.3	6.6
	14 / 4	6.0	5.0	1.6	1.3	1.0	1.6	9.3	8.6
	21 /4	8.3	7.0	1.0	0.6	2.3	2.0	15.6	13.6
	28 /4	5.6	4.3	0.6	0.6	1.6	1.6	12.0	10.0
	5 / 5	6.6	6.3	2.0	1.6	2.0	2.6	17.6	16.6
	12 / 5	7.3	5.6	6.0	5.0	5.0	4.0	20.3	19.3
	19 / 5	6.6	4.3	8.6	6.3	5.6	6.6	23.0	21.6
	26 / 5	5.3	4.6	9.6	6.0	6.6	6.0	15.3	13.3
	Total	51.3	41.4	33.7	25.4	24.7	25.4	120.4	109.6
	% R.	57.4	62.2	72.0	76.8	79.5	76.8	-----	-----
Autumn	22 / 9	3.0	2.6	3.0	2.0	1.6	2.3	6.0	6.6
	29 / 9	3.0	3.3	0.6	0.6	2.3	2.3	10.6	10.0
	6 / 10	5.6	5.0	2.0	1.6	2.3	2.6	20.0	16.0
	13/10	5.3	3.0	2.0	1.3	3.3	3.0	17.0	13.3
	20/10	4.6	3.6	4.0	3.0	7.3	6.0	18.0	17.6
	Total	21.5	17.5	11.6	8.5	16.8	16.2	71.6	63.5
	% R.	69.9	72.4	83.8	86.6	76.5	74.4	-----	----
Total		72.8	58.9	45.3	33.9	41.5	41.6	192.0	173.1
Mean		5.6	4.5	3.5	2.6	3.2	3.2	14.8	13.3
% Reduction		62.1	65.9	76.4	80.4	78.3	75.9	-------	-----

L.S.D. = 3.5 & 2.6 at 1% & 5% respectively in 2002 and 3.0 & 2.3 at 1% & 5% respectively in 2003.

Table (2): Weekly mean number of *P. citri* moths / trap in treatments of *Trichogramma*, Agerin and Ethion at Gharbia Governorate during 2002 & 2003.

Season	Ex. Date	*T. evanescens*		Agerin		Ethion		Control	
		2002	2003	2002	2003	2002	2003	2002	2003
Spring	7 / 4	7.0	5.6	6.3	6.0	8.3	7.6	9.3	7.6
	14 / 4	3.3	2.6	2.3	1.6	1.3	2.0	5.0	6.3
	21 /4	4.6	4.0	2.0	2.3	1.6	2.3	6.3	7.6
	28 /4	6.0	5.3	1.6	2.6	2.0	2.6	10.3	11.6
	5 / 5	3.0	3.3	0.6	1.3	1.6	1.3	7.6	9.3
	12 / 5	3.6	2.6	1.6	2.0	2.3	2.0	11.0	14.3
	19 / 5	3.0	2.3	3.6	4.3	4.6	5.3	15.0	13.6
	26 / 5	3.3	2.6	5.6	6.6	6.3	7.0	19.3	15.6
	Total	33.8	28.3	23.6	26.7	28.0	30.1	83.8	85.9
	% R.	59.7	67.1	71.8	68.9	66.6	64.9	-----	-----
Autumn	22 / 9	4.6	5.3	4.3	4.6	4.0	5.6	5.6	7.3
	29 / 9	2.0	2.3	2.0	2.6	0.6	1.3	7.6	6.6
	6 / 10	1.3	2.6	0.6	1.0	1.3	1.6	9.3	10.3
	13/10	2.3	2.3	1.3	1.6	1.0	2.6	16.3	12.6
	20/10	1.3	0.6	6.3	7.6	6.6	8.3	16.6	15.6
	Total	11.5	13.1	8.5	17.4	13.5	19.4	55.4	52.4
	% R.	79.2	75.0	84.7	66.8	75.6	62.9	-----	----
Total		45.3	41.4	32.1	44.1	41.5	49.5	139.2	138.3
Mean		3.5	3.2	2.5	3.4	3.2	3.8	10.7	10.6
% Reduction		67.3	69.8	76.7	62.9	70.1	64.2	-----	----

L.S.D. = 3.1 & 2.3 at 1% & 5% respectively in 2002 and 2.7 & 2.0 at 1% & 5% respectively in 2003.

Table (3): Weekly mean number of *P. citri* larvae parasitized with *Bracon brevicornis* and larvae of *Chrysoperla* sp. in treatments of *Trichogramma*, Agerin and Ethion at Gharbia Governorate during 2002.

Season	Ex. Date	*T. evanescens*		Agerin		Ethion		Control	
		B. br.	*C.* sp.	*B. br.*	*C.* sp.	*B. br.*	*C.* sp.	*B. br.*	*C.* sp.
Spring	7 / 4	1.0	3.3	1.0	3.3	0.0	0.0	2.0	4.3
	14 / 4	0.3	4.6	0.3	5.6	0.0	0.6	3.6	5.3
	21 /4	1.3	8.3	0.0	6.0	0.3	1.3	4.6	8.6
	28 /4	0.6	7.6	0.0	5.6	0.0	0.3	3.3	7.3
	5 / 5	0.6	9.3	0.3	7.0	0.0	0.0	2.3	10.6
	12 / 5	0.0	8.6	0.3	5.6	0.3	0.6	3.6	9.3
	19 / 5	0.3	11.3	1.0	6.0	0.0	1.3	4.3.	9.6
	26 / 5	0.0	10.6	0.6	8.3	0.3	1.6	2.6	11.3
	Total	4.1	63.6	3.5	47.4	0.9	5.7	26.3	66.3
	% R.	84.4	0.0	86.7	28.5	96.6	91.4	-----	-----
Autumn	22 / 9	0.6	7.6	1.0	5.6	0.0	0.3	1.3	8.3
	29 / 9	0.3	8.3	0.6	7.6	0.0	0.0	2.6	9.6
	6 / 10	0.6	7.0	0.3	4.3	0.3	0.0	3.6	6.3
	13/10	1.0	6.6	1.6	6.6	0.3	0.6	5.3	7.3
	20/10	0.6	5.3	0.3	3.3	0.0	0.3	2.6	5.6
	Total	3.1	34.8	3.8	27.4	0.6	1.2	15.4	37.1
	% R.	79.9	0.0	75.3	26.1	96.1	96.8	------	-----
Total		7.2	98.4	7.3	74.8	1.5	6.9	41.7	103.4
Mean		0.55	7.57	0.56	5.75	0.12	0.53	3.2	7.95
% Reduction		82.8	0.3	82.5	27.7	96.3	93.3	------	-----

B. br. = *Bracon brevicornis* *C. sp.* = *Chrysopa larvae*

L.S.D. = 0.7 & 0.5 at 1% & 5% respectively for *B. brevicorns* and 1.7 & 1.4 at 1% & 5% respectively for *Chrysoperla* sp.

Table (4): Weekly mean number of *P. citri* larvae parasitized with *Bracon brevicornis* and larvae of *Chrysoperla* sp. in treatments of *Trichogramma*, Agerin and Ethion at Gharbia Governorate during 2003.

Season	Ex. Date	*T. evanescens*		Agerin		Ethion		Control	
		B. br.	*C.* sp.	*B. br.*	*C.* sp.	*B. br.*	*C.* sp.	*B. br.*	*C.* sp.
Spring	7 / 4	0.6	6.0	0.6	4.3	0.0	0.3	1.6	5.6
	14 / 4	0.6	5.6	0.0	5.0	0.0	0.0	3.3	5.3
	21 /4	1.0	6.3	0.3	5.3	0.6	1.0	3.0	6.6
	28 /4	0.6	8.3	0.0	7.0	0.0	0.0	2.6	8.6
	5 / 5	0.0	11.0	0.0	7.6	0.0	0.3	2.3	10.3
	12 / 5.	0.3	10.6	0.6	8.3	0.0	0.6	2.6	9.6
	19 / 5	0.6	10.0	0.3	8.6	0.3	1.0	3.6	10.3
	26 / 5	0.3	11.6	0.6	10.3	0.3	1.3	2.3	12.6
	Total	4.0	69.4	2.4	56.4	1.2	4.5	21.3	68.9
	% R.	81.2	0.0	88.7	18.1	94.4	93.5	------	-----
Autumn	22 / 9	0.3	9.6	0.0	8.6	0.0	0.0	1.6	10.3
	29 / 9	0.6	7.6	0.3	6.6	0.0	0.6	3.0	8.6
	6 / 10	0.0	10.3	0.6	8.3	0.3	0.6	2.6	9.6
	13/10	1.0	8.0	0.6	7.3	0.0	0.3	3.3	8.3
	20/10	0.3	7.3	0.3	5.6	0.6	0.6	1.3	6.3
	Total	2.2	42.8	1.8	36.4	0.9	2.1	11.8	43.1
	% R.	81.4	0.0	84.7	15.5	92.4	95.1	-----	-----
Total		6.2	112.2	4.2	92.8	2.1	6.6	33.1	112.0
Mean		0.48	8.63	0.32	7.14	0.16	0.51	2.55	8.6
% Reduction		81.2	0.0	87.5	16.9	93.7	94.1	----	-----

B. br. = *Bracon brevicornis* *C.* sp. = *Chrysoperla* larvae

L.S.D. = 0.14 & 0.11 at 1% & 5% respectively for *B. brevicornis* and 1.8 & 1.3 at 1% & 5%, respectively for *Chrysoperla* sp.

REFERENCES

Abo-Sheaesha, M. A. 1994. Studies on *Prays citri* Mill. (Hyponomeutidae: Lep.) and it's control. Ph. D. Thesis, Faculty of Agric., Al-Azhar University, Egypt pp. 143.

Bodenheimer, F. S. 1951. Citrus entomology in the Middle East: The Citrus flower moth *Prays citri* Mill. (Hyponomuotidae). 663 pp. Hoitsema Brothers-Groning. Holland.

El-Dessouki, S. A.; El-Awady, S. M. and Abo-Sheaesha, M. A. 1987. Host-Plant Preference, Number of Generations and Population Fluctuations of Citrus Flower Moth, *Prays citri* Mill., (Lep. Hyponomeutidae) at Gharbia Governorate, Egypt. The 2nd Nat. Conf. Of Pests & Dis. of Veg. & Fruits Ismailia 20 – 22 October 1987.

Giammanco, G.; Militelo, M. and Mineo, G. 1966. Experiments on the control of *Prays citri* by means of *Bacillus thuringiensis*. Entomophaga, 11:211-212.

Liotta, G. and Mineo, G. 1963. Observation on the bionomics of *Prays citri* (Citrus moth) in Sicily. Bull. 1st Ent. (R.A.E. 52: 332).

Mineo, G. 1966. New entomophagous parasites of *Prays citri (*citrus moth) found in Sicily. Bull. 1st Ent. Agric. Ass. Fitopat. Polermo. : 1-5.

Mineo, G.; Pralavorio, R.; Maniglia, G.;Voegele, J. and Arambourg, Y. 1978. Tests on the biological control of *Prays citri* Mill. (Lep.: Hyponomeutidae) with *Ageniaspis fuscicollis* Dam. (var. *praysincola)* Silv. (Hym.: Encyrtidae) and *Trichogrammma evanescens* Westw. (Hym.: Trichogrammatidae) on lemon in Sicily. Bolletino dell' Isttituto di Entomologia Agraria e dell' Osservatorio di Fitopatologia di Palermo, 9: 143 – 160.

Shehata, W. A. 1982. Studies on Biological, Ecological and control for *Prays citri* Mill. (Citrus flower moth). M. Sc. Thesis. Faculty of Agric., Cairo University, pp. 118.

Shehata, W. A. and Nasr, F. N. 1998. Laboratory evaluation and field application of bacterial and fungal insecticides on the Citrus flower moth *Prays citri* Mill. (Lep.: Hyponomeutidae) in lime orchards in Egypt. Anzeiger fur Schadlingskunde, Pflazenschutz, Umweltschutz. 1998, 71: 3, 57 – 60; 8 ref.

Silayna, H. S. 1937. Annual report of the Director of plant Industry for the fiscal year ending December 31 (1936). Manila, Philippine. Dep. Agric.: 178.

Sternlicht, M. 1974. Field and laboratory studies on sexual attractiveness of females of *Prays citri* Mill. (Lepidoptera; Hyponomeutidae) Bull. Ent. Res. 63:473-481.

Tawfik, M. F. S., Hafez, M. and Raouf, A. 1970. Survey of the natural enemies of Black scale, *Chrysomphalus ficus* (Ashm.), in the world and in U. A. R. Tech. Bull. , U.A. R. Mini. Agric. and Agrarian Reform, Plant Protection Dep. No, 2: 17-32.

المكافحة الحيوية باستخدام طفيل الترايكوجراما والمبيد الحيوي أجيرين مقارنة بمبيد الإثيون لمكافحة فراشة أزهار الموالح في بساتين الليمون

محمد عبدالغفار أبو شعيشع* و عصام عجمي**

*مركز البحوث الزراعية، معهد بحوث وقاية النباتات، مصر

**كلية الزراعة، جامعة القاهرة

تم دراسة فاعلية وسيلتين حيويتين لمكافحة فراشة أزهار الموالح *Prays citri* (Mill.) هما الإطلاق الكثيف لطفيل البيض ترايكوجراما ايفانيسينس *Trichogramma avanescens* (West.) بجرعة ٩٠٠٠٠ دبور/ فدان/ إطلاقة والمبيد البكتيرى أجرين (*Bacillus thuringiensis*) بمعدل ٧٥جم/ ١٠٠ لتر ماء مع مقارنة النتائج مع المبيد العضوى الفوسفورى الأيثون (Ethion) والذى استخدم بمعدل ١٥٠ سم٣/ ١٠٠ لتر ماء وذلك فى حدائق الليمون فى منطقة وسط الدلتا (محافظة الغربية) خلال موسمى ٢٠٠٢ و ٢٠٠٣. وقد اظهرت النتائج أن النسبة المئوية لخفض الإصابة اليرقية لفراشة أزهار الموالح كانت ١٦٠٢، ٧٦٠٤ و ٧٨٠٣% لعام ٢٠٠٢ و ٦٥٠٩، ٨٠٠٤ و ٧٥٠٩% لعام ٢٠٠٣ بعد المعاملة بكل من الترايكوجراما والأجرين والإيثون على التوالى. كما أظهر التحليل الإحصائى عدم وجود اختلافات معنوية بين الطرائق الثلاثة فى خفض نسب الإصابة اليرقية للآفة. كما اظهرت النتائج أن المبيد الفوسفورى كان الأكثر تأثيراً على الأعداء الطبيعية على حين كان الترايكوجراما الأقل تأثيراً لهذه الآفة. يمكن القول أن المكافحة البيولوجية بالطفيل أو البكتريا هى وسيلة مناسبة لمكافحة فراشة أزهار الموالح فى حدائق الليمون أكثر أمانا من الوسيلة الكيميائية.