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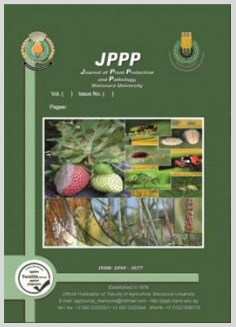
Efficacy of the Egg Parasitoids *Trichogramma evanescens* West. (Hymenoptera, Trichogrammatidae) for Controlling the Leopard Moth Borer, *Zeuzera pyrina* L. (Lepidoptera: Cossidae) in Apple and Pomegranate Orchards in Egypt

Askar, S. I.*

Plant Protection Department, Faculty of Agriculture, Damanhour University, Egypt



ABSTRACT

The Experiment was conducted at Al-Nubariya district, Al-Beheira Governorate, Egypt, during three successive years 2016, 2017 and 2018. *Trichogramma evanescens* was released (twice a year) in the selected orchards to control the leopard moth, *Zeuzera pyrina* (L.). *Z. pyrina* was recorded with high numbers in the first year that decreased in positive relation with the parasitoid in the second and the third year. The parasitoid numbers showed significant variation between all months more than the variation observed in *Z. pyrina* monthly numbers. in the first year, *T. evanescens* showed high activity only in pomegranate trees but in second and third year no significant variation appeared between the two orchards. Moreover, data resulted significant variation between each years and *Z. pyrina* reduction in numbers by the time. Generally, the parasitoid recorded 2.74±0.58, 4.65 ±1.00 and 5.08 ±0.59 in year 2106, 2017 and 2018, respectively. Meanwhile, *Z. pyrina* recorded mean number of 3.22 ±0.45, 1.99± 0.37and 1.35 ±0.23 in year 2106, 2017 and 2018, respectively.

Keywords: parasitoid, *Trichogramma evanescens*, Zeuzera pyrina, Apple, Pomegranate, Egypt

INTRODUCTION

Apple *Malus domestica* Borkh. and pomegranate *Punica granatum* L. were cultivated in many parts of the world (Youssef *et. al* 2004; Giuseppe *et. al.* 2016). The leopard moth borer, *Zeuzera pyrina* L., (Lepidoptera: Cossidae) is a cussed moth whose larvae bore into twigs, branches and trunks of various woody species, weakening and sometimes killing trees or shrubs. Recently, it caused serious losses of apple trees (Hristina Kutinkova 2006; EL-Ashry, *et al.* 2018). In Egypt, the leopard moth, *Z. pyrina* (L.), is a damaging pest for many fruit trees *e.g*., apple (*Malus* spp.), pear (*Pyrus* spp.) peach (*Prunus* spp.), and olive (*Olea*) (Hegazi *et. al.* 2010, Merghem, 2016, *Abdel-Moaty et al. 2019*). Recently, it caused serious yield losses in newly established olive orchards in Egypt, including the death of young trees (Hegazi *et. al.* 2010). *Z. pyrina* has become of increasing impact in North Africa in the last few decades (Katsoyannos, 1992).

Biological control is one of the most promising alternatives to the reliance on pesticides in pest management. The use of biological agents could result in better control and overcoming the issues occurring in traditional pest control methods (Oliveira *et al*., 2003 and Imran *et al.*, 2016). Egg parasitoids of the genus *Trichogramma* are keystone natural enemies of many lepidopteran pests in agriculture and forestry (Li, 1994). More than 150 different species are known from various biotopes (Pinto and Stouthamer, 1994; Pinto, 1999). *Trichogramma* species are among the most commonly used groups of natural enemies because they are relatively easy to culture and, being egg parasitoids (Hegazi *et al.* 2013; Askar *et al.* 2016). In the present study, field application with releasing *T. evanescens* against *Z. pyrina* in apple and pomegranate orchards to estimate the efficacy of this parasitoid in controlling this pest under the Egyptian field condition.

MATERIALS AND METHODS

Rearing of *Trichogramma evanescence*

Production of the parasitized egg cards with *T. evanescens* was achieved through mass rearing the egg parasitoid and the Angoumois grain moth, *Sitotroga cerealella* under laboratory conditions of 22±2 C° and 70±5 % R.H. according to (Zheng *et al.* 2003). Three different groups of parasitized eggs of 2, 4, and 6-days old were mixed equally together after the parasitism completed. This will enable successive parasitoid emergence from the cards daily along one week. The blank paper cards were firstly smeared with a very thin layer of egg albumin and the mixed three ages of the parasitized *Sitotroga* eggs were gently placed on the card and left for 10-15 minutes to glue by the egg albumin. The cards were gently tapped on a tray to drop the unglued eggs. The cards were cut in small rectangular pieces each carrying about 1000-1500 eggs with about 85-90% parasitized eggs.

Field experiments

The Experiment was conducted at Al-Nubariya district, Al-Beheira Governorate, Egypt, during the three successive years 2016, 2017 and 2018. Six farms were selected; three orchards of apples and three of pomegranates. The area of Fedden (4200 m^2) of each treated orchard was determined to be treated with different rates of *T. evanescens* parasitoid cards and the treated area was determined consistently at the middle of each orchard. In the north direction of each orchard, a half fadden area was designated as control to compare the results within treatments. The distance between the six selected farms was 3-5 km away from each other. Under field conditions of irrigation, fertilization and chemical control (Cidial 50% E Sumision

*** Corresponding author.**
E-mail address: biocontrol1980@yahoo.com
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Basudin 60% EW Stimex), *T. evanescens* parasitoid was released in the selected orchards. The selected orchards were similar for all parameters considering age, plant height and training system. Apple and pomegranate trees aged from 10-12 years in each orchard.

Release of the egg parasitoid *T. evanescens*

In order to estimate efficacy of the egg parasitoid *T. evanescens*, it was released as parasitized host egg cards during occurrence and dispersal period of the leopard moth borer, *Z. pyrina* (twice a year). The first release was applied when *Z. pyrina* adults were observed for first time in the field. After two months of the first release, the second was applied. At the middle of each filed, the parasitoid was released at a rate of 1, 2 and 5 cards per 20 trees for each treatment. Each card is carrying three different ages of *S. cerealella* eggs parasitized with *T. evanescens* as pupae inside the host eggs.

Sampling of *Z. pyrina* and the parasitoid *T. evanescens*

Data was taken weekly by direct count of the epidermal skin of the branches for monitoring; and then the skin was dissected in order to determine the fluctuation of the leopard moth borer. According to Herz *et al.* (2007), *Trichogramma*-fauna was mainly done by exposure of sentinel eggs which were put in particular baiting devices. These consisted of small plastic frames (2x2 cm), covered from both sides with fine nylon or metal mesh to allow access of small *Trichogramma*-wasps and to prevent predation on the content inside. *S. cerealella* fresh egg cards were introduced weekly in the same area of treatments and control. The fresh egg cards were distributed at rate of 1, 2 and 5 cards for 20 trees for recovery the natural occurrence of the parasitoid in control and the progeny of the released parasitoid in the treatments after each release. *S. cerealella* fresh eggs cards containing 1000-1500 fresh eggs and aged one day were left in the filed for two days; then collected and kept under laboratory conditions till the parasitoid adults emerged, then counted. The distribution process of the cards with the fresh host eggs were repeated weekly and collected after two days during the study period.

Data analysis

Obtained data was subjected to ANOVA statistical analysis using SAS statistical computer program to detect occurrence of the *T. evanescens* and the reduction of *Z. pyrina* ($p< 0.005$). Regression formula and relation coefficient factors (r) between the numbers of parasitoid and pest were calculated also under different release rate.

RESULTS AND DISCUSSION

Results:

1- Population density of *Z. pyrina* in relation to *T. evanescens* release during three successive years

During the three successive years, 2016, 2017 and 2018 from January to December for each year, the egg parasitoid *T. evanescens* was released when *Z. pyrina* pupa were recorded for the first time at the end of April, and released again a month later. Data were collected and recorded as mean numbers of *Z. pyrina* in relation to *T. evanescens* as shown in (fig. 1a, b and c). In the three years, *Z. pyrina* was observed for first time in 3rd April 2016 and 2016, while three weeks later in 2018. *Z. pyrina* was recorded at the beginning of the study period with few numbers less than two insects/20 plants. The population increased gradually in the next two years recording the highest numbers of 9.13 and 6.50pupa/20 trees in 7th August 2016 and 2017, respectively; while in year 2018 the highest number was 4 pupa/ 20 trees in 28th Augst. The population decreased till the pest disappeared at the binging of November. Field and environmental conditions did not help *Z. pyrina* to occur in the period from November to April.

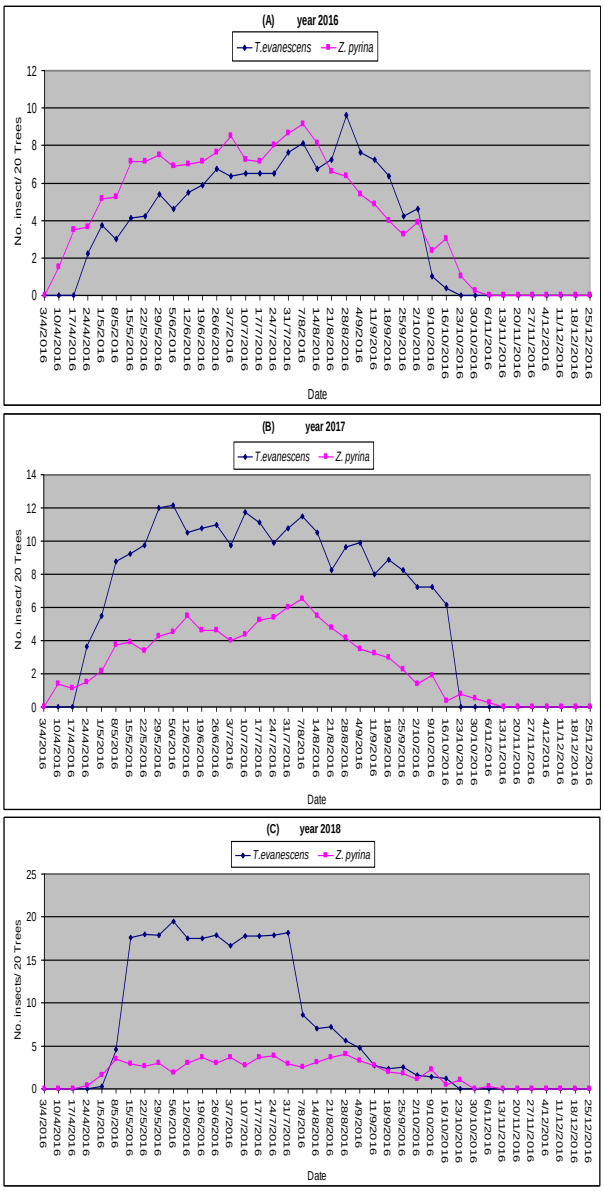

Fig. 1 A, B and C. Average numbers of *Z. pyrina* and the parasitoid *T. evanescens* on apple and pomegranates after parasitoid release at El-Beheira Governorate during three successive years.

On the other hand, *T. evanescens* was recorded as shown in (fig. 1 A, B, and C), as well as the released parasitoid distribution between trees and has begun on the non-parasitized *S. cerealella* eggs cards. Data reflected low numbers of *T. evanescens* at the beginning of the study period after two weeks from the releasing time, with mean number of 2.25, 3.63 and 0.25/ 20 trees in years 2016, 2017 and 2018 respectively. In the first year 2017, *T. evanescens* population increased in numbers gradually till recorded the highest numbers of 9.63 adults/ 20 trees in 28th. In year 2017, the parasitoid was observed in high numbers than in year 2016 and still in high numbers for 12 weeks; so the population was recorded with number between 9.75 and 12.13 adults/20 trees.

In the third year 2018, *T. evanescens* recorded the highest number compared with the previous two years 2016

and 2017. In year 2018, the parasitoid numbers increased faster during three weeks and recorded 17.78 adults/ trees; the parasitoid adult numbers recorded for twenty weeks later were not more than 19.5 adults/ 20 trees. In the three years, *T. evanescens* disappeared as a response to field climatic conditions during the period between November and April

In the first year (table 1) the highly mean numbers of *T. evanescens* were recovered in August. The parasitoid number increased in the second and the third years recordeding the highest number with $10.88^{a}\pm1.95$ and $17.88^{a}\pm1.17$ in July 2016 and 2017, respectably. On the other way, *Z. pyrina* recorded high numbers in the first year that decreased in a positive relation with the parasitoid in the second and the third years. As the general mean shown in table (1), the parasitoid numbers recorded 2.74±0.58, 4.65 ±1.00 and 5.08 ±0.59 in year 2106, 2017 and 2018 respectively. Meanwhile, *Z. pyrina* recorded respected mean numbers of 3.22 ±0.45, 1.99± 0.37and 1.35 ±0.23 in year 2106, 2017 and 2018. In the contrast, the parasitoid numbers showed significant variation between all months more than the variation observed in *Z. pyrina* monthly numbers.

As shown in table (2), high activity of the parasitoid appeared in pomegranate trees in the first years with significant difference between the two orchards but in the second and the third year no significant variation was observed between the two orchards. The parasitoid remained similar active in pomegranate and apple. In the same time, *Z. pyrina* was recorded with no significant variation in numbers in each orchard and also in each year's during the study period. Along the time for three years, the parasitoid numbers increased while those of the pest deceased from the first to the third study year.

Table 1. Monthly density of *Z. pyrina* and *T. evanescens* after parasitoid release during three years

Month	2016		2017		2018	
	T. evanescens	*Z. pyrina*	*T. evanescens*	*Z. pyrina*	*T. evanescens*	*Z. pyrina*
	mean± SE	mean± SE	mean ±SE	mean± SE	mean ±SE	mean ±SE
Jan.	$0.00^{f}\pm0.00$	$0.00^{e}\pm0.00$	$0.00^{d}\pm0.00$	$0.00^{e}\pm0.00$	$0.00^{d}\pm0.00$	$0.00^{e}\pm0.00$
Feb.	$0.00^{f}\pm0.00$	$0.00^{e}\pm0.00$	$0.00^{d}\pm0.00$	$0.00^{e}\pm0.00$	$0.00^{d}\pm0.00$	$0.00^{e}\pm0.00$
Mar.	$0.00^{f}\pm0.00$	$0.00^{e}\pm0.00$	$0.00^{d}\pm0.00$	$0.00^{e}\pm0.00$	$0.00^{d}\pm0.00$	$0.00^{e}\pm0.00$
April	$0.56^{ef}\pm0.12$	$2.16^{d}\pm0.46$	$0.90^{d}\pm0.35$	$1.00^{d}\pm0.36$	$0.00^{d}\pm0.00$	$0.09^{e}\pm0.05$
May.	$4.10^{d}\pm0.73$	$6.43^{b}\pm1.08$	$9.05^{b}\pm1.73$	$3.48^{c}\pm0.56$	$15.68^{b}\pm0.93$	$2.73^{bc}\pm0.44$
Jun.	$5.83^{c}\pm0.92$	$7.43^{ab}\pm1.22$	$10.83^{a}\pm1.91$	$4.65^{b}\pm0.93$	$17.80^{a}\pm1.36$	$3.03^{ab}\pm0.39$
Jul.	$6.78^{b}\pm1.25$	$7.75^{a}\pm0.94$	$10.88^{a}\pm1.95$	$5.25^{a}\pm0.95$	$17.88^{a}\pm1.17$	$3.28^{a}\pm0.45$
Aug.	$7.94^{a}\pm1.53$	$7.56^{a}\pm0.40$	$9.97^{ab}\pm2.00$	$5.22^{a}\pm0.70$	$7.13^{a}\pm1.20$	$3.31^{a}\pm0.31$
Sept.	$6.38^{bc}\pm1.75$	$4.38^{c}\pm0.24$	$8.75^{b}\pm2.23$	$3.00^{c}\pm0.22$	$3.09^{c}\pm1.05$	$2.44^{c}\pm0.21$
Oct.	$1.20^{e}\pm0.35$	$2.10^{d}\pm0.13$	$4.13^{c}\pm1.16$	$0.98^{d}\pm0.12$	$0.85^{d}\pm0.58$	$0.98^{d}\pm0.23$
Nov.	$0.00^{f}\pm0.00$	$0.00^{e}\pm0.00$	$0.00^{d}\pm0.00$	$0.06^{e}\pm0.03$	$0.00^{d}\pm0.00$	$0.06^{e}\pm0.03$
Dec.	$0.00^{f}\pm0.00$	$0.00^{e}\pm0.00$	$0.00^{d}\pm0.00$	$0.00^{e}\pm0.00$	$0.00^{d}\pm0.00$	$0.00^{e}\pm0.00$
General mean	2.74±0.58	3.22 ±0.45	4.65 ±1.00	1.99± 0.37	5.08 ±0.59	1.35 ±0.23
LSD 5%	0.74	1.07	1.26	0.56	1.11	0.5

Table 2. Effect of host plant on activity of *T. evanescens* in control treatments of *Z. pyrina* during the three successive years

Crop	Year					
	2016		2017		2018	
	T. evanescens	*Z. pyrina*	*T. evanescens*	*Z. pyrina*	*T. evanescens*	*Z. pyrina*
	mean± SE	mean ±SE	mean± SE	mean± SE	mean ±SE	mean ±SE
Pomegranate	$2.89^{a}\pm1.14$	$3.02^{a}\pm1.01$	$4.76^{a}\pm1.76$	$2.07^{a}\pm0.77$	$5.61^{a}\pm1.10$	$1.38^{a}\pm0.46$
Apple	$2.57^{b}\pm1.08$	$3.27^{a}\pm0.93$	$4.33^{a}\pm1.67$	$1.87^{a}\pm0.61$	$5.79^{a}\pm1.09$	$1.28^{a}\pm0.40$
LSD5%	0.3	0.44	0.52	0.23	0.45	0.2

T. evanescens was released at three levels one, two and five cards as for twenty trees (Table 3). It was found that there was a significant difference in the parasitoid number in the first year, and the pest did not show any significant difference between the treatments with cards of two or five cards. The parasitoid recovery was recorded with mean numbers in three years 2016, 2017 and 2018. Data showed significant variation between treatments in the first year. In the second year, the parasitoid also was more active and data recorded significant variation between all treatments. In the third year, the parasitoid showed highest numbers compared with the first and the second year. On the other way, *Z. pyrina* recorded the highest numbers in the control treatment that decreased gradually as well as more parasitoid cards were released. *Z. pyrina* showed no significant numbers when the parasitoid was released with two and five cards in the three years. Reduction on *Z. pyrina* number was increased when more than two to five cards applied. The parasitoid reflected the highest number when five cards were applied (Table 3); it reflected also that no parasitoid was found in first year in control units but observed a few numbers in the control unit in the second and the third year.

Table 3. Effect of release rate on activity of *T. evanescens* in control treatments of *Z. pyrina* during the three successive years

Treatments	Year					
	2016		2017		2018	
	T. evanescens	*Z. pyrina*	*T. evanescens*	*Z. pyrina*	*T. evanescens*	*Z. pyrina*
	mean ±SE	mean ±SE	mean ±SE	mean ±SE	mean ±SE	mean± SE
Control	$0.00^{d}\pm0.00$	$5.20^{a}\pm1.46$	$0.26^{d}\pm0.11$	$3.77^{a}\pm1.11$	$0.58^{d}\pm0.23$	$1.90^{a}\pm0.62$
1 Card	$1.61^{c}\pm0.59$	$2.56^{b}\pm0.71$	$2.47^{c}\pm0.85$	$1.68^{b}\pm0.51$	$2.98^{c}\pm0.72$	$1.52^{b}\pm0.43$
2 Cards	$4.18^{b}\pm1.22$	$2.18^{b}\pm0.58$	$6.65^{b}\pm1.74$	$1.13^{c}\pm0.32$	$7.69^{b}\pm0.91$	$0.97^{c}\pm0.29$
5 Cards	$5.00^{a}\pm1.50$	$2.66^{b}\pm0.75$	$8.79^{a}\pm2.32$	$1.31^{c}\pm0.34$	$9.56^{a}\pm1.65$	$0.91^{c}\pm0.25$
LSD 5%	0.74	0.62	0.73	0.32	0.64	0.29

Obtained data and results of statistical analysis showed that, *T. evanescens* increased activity and recorded mean numbers of 2.73±1.10, 4.54±1.71 and 5.31±1.09. Meanwhile, *Z. pyrina* was recorded in positive relation with

numbers of 3.15±0.97, 1.97±0.69 and 1.33±0.43 in the successive years 2016, 2017 and 2018 (table 4). Moreover, data showed significant variation between the years; so *Z. pyrina* decreased gradually in numbers by the time.

Data in Table (5) showed that, in pomegranate and apple, releasing of *T. evanescens* reflected significant difference in the value of correlation coefficient between *T. evanescens* and *Z. pyrina* at both the crops during the study period. The regression line between the parasitoid and the pest was recorded in Table (6) as the line slope values and the value cut from the axis (a and b) to calculate population of the parasitoid related to the pest at any time. The regression line reflected positive relationship between *T. evanescens* and *Z. pyrina.* The parasitoid increased in number as well as the pest increased.

Table 4. Mean density of *T. evanescens* and *Z. pyrina* after releasing parasitoid in three successive years

year	*T. evanescens* mean± SE	*Z. pyrina* Mean± SE
2016	2.73^{b}±1.10	3.15^{a}±0.97
2017	4.54^{a}±1.71	1.97^{b}±0.69
2018	5.31^{b}±1.09	1.33^{c}±0.43
LSD 5%	0.74	0.47

Table 5. Regression and correlation co-efficient factor between *T. evanescens* and *Z. pyrina* in three successive years

Regression and correlation factors	Year 2016		2017		2018	
	Pomegranate	Apple	Pomegranate	Apple	Pomegranate	Apple
A	4.74	3.87	2.90	3.13	0.91	0.78
B	8.09	8.21	1.84	3.59	2.70	1.14
R	0.48**	0.58**	0.29**	0.53**	0.78**	0.64*
R2	0.23	0.35	0.09	0.28	0.62	0.42

Discussion

Amongst the Lepidoptera, the leopard moth *Zeuzera pyrina* (L.) (Cossidae) is the most damaging apple and pomegranate pests in the Mediterranean area,. The species is widely distributed in Europe, North Africa, Asia, and the USA. The moth is a polyphagous species and has been reported on several genera of host plants (*e.g. Prunus, Malus, Pyrus, Olea, Acer, Fagus, Tilia, Platanus, Quercus, Salix, Populus, Ulmus,* and *Tamarix*) . Its larvae are woodborers affecting a wide variety of trees and shrubs – over 150 plant species of up to 20 taxonomic genera, (Gatwick, 1992). Hegazi *et al.* (2016) reported that, the population of leopard moths was smaller in 2006 and high in 2007 but in 2009, its density was generally higher than any year before. The deference's in population may be caused by pesticide chemical applications that are less successful due to the cryptic habitat of the larvae inside the branches and the long oviposition period of adults (Shamseldean *et al.*, 2009).

Our study recorded some pesticides applied to control *Z. pyrina*, the pesticide can reduce activity of the parasitoid. Youssef *et al.* (2004) reported that the recommended field dose of the six insecticides (Malathion, Quik, Cidial, Dimethoate, Actellic, Deltamethrin) reduced parasitism by 80–95% for the adult stage of the egg parasitoid. Due to the continuous application of pesticides and the sensitivity of the parasitoid, not record of any natural presence of the parasitoid was mentioned during the first year of the study, but the presence of the parasitoid in the control in the second and third year as a result of the previous release in the first year. The results agree with those of Hegazi *et al.* (2012) who found no parasitism with *Trichogramma* species in the pre-release monitoring of experimental plots, in the control plot and buffer sites between plots, indicating absence of native egg parasitoids in olive trees; but they found *Trichogramma* parasitized the sentinel eggs over the experimental period and we never found more than one species per egg-card (except *T. bourarachae*. Of the total amount of sentinel egg cards per release, 35.3% were found parasitized by *T. evanescens*.

These results are also in line with those of Herz *et al.* (2007) who recorded that, the natural *Trichogramma* fauna never been collected in field surveys in olive groves in Egypt, neither in other countries. Meanwhile, in spite of the spraying of pesticides during the study period, the parasitoid showed a clear activity in the process of parasitism, which is due to any high density of divorce as well as repetition process for more than once. Imran *et al.* (2016) reported that, the control percentage was between 80% and 90% after applying treatment with *Trichogramma minutum* against borers on jasmine.

On the other way of the plant structure effect on the parasitoid dispersal and activity, there is a significant difference in the efficacy and spread of the parasitoid in the tested crops; so Hegazi *et al.* (2016) reported, the differences among the olive varieties were highly significant and the results suggest more *Z. pyrina* pupal skins were found on Hamed, Sennara and Toffahi varieties than others. The results suggested that more eggs were deposited on susceptible tree (Toffahi) than *Z. pyrina*-resistant tree (Shami). Also, the parasitoid showed a high response in activity and parasitism rates between the seasons of the year in response to the change in temperature, where it disappeared during 6 consecutive months, which confirms the inactivity of the parasitoid under low temperatures. Various species and strains of *Trichogramma* tag and destroy different host eggs and prefer different crop habitats and have distinct searching abilities and strength to weather conditions (Imran, *et al.*, 2016).

Forever, environmental conditions affect the parasitoid activity. Chapman *et al.* (2009) reported that, weather conditions such as wind and rain can affect the movement of parasitoids and their subsequent levels of parasitism. Thorpe (1985) recorded that, *Trichogramma* species appear to be adapted to different plant structures in the same environmental conditions. At Borg el-Arab district, Alexandria Governorate, Egypt, during the two successive years 2015 and 2016, Abdel-Moaty *et al.* (2019) recorded that, the mean rate of *Z. pyrina* infestation in pear trees neighboring to casuarina trees were 15 – 21% (mean, 18%). However, pear trees far away and not neighboring to casuarina trees showed significantly lower rate of the borer infestation (7 - 9%, mean 8%). On the other hand, the rate of *Z. pyrina* infestation in casuarina trees neighboring to pear trees was 13 – 18% (mean, 15.5%). The degree of *Z. pyrina* infestation in casuarina trees surrounding pear trees was high (0.42 – 0.57, mean 0.5 moths / tree / year); and recorded also that the seasonal cycle of *Z. pyrina* moths consisted of 7 – 8 months of moths' activity in casuarinas trees and pear orchards.

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تقييم كفاءة طفيل البيض *Trichogramma evanescens* West. (Hymenoptera ،Trichogrammatidae) على حفار ساق التفاح ، *Zeuzera pyrina* L. (Lepidoptera: Cossidae) في بساتين التفاح والرمان في مصر

سلامه ابراهيم عسكر*

قسم وقاية النبات، كلية الزراعة ، جامعة دمنهور

تم إجراء التجربة في مدينة النوبارية ، محافظة البحيرة ، مصر ، خلال ثلاث سنوات متتالية 2016 و 2017 و 2018. حيث تم اطلاق الطفيل *Trichogramma evanescens* (مرتين في السنة) في البساتين المختارة للتحكم في حفار ساق التفاح ، *Zeuzera pyrina* (L .) حيث سجلت اعداد حفار ساق التفاح بأعداد كبيرة في السنة الأولى انخفضت في علاقة إيجابية مع الطفيل في السنة الثانية والثالثة. أظهرت أرقام الطفيل تبايناً كبيراً بين جميع الأشهر أكثر من التباين الذي لوحظ في التعداد الشهري لـ *Z. pyrina* في السنة الأولى ، لوحظ نشاطًا عاليًا للطفيل فقط في أشجار الرمان مقارنة بالتفاح ولكن في العامين الثاني والثالث لا يوجد اختلاف كبير بين البستانين. علاوة على ذلك ، اظهرت النتائج تباينًا كبيرًا بين كل سنة وبين انخفاض الآفة في التعداد مع مرور الوقت. من حيث المتوسط العام ، تم تسجيل الطفيل بمتوسط تعداد 2.74 ± 0.58 و 4.65 ± 1.00 و 5.08 ± 0.59 في عام 2106 و 2017 و 2018 على التوالي وفي الوقت نفسه ، سجل حفار ساق التفاح متوسط عدد 3.22 ± 0.45 و 1.99 ± 0.37 و 1.33 ± 0.23 لكل شجره في أعوام 2106 و 2017 و 2018على التوالى.