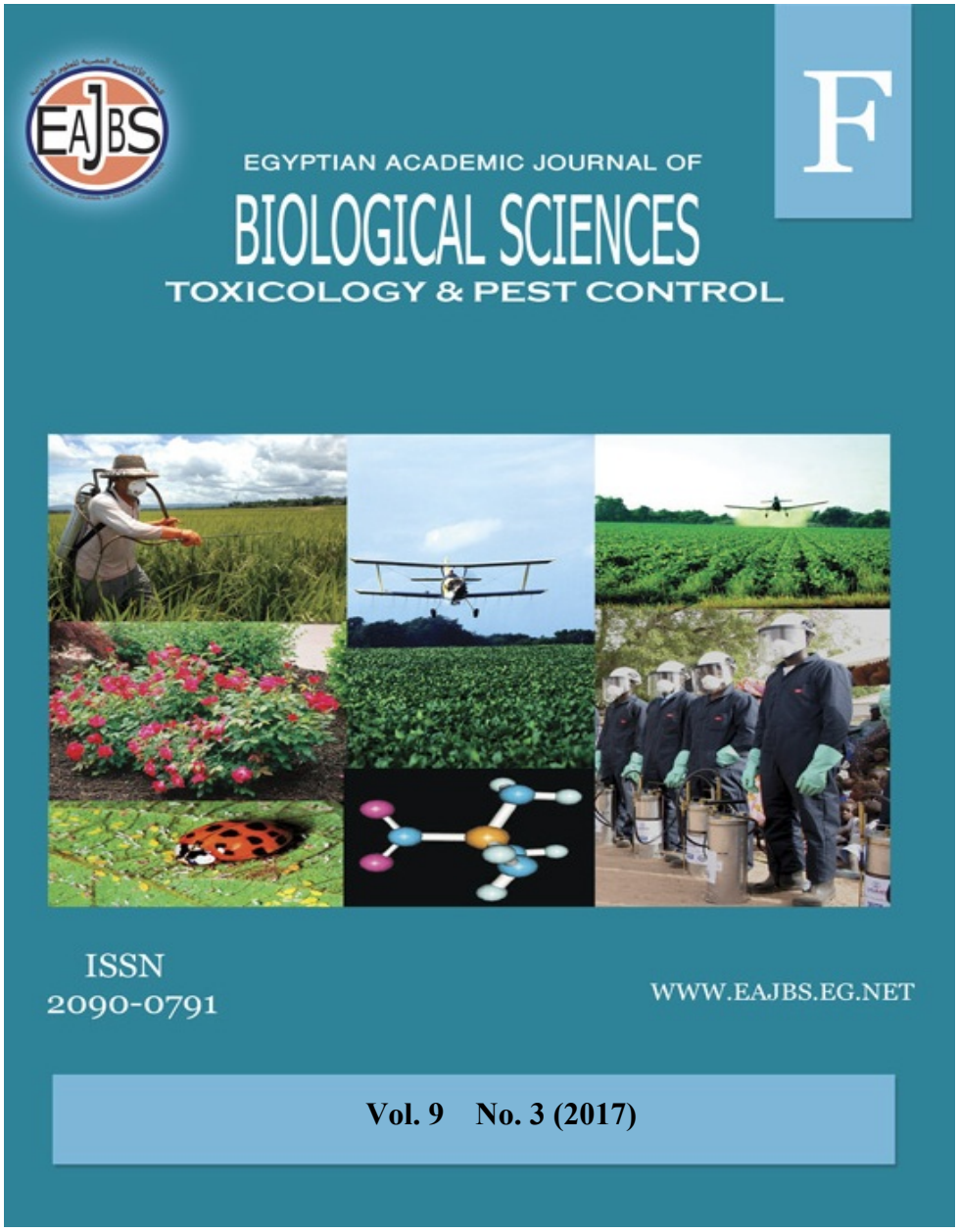

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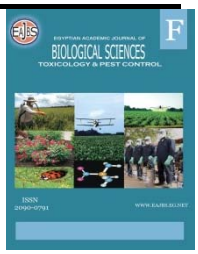

Leopard Moth Borer, *Zeuzera pyrina* L. (Lepidoptera: Cossidae) Threat to Olive Trees, *Olea europaea* L. (Lamiales: Oleaceae) in Fayoum Governorate and Its Suppressing Trials Using IPM Tactics

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ABSTRACT

Olive tree, *Olea europaea* L. (Lamiales: Oleaceae) is an economically important and strategic crop which widely spreads throughout the Mediterranean basin countries including Egypt. It suffers from several serious insect pest attacks especially those arising from wood-boring insects such as leopard moth, *Zeuzera pyrina* L. (Lepidoptera: Cossidae). Present study concerns with the dispersion power of this cossid borer attacking olive groves at several localities in Fayoum governorate. Additionally, population fluctuation, infestation rates and degrees have been studied recording the highest levels of infestation reaching 74% and 4.4 hole/tree, respectively whereas the lowest levels of infestation were 15% rate of infestation and 1.2 hole/tree degree of infestation. Trials to suppress these attacks using IPM tactics were applied with agricultural processes; pruning and mechanical control, biological control tools using the green lacewing predator, *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) release in addition to chemical pesticide usage (Cidial-L 50%).

INTRODUCTION

Wood boring insects are considered to be one of the most serious and devastating threat to olive trees, *Olea europaea* L. (Lamiales: Oleaceae) in the olive groves all over the Mediterranean basin counties in addition to Egypt. Leopard moth, *Zeuzera pyrina* L. (Lepidoptera: Cossidae) is a dangerous wood borer which is a polyphagous pest that attacks many fruit trees such as apple, pear and olive as well causing significant damage, detrimental effects and yield loss. In Egypt, olive is a popular fruit crop implanted in the old and newly reclaimed lands for trade and export purposes especially the olives and oils. Olive groves suffer from the attacks of this cossid borer leading to the loss of the nutritional and fruits values that mainly processed in many industries in addition to oil extract products (Feron *et al.*, 1966; Baker, 1972; Navon, 1977; Jacoboni and Fontanazza, 1981; El-Hakim and El-Sayed, 1982; Barranco and Rallo, 1985; Katlabi, 1989; Tous and Romero, 1993; UNCTD, 1993; IOOC, 1994; Martin *et al.*, 1994; Tous and Ferguson, 1996; Loumou and Giourga, 2003; Chen and Welter, 2007; Hegazi *et al.*, 2015 and Shahidi, 2017).

Only chemical control is applied for that cossid borer control in Egypt and such trials with chemical insecticides got limited success.

Extensive use of chemical insecticides resulted in health, environmental and economic problems as hazard effects against human, beneficial animals and environmental pollution (Abdel-Kawy *et al.*, 1992; Gloria *et al.*, 2008 and Rosell *et al.*, 2008).

Alternative measures for effective, safe, and cheap control were promoted to solve these problems. These measures included the individual application of the biological control agents or by their use in integrated pest management (IPM) programs. From these alternatives there is the green lacewing predator, *Chrysoperla carnea* (Stephens) (Chrysopidae: Neuroptera) which are potential, environmentally safe and widely used against many insect pests. Pruning processes and screw elastic wire are also recognized as effective mechanical control measures. (Greathead, 1976; Arambourg, Y. 1983; Katsoyannos, 1992; Lopez-Villalta, 1999; Collier and Steenwyk, 2003; Hegazi and Khafagi, 2003; Abed El-Hadi *et al.*, 2005; Hilal and Ouguas, 2005 and Chakaravarthy *et al.*, 2008).

Present study concerns with the dispersion power of this cossid borer attacking olive groves at several localities in Fayoum governorate. Additionally, population fluctuation, infestation rates and degrees have been studied. Trials to suppress these attacks using IPM tactics were applied with agricultural processes; pruning and mechanical control, biological control tools using predator release in addition to chemical pesticide applications.

MATERIALS AND METHODS

Target wood borer:

Leopard moth borer, *Zeuzera pyrina* L. (Lepidoptera: Cossidae).

Target host plant:

The olive tree, *Olea europaea* L. (Lamiales: Oleaceae).

Survey visits:

Periodical survey visits were made to 23 localities at 6 districts in Fayoum governorate (Ebshaway, Etssa, Fayoum, Senoris, Tameia and Yousef El-Sedeek) to investigate the existence and geographical distribution of that cossid borer during 2015 season. These locations were visited to explore the infested olive fields with the tested boring pest. Infested locations, levels of infestation and seasonal abundance of *Z. pyrina* were determined throughout 2015-2016 seasons.

Sampling of target pest:

Stages of *Z. pyrina* were collected from infested olive orchards at different locations in Fayoum governorate with no previous insecticidal treatments. Identification of the sampled stages was confirmed at the Department of Classification and Taxonomy, Plant Protection Research Institute, Agricultural Research Centre.

Green lacewing Predator:

The green lacewing predator, *Chrysoperla carnea* were encountered attacking *Z. pyrina* and these stages were collected and sampled for laboratory identification. Identification was done by proposed keys of New (1980) and the green lacewing predator, *C. carnea* was confirmed. Larval instars of *C. carnea* were supplied for further laboratory and field experiments from mass-production culture of Bollworm Department, Plant Protection Research Institute, Agricultural Research Centre, Dokki, Giza.

Laboratory screening experiments:

To test the efficiency of *C. carnea* against *Z. pyrina* stages, freshly sampled eggs and larvae were used. 20 individuals of each borer stage were put in a cylindrical glass jar 25 cm diameter x35 cm length cm and exposed separately to two groups of 10, 15, 25 individuals of 2nd and 3rd larval instars of *C. carnea*. Chemical control treatment was applied using a recommended insecticidal dosage

of Cidial L 50% EC at 3ml per 1litre of water (due to recommendations of Egyptian Agricultural Ministry) as a control reference. Five replicates were used for each treatment; and control checks were made using distilled water only. Mortality percentages were recorded after 7 days; the time at which Cidial insecticide resulted in 100% mortality, then the achieved values were corrected with Abbott's formula according to Abbott (1925).

Field control studies:

The highly infested olive grove of Naqalifa at Senoris district in Fayoum governorate was chosen for field control studies using the provided effective rates of application in laboratory experiments *i.e.* 25 individuals of 2nd larval instars for *C. carnea*. Timing of field trials was determined according to the obtained ecological results of *Z. pyrina* activity which was on 4th week of April while mechanical control measures were applied during winter against hibernating larvae. Five infested olive branches were used for each treatment. Mechanical control measures were represented using screw elastic wire and pruning processes while chemical control was applied using Cidial L 50% EC as 3ml per 1litre of water and control checks were just treated with water.

Field treatments were evaluated by calculation the reduction of infestation using Henderson and Tilton's formula (1955):

Reduction of infestation (%) = (C – T / C) X 100

Where:

C: Mean number of alive larvae in untreated control olive branches.

T: Mean number of alive larvae in treated control olive branches.

RESULTS AND DISCUSSION

Survey and occurrence of *Z. pyrina* L.:

Table (1) shows that olive groves the occurrence of the cossid borer at the surveyed localities in Fayoum governorate districts. Leopard moth borer was recognized in fourteen locations at the six districts of the governorate while the borer was not encountered in nine locations throughout the same surveyed districts.

Table 1: Occurrence of *Z. pyrina* infesting olive groves in different locations at districts of Fayoum governorate in Egypt during 2015.

District	Locality	Existence*
Ebshaway	Aboksa	+
	Kasr Baiad	-
	Tobhar	+
	Zeid	-
Ettsa	Al-Gaafra	+
	Al-Hegr	-
	Al-Meer	+
	Al-Qasemeia	-
	Danial	+
	Kalamsha	-
	Nawara	-
Fayoum	Beni Saleh	-
	Demo	+
Senoris	Behmo	+
	Fedemeen	+
	Gorfos	+
	Naqalifa	+
	Sanhor	+
Tameia	Fanoos	+
	Kafr Mahfouz	-
	Sawi	+
Yousef Al-Sedeek	Al-Mokrani	-
	Kasr El-Gebali	+

* (+) indicates to the presence of *Z. pyrina*; (-) indicates to the absence of the borer.

Z. pyrina was found to be more distributed and existed at Senoris district as it was found in the all five localities of the district; Behmo, Fedemeen, Gorfos, Naqalifa and Sanhor. At Ettsa district, it was reported in three locations; Al-Gaafra, Al-Meer and Danial whereas in Ebshaway and Tameia districts it was recorded in two locations; Aboksa and Tobhar in Ebshaway while Fanoos and Sawi in Tameia. On the other hand, this cossid borer was just found in one location in both the two rest districts; Fayoum and Yousef Al-Sedeek districts at Demo and Kasr El-Gebali.

These obtained results are matching with those of Hegazi and Khafagi (2003) which pointed out that *Z. pyrina* were widely distributed attacking olive groves in Egypt in addition to the confirmation with Barranco and Rallo (1985) results in Spain, Collier and Steenwyk (2003) through California in the United States of America, Hilal and Ouguas (2005) in Morocco, and Ulaşli and Can Cengiz (2016) in Hatay Province.

Infestation levels of leopard moth borer:

Figs. (1&2) elucidate the rates and degrees of infestation with *Z. pyrina* at the fore-mentioned surveyed locations in the different districts of Fayoum governorate. This cossid borer revealed the highest values of both rate and degree of infestation at the locations of Senoris district more than those of the same estimated locations in the rest districts. The locality of Naqalifa which belongs to Senoris district recorded the highest levels of infestations reaching 74% and 4.4 hole/tree respectively for the rate and the degree of infestation.

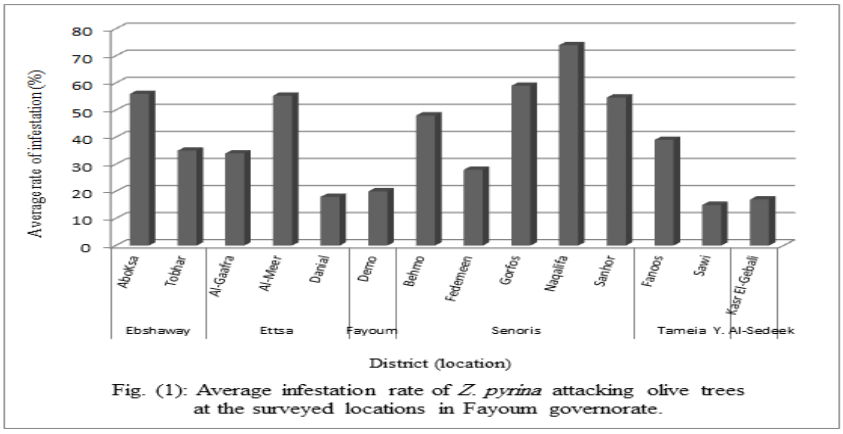

Fig. (1): Average infestation rate of *Z. pyrina* attacking olive trees at the surveyed locations in Fayoum governorate.

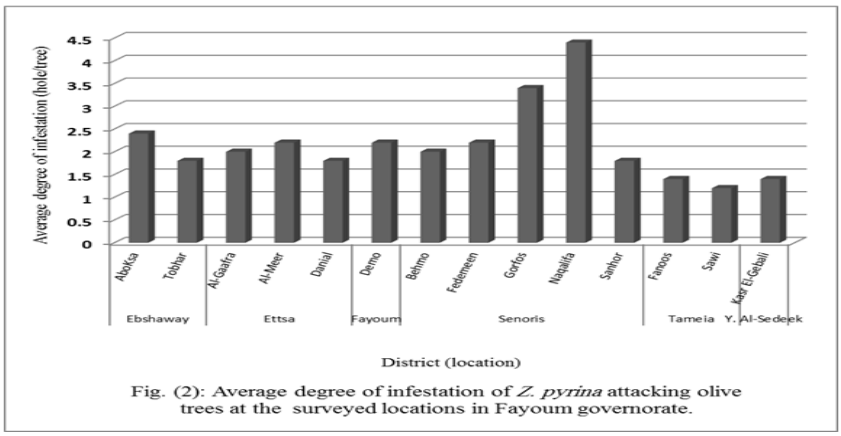

Fig. (2): Average degree of infestation of *Z. pyrina* attacking olive trees at the surveyed locations in Fayoum governorate.

On the other side, the lowest levels of infestation were recorded in Tameia district at Sawi location recording a rate of infestation was 15% and a 1.2 hole/tree degree of infestation.

According to Figs. (1&2), Olive groves at Naqalifa locality were noticed to be more susceptible to the infestation with *Z. pyrina* attacks than any other olive groves of the other districts in Fayoum governorate. Meanwhile, locality of Sawi in Tameia district showed the highest resistance to the borer infestations.

Obtained results confirm, in accordance with Hegazi *et al*. (2015), that *Z. pyrina* is a very injurious pest to olive groves in Northern Egypt causing serious damage of great concern as Egypt provides a favourable environment for the activity of this cossid borer. As a result of recording the highest infestation levels and broad distribution of *Z. pyrina* through all the surveyed locations in the Senoris district, the Naqalifa locality was chosen for the further field ecological and control studies.

The fore mentioned results reveal that *Z. pyrina* with such dispersive power and levels of infestations in olive groves at Fayoum governorate is considered to be a dangerous threat to olive in Egypt. This situation needs more extensive research work for the control of this devastating borer.

Population fluctuation of leopard moth borer:

The data presented in Fig. (3) Show the relation between the emergence of *Z. pyrina* adults on the olive trees, indicated by the number of the pupal skins of emerged moths, and the time of inspection throughout 2015-2016 seasons at Naqalifa in Fayoum governorate.

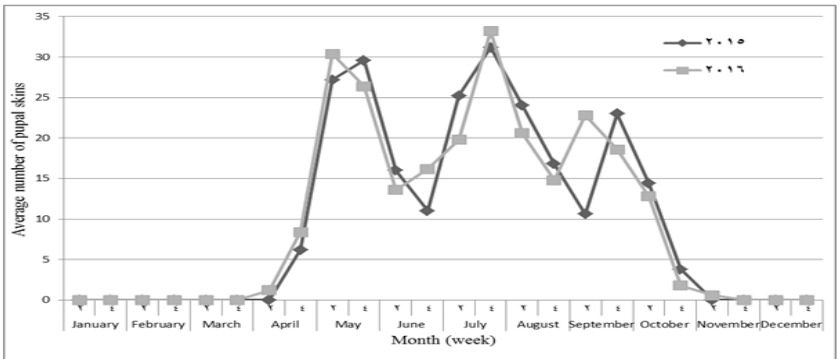

Fig. (3): Average number of pupal skins of *Z. pyrina* attacking olive trees at Naqalifa in Fayoum governorate throughout 2015-2016.

In 2015, *Z. pyrina* adults started to emerge during the 4th week of April in 2015 with an average rate of emergence 6.2 moths. Whereas in 2016, it started to emerge during the 2nd week of April with an average rate of emergence was 1.2 moth. During 2015, emergence of adult moths continued till it reached the first peak of emergence on the 4th week of May recording 29.6 moths then it fluctuated till ceased on the 4th week of October then it completely stopped on 2nd week of November. Meanwhile, in 2016, the first peak of emergence on the 2nd week of May recording 30.4 moths and the emergence ceased on the 2nd week of November and the complete stoppage of emergence was on 4th week of November. These findings are parallel to those of Ismail *et al.* (1992) confirming the damage of this cossid borer to olive trees.

During this study in Naqalifa, *Z. pyrina* revealed slightly high emergence rates in 2016 season more than that recorded in 2015 as it showed total emerged moths reached 241.2 whereas this figure was 239 adult moths in 2015

thus control studies were subsequently suggested.

Laboratory screening experiments:

Fig. (4) Represents laboratory control treatments against *Z. pyrina* immature stages using *C. carnea* and Cidial L50%. A week after treatment, Cidial L50% resulted in 100% mortality for both egg and larval stages of that leopard moth borer.

In addition to this vanishing power of Cidial, the 2nd larval instars of *C. carnea* revealed a potential efficiency recording average 100 and 94 mortality percentages for egg and larval stage, respectively. This finding is matching with Abed El-Hadi *et al.* (2005) who confirmed the possibility of the successful control for this lepidopterous borer by other than chemical pesticides. Through the obtained results release of the 2nd larval instars of *C. carnea* caused mortality percentages higher than that of the 3rd larval instars release for both for *Z. pyrina* larvae and egg stages. Also, laboratory experiments indicated that Cidial at 3ml./1litre water and the 2nd larval instars of *C. carnea* at 25 individuals release are effective treatments for the control of *Z. pyrina* stages.

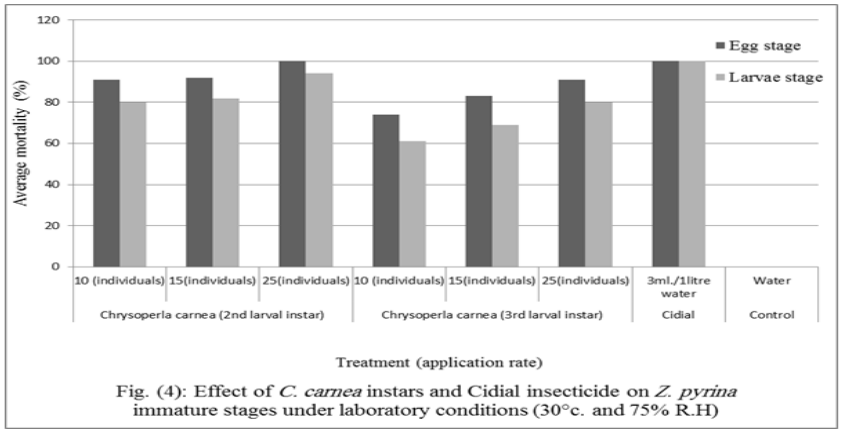

Fig. (4): Effect of *C. carnea* instars and Cidial insecticide on *Z. pyrina* immature stages under laboratory conditions (30°c. and 75% R.H)

Field applications:

Effect of IPM elements; *C. carnea* and Cidial in addition to mechanical and agricultural control measures, on infestation reduction with *Z. pyrina* attacking olive trees at Naqalifa in Fayoum governorate is shown in Fig. (5).

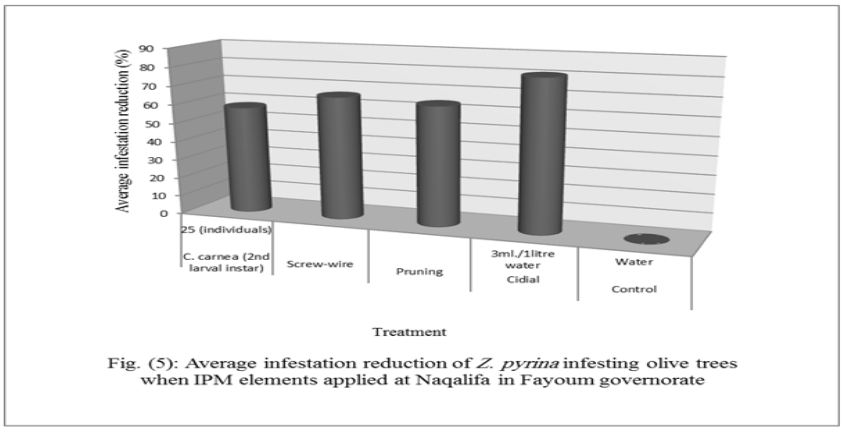

Fig. (5): Average infestation reduction of *Z. pyrina* infesting olive trees when IPM elements applied at Naqalifa in Fayoum governorate

Field applications revealed that Cidial resulted in the highest average reduction of infestation reached 80.8 %. The application of agricultural and mechanical control tools were noticed to achieve a considerable average levels of infestation reduction recording 63.8 and 66.2 % infestation reduction respectively

for pruning processes and screw elastic wire. In case of *C. carnea* instars release; the average infestation reduction was the lowest scoring 57.8 %.

During field applications, the mortality rates were markedly less than those resulting from laboratory experiments especially for the *C. carnea* release; this may be attributed to the effect of the natural field conditions.

Meanwhile Cidial treatments showed the highest mortality levels through both the laboratory experiments in addition to the field trials in olive groves. These findings are consistent with Coyle *et al*. (2005) in North America and Kinawy *et al*. (1992) observations when they applied the horticultural, mechanical and chemical treatments against another cossid borer, *Paropta paradoxa* H.-Schaeff. (Lepidoptera: Cossidae) infesting apple trees in Egypt.

On average, the total reduction of infestation resulted by the biological control agent and the mechanical control measures achieved 62.6 % compared to the average reduction percentage 80.8 % for insecticidal application. So these elements could be used altogether in IPM programs for successful control trials against *Z. pyrina* enhancing the possibilities of olive production increment in accordance with the results of Sergeeva (2014) and Brown *et al.* (2017) who confirmed that IPM programs resulted in a significant control of this boring moth.

From the foregoing results of the laboratory experiments and field applications, it is obvious that the bio-control agent *C. carnea*, agricultural processes with mechanical control are strongly recommended to be used as control measures against *Z. pyrina* infestations in olive graves or may be used as components in IPM programs to control this cossid borer.

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ARABIC SUMMERY

تهديد حفار ساق التفاح *Zeuzera pyrina* (Lepidoptera: Cossidae) لأشجار الزيتون *Olea europaea* (Lamiales: Oleaceae) فى محافظة الفيوم و محاولات الحد منه بإستخدام وسائل المكافحة المتكاملة للآفات

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١- قسم بحوث الناخرات و النمل الأبيض– معهد بحوث وقاية النباتات

٢- قسم بحوث الزيتون–معهد بحوث البساتين– مركز البحوث الزراعية – الدقى – جيزة – مصر

تعد شجرة الزيتون *Olea europaea* L. (Lamiales: Oleaceae) من المحاصيل ذات الأهمية الإقتصادية و الإستراتيجية و التى تنتشر بكثافة فى دول حوض البحر المتوسط و منها جمهورية مصر العربية ، و يعانى شجر الزيتون من الإصابات الحشرية الخطرة العديدة و لا سيما تلك الهجمات الناجمة عن الإصابة بالحفارات مثل حفار ساق التفاح *Zeuzera pyrina* L.(Lepidoptera: Cossidae) ، و تهتم الدراسة الحالية ببحث شدة إنتشار هذا الحفار عند مهاجمة بساتين الزيتون فى العديد من المناطق بمحافظة الفيوم ، بالإضافة إلى دراسة تذبذب تجمعات هذا الحفار العددية و مداها تزامنا مع مستويات الإصابة من حيث معدلاتها و درجات الإصابة وقد تم رصد أعلى مستويات محققة ٧٤ % و ٤.٤ ثقب/شجرة على التوالى بينما سجلت أقل مستويات للاصابة ١٥ % بالنسبة لمعدل الاصابة و ١.٢ ثقب/شجرة لدرجة الاصابة ، كما تم تطبيق طرق المكافحة المتكاملة للآفات و ذلك للحد من هجمات هذا الحفار مثل: العمليات الزراعية كالتقليم و المكافحة الميكانيكية ، و المكافحة الحيوية كإطلاق مفترس أسد المن *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) بالإضافة لإستخدام المبيد الكيميائي سيديال- ل ٥٠ %.

الكلمات المفتاحية: حفار ساق التفاح ، المكافحة المتكاملة للآفات ، محافظة الفيوم ، شجرة الزيتون ، مفترس أسد المن.