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The repellent and toxic effects of some eco-friendly formulations against the important olive tree insects in Egypt

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Field evaluation of Neem based pesticides " Entomax and Neem Azal T/S" was carried out against the jasmine moth *Palpita unionalis,* the olive fruit fly , *Bactrocera oleae* and *Zeuzera pyrina* (larval stage) infesting olive trees in new reclaimed area at Wadi El-Natrun (El-Behera governorate) during 2017 season. The toxic and repellent effects of Entomax and Neem Azal T/S against the previous insects were compared with the recommended pesticide (Cidial). Four sprayings during four weeks were conducted. The recommended rate application was 3.0, 1.0 and 1.5 ml/liter for Entomax, Neem Azal T/S and Cidial, respectively. The results showed that Entomax was high effective than Neem Azal T/S whereas; Entomax caused 93.2 and 70.64% for *Bactrocera oleae*; 97.32 and 85.76% for *Palpita unionalis* and 86.7 and 81.4% for *Zeuzera pyrina* larvae mortality and repellency, respectively. While, Neem Azal T/S achieved 90.9 and 64.24% for *Bactrocera oleae*; 96.37 and 80.57% for *Palpita unionalis* and 83.8 and 79.2% for *Zeuzera pyrina* larvae mortality and repellency, respectively. In addition, cidial compound achieved 96.47% mortality and 78.14% repellency for *Bactrocera oleae*; 96.75% mortality and 78.72 % repellency for *Palpita unionalis* and 82.3% mortality and 62.3 repellency for *Zeuzera pyrina* larvae. Entomax was the highest effect followed by Neem Azal T/S and cidial was the least effective against *Zeuzera pyrina* larvae The results showed that Entomax and Neem Azal T/S could be used in the integrated pest management for the olive trees pests.

Keywords: ***Palpita unionalis*, *Bactrocera oleae, Zeuzera pyrina,* olive trees, Entomax, Neem Azal T/S, Cidial, Eco-friendly.**

INTRODUCTION

In recent year, the jasmine moth, *Palpita unionalis* (Hübner) (Lepidoptera: Pyralidae), the olive fruit fly, *Bactrocera oleae* Gmelin and the leopard moth *Zeuzera pyrina* L.Become the three main insects in commercial olive trees in Egypt. They are present throughout the Mediterranean, Asia Minor and North Africa regions (Balashowsky, 1972; Hegazi et al., 2007; Ghoneim, 2015; Hamadah et al., 2017). *Palpita unionalis* larvae attack numerous plant species like *Ligustrum vulgare*, *Jasminum officinale*, *Olea europaea*, *Philirea media*, and *Arbutus unedo*. Larvae attack all parts of (leaves, shoots and fruits) the olive young tree, feeding on leaves where damage can reach up to 90% of the leaf area and this was affected the development of the plant shoots. In addition, during the ripening of fruit may reduction in the yield by 30%, especially with high infestations in late summer and autumn (Arambourg, 1986; López -Villalta, 1999). Also premature fruit fall can result from larvae feeding on the fruit holds. Also, the olive fruit fly, *Bactrocera oleae* (Diptera: Tephritidae) is the most serious insect pest infect olive plantations (*Olea europea* L.) in the world (Economopoulos, 2002) causing serious qualitative and quantitative consequences with economic impacts and monetary losses (Economopoulos et al., 1986). Under favorable conditions (coastal climate) for the development of the olive fruit fly, the insect is able to infest more than 90% of olive fruits (Athar, 2005; Kapatos and Fletcher, 1984). Olive fruit flies more active in more humid climates than in dry regions. However, another insect pest, the leopard moth *Zeuzera pyrina* L. (ZP) (Lepidoptera: Cossidae) had become important in North Africa in the last few decades (Katsoyannos, 1992). The larvae of ZP are cryptic woodborers weak a wide variety of trees and shrubs, to include over 150 plant species from 20 genera (Carter, 1984; Castellari, 1986; Kutinkova *et al*., 2006). The greatest damage was observed in nurseries (Castellari, 1986). In Egypt, ZP larvae caused damage in tunnels, major branches and trunk structural critical wood whereas it may cause complete death of young trees (Hegazi *et al*., 2016).

Almost, *P. unionalis*, *B. oleae and Z. pyrina* were controlled by organophosphorus insectcides (Roessler, 1989). However, the extensive use of chemical insecticides leads to environmental pollution; hazard to human and animal farms. For these reasons, the researchers trend to use of the insecticides of plant origin such as neem (*Azadirachta indica* A. Juss.) has emerged as an excellent alternative to synthetic insecticides for the pest management of pests. Neem formulations were less harmful to environment and had no effect on quality and quantity of olive oil (Schmutterer &Singh, 2002; Abd El-Salam et al., 2012).

This study focused to test the efficacy of Entomax and Neem azal T/S formulations in comparison with organophosphorus compound such as Cidial against the jasmine moth, olive fruit fly and the leopard moth populations.

MATERIALS AND METHODS

Formulations used

Neem based pesticide was used in two commercial formulations as follows: Entomax contained 0.15% azadirachtin as active ingredient and kindly obtained from Holland Farming, a member of the Marbax Group of companies B.V. Recommended rate is 300 ml/100 liters of water. Neem azal T/S contained 1.0 % azadirachtin as an active ingredient and kindly obtained from Trifolio M GmbH, Lahnau, Germany. Recommended rate is 100 ml/100 liters of water. Cidial (50% EC.) was organophosphorus formulation contained phenthoate S-α- ethoxy carbonyl benzyl O, O- dimethyl phosphorodithioate. Recommended rate is 150 ml / 100 liters of water.

Field Evaluation

The present study was carried out in a new reclaimed area of 15 feddan cultivated with olive trees (*Olea europaea* L.), newly fruitful, variety Toffahi 5 years old. The farm located at Wadi El-Natrun, Behera Governorate (A farm 120 Km north Cairo). The farm was highly infested with the jasmine moth *Palpita unionalis*, the olive fruit fly *Bactrocera oleae* and the leopard moth *Zeuzera pyrina* in 2017 season.

The farm divided four blocks; three blocks selected for treatment by the recommended rate for three formulations and selection randomly 10 olive trees for treated with the previous formulations. Each block was specialized for one treatment. The fourth block was to specialize without treatment (water alone). 10 leaves, 10 branches (ca.30 cm long) and 25 olive fruits other/tree (began to ripen) selected randomly and taken in paper bags for inspection in the laboratory by binocular microscope.

Number of leaves, branches and fruits infested and live larvae for the jasmine moth, the leopard moth and the olive fly were counted.

Four applications were carried out during 4 weeks to start July 7 and final July 28. Samples were taken before spraying and after week from spraying. The percentage reduction in number of live larvae of *B. oleae* for the olive fruits, *P. unionalis* in leaves and *Z. pyrina* in branches were calculated with Henderson and Tilton 1955 formula.

$$\left(1 - \frac{T_a \times C_b}{T_b \times C_a}\right) * 100$$

T_a = the number of insects after treatment (in treatments).

T_b = the number of insects before treatment (in treatments).

C_b = the number of insects before treatment (in control).

C_a = the number of insects after treatment (in control).

In addition, the repellent effect was calculated by

Lundgren 1975 formula as follows:

$$\text{The repellent effect} = \frac{C+T}{C+T} \times 100$$

Whereas, C and T means number of infested olive fruits or leaves in control and treatment, respectively. Spray applications carried out by motor knapsack sprayer (15 L capacity, Japan manufacture). Each treatment repeated 10 times (one tree/replicate).

Statistical analysis

One-way analysis of variance (ANOVA) and comparisons were made based on Duncan's new multiple range test (computer program Microstat version 2.5, 1991) to analyzed the data.

RESULTS

I-Toxic and repellent effect of neem and cidial formulations against the olive fruit fly, *Bactrocera oleae.*

Data obtained in table (1) indicated that Entomax treatment was more efficiency than neem azal T/S. However, it was decreased the mean number of alive larvae from 20.0 to 5.3/tree after the 1st spray by week, while in comparison with untreated trees that recorded 24.9 alive larvae/tree before spray increased 26.8 alive larvae/tree after week from the firstly spray. With repeated the weekly sprayings, Entomax achieved reduction in the mean number of live larvae reached 93.2% after the fourth sprayings. In addition, the results showed that neem azal T/S formulation was promised but it was lower efficacy than Entomax. Neem azal T/S achieved 90.9% reduction in the mean number of alive larvae after the fourth sprayings.

The data obtained in table (1) showed that cidial formulation was the most efficiency followed by Entomax and neem azal T/S. Cidial was caused 96.47% reduction in the mean number of live larvae and 78.14% repellency after the fourth sprayings. However, the present aim of the work is minimizing the use of traditional chemicals to get clean environment, we are not encourage to use synthetic insecticides but when the botanical insecticides could not control and decreased the damage of insect pests. Here, it must be use the safe insecticides which it had degradation quickly. Indeed, the real importance of azadirachtin is as insecticidal effects. Neem formulations were found as feeding deterrence at much lower concentrations than required. Insects ingesting azadirachtin and related minor compounds in the seed kernels do not die immediately, but soon stop feeding. Non-lethal effects include caused to reduce feeding, delays in development of immature insects, incomplete ecdysis, malformed pupae and adults, sterile eggs and reduced fecundity. (Niemann *et al*., 2002; Schmutterer, 2002; Schmutterer & Singh, 2002).

Results in Table (2) showed that Entomax and Neem azal T/S formulations had gradually repellent effect increased with repeated weekly sprayings. Entomax achieved 25.4% repellent after the 1st application increased 69.6% after the 2nd application compared with Neem azal T/S that caused 22.3% repellency increased 57.37% after the 2nd application. Entomax was more repellent than Neem azal T/S, whereas, after the four applications sequentially achieved 70.64% repellency followed by Neem azal T/S caused 64.24%.Cidial formulation was the most efficiency followed by Entomax and Neem azal T/S. Cidial achieved 99.2% repellency after the fourth application. While, it caused 78.14% repellency after fourth applications to *Bactrocera oleae* sequentially.

Results showed that *Bactrocera oleae* was more susceptible to cidial as compared with Entomax and Neem azal T/S. the percentage fruits infestation after 4 weeks from application reached 0.4, 1.2 and 3.6 for Cidial, Entomax and Neem azal T/S. respectively, while the infestation of fruits in control reached 100%. Singh, (2003) tested effect of pure azadirachtin at concentration of 2.0 ppm on the fecundity and post-embryonic development of *Bactrocera cucurbitae* and *Bactrocera dorsalis* flies. He found that no eggs lying, pupation or adult emergences were recorded at these concentrations. Azadirachtin even at 0.125-ppm concentration recorded 89.0 and 82.0% reduction in eggs laying for *B. cucurbitae* and *B. dorsalis*, respectively, when compared with controls. Fertility of the laid eggs from treatments was only 46 and 51.6%, respectively.

Azadirachtin has been effected on juvenile hormone (JH) and ecdysone to reduce ovary weight, ovary proteins, Yolk synthesis and vitellogenin synthesis (Handler and Postlethwait, 1978; Ludlum and Sieber, 1988; Rao et al., 1996). Maria et al., (2012) evaluated the efficacy of Spintor Cebo (Dow Agrosciences Ibérica, S.A.) against the olive fruit fly, *Bactrocera oleae* as well as the impact of the treatments on non-target arthropods. Results suggest that this insecticide

Table (1): Toxic effect of neem and cidial formulations against the olive fruit fly, *Bactrocera oleae.*

Means followed by the same letters are not significant (P ≤ 0.05).

Formulations	Rate of application ml/l	1st spray			2nd spray		3rd spray		4th spray		Avg.% Reduction after 4 sprays
		Mean No. alive larvae /25 olive fruits /tree ± SE & % Reduction									
		Before spray	After 1st spray by week	% Reduction	After 2nd spray by week	% Reduction	After 3rd spray by week	% Reduction	After 4th spray by week	% Reduction	
Entomax	3.0	20.0±1.06b	5.3±1.3b	75.4	0.5±0.2c	97.8	0.1±0.1b	99.6	0.0±0.0b	100	93.2
Neem azal T/S	1.0	20.3±0.95ab	5.6±0.62b	74.5	2.1±0.3b	90.8	0.3±0.15b	98.8	0.1±0.1b	99.6	90.9
Cidial	1.5	22.2±2.16a	3.2±0.74b	86.7	0.2±0.31c	99.2	0.0±0.0b	100	0.0±0.0b	100	96.47
Cont.	0.0	24.9±1.08a	26.8±0.96a	-------	27.7±0.49a	------	28.5±0.37a	-----	25.8±0.61a	-----	-------
F	---	2.26 UN	137.9*	---	1773.2*	------	4672.6*	------	1731.9*	------	------
$LSD_{0.5}$	----	4.2	2.71	---	0.9	------	0.59	------	0.88	------	------

Table (2): Repellent effect of neem and cidial formulations against the olive fruit fly, *Bactrocera oleae.*

Formulations	Rate Of Application ml/l	1st spray			2nd spray		3rd spray		4th spray		Avg. % Repellent after4th sprays
		Mean No. fruits infestation /tree ± SE &% Repellent									
		Before spray	After 1st spray by week	% Repellent	After 2nd sprayby week	% Repellent	After3rd spray by week	% Repellent	After4th spray by week	% Repellent	
Entomax	3.0	16.8±1.55a	13.2±1.65b	25.4	4.3±0.39c	69.6	1.3±0.15c	89.96	0.3±0.15c	97.6	70.64
Neem azal T/S	1.0	17.3±1.35a	14.1±1.34b	22.3	6.5±0.7b	57.37	2.1±0.31b	84.26	0.9±0.23b	93.05	64.24
Cidial	1.5	17.8±1.67a	10.1±1.61b	37.46	2.8±0.24d	79.1	0.4±0.16d	96.8	0.1±0.1c	99.2	78.14
Cont.	0.0	20.6±1.09a	22.2±0.9a	---	24.0±0.51a	-----	24.6±0.3a	------	25.0±0.0a	-----	----
F	---	1.39 UN	13.25*	----	396.1*	-----	2255.6*	-----	6880.8*	------	-----
$LSD_{0.5}$	---	4.12	4.06	---	1.41	----	0.7	-----	0.42	------	-----

Means followed by the same letters are not significant (P ≤ 0.05).

could be as effective as dimethoate and since it was reported as having more benign toxicological and ecological profiles, it seems to be a good alternative to control the pest. Pontikakos et al., (2012) investigated the effectiveness of a mobile agro-environmental Location Aware System (LAS) in ground spray applications by dimethoate (400 g/l.) against olive fruit fly; under real conditions. They found that the current applications achieved 96.0% reduction in the population of *B. oleae*. In addition, with the utilization of the LAS, the amount of spray solution was reduced by 4.8 %, the duration of the sprays was decreased by 17.3% and the effectiveness of the sprays was increased by 5.7% compared to common spray tactics. In this manner, cost reduction of the spraying application is achieved along with the protection of the environment. Pascual et al., (2017) assayed the efficacy of Surround WP for controlling *B. oleae* at a dose of 3 g/100 l. This formulation reduced percentage of olives attacked by *Bactrocera oleae* to 3.0% compared by 20.0% in control at the end of the crop season after two spray applications. Gonçalves et al., (2012) evaluated the efficacy of the spinosad (at 75 ml/ha) against the olive fruit fly, *Bactrocera oleae*. The authors indicated that spinosad achieved 99.0. Percentage reduction in the percentage of infested fruits. Caleca et al., (2008) indicated that olives sprayed with Surround WP (with or without Coprantol Ultramicron) were significantly less infested than those of all other tests were.

Also, Varikou et al., (2016) use attractant materials (hydrolysed protein at 75% w/w) that was mixed with alpha - cypermethrin, thiacloprid,thiacloprid + deltamethrin or dimethoat e (300 ml /200 L) and these formulations were tested during three successive summers (2012–2014) according to European Plant Protection Organization standards. The products were alternated with one another over time in the experimental plots. The authors indicated that all of the bait spraying solutions were effective against *B. oleae* at all of the doses tested.

II- **Toxic and repellent effect of neem and cidial formulations against the jasmine moth *Palpita unionalis***.

Data in Table (3) proved that the olive larva, *Palpita unionalis* was more susceptibility to all formulations tested. Entomax was the highest efficacy followed by Cidial and Neem azal T/S. There is no significance different between the tested formulations. The mean number of live larvae/10 leaves/tree before spray ranged between 3.0- 3.6 larvae/10 leaves/tree. After first application, the mean number of live larvae /tree decreased to 0.5, 0.7 and 0.8 live larvae/10 leaves /tree in Entomax, Cidial and Neem azal T/S treatments, respectively, compared with 5.3 live larvae/10 leaves / tree in control. Entomax gave 89.4% reduction followed by Cidial (87.2 %) and Neem azal T/S (85.8%). After the fourth application, all tested formulations achieved 100% reduction in live larvae/10 leaves /tree. While, the population of the olive larva, *Palpita unionalis* recorded 5.2 live larvae/10 leaves /tree.

As for repellent effect of the tested formulations and presented in Table (4) showed that , after the 1st application, Entomax gave 52.27% repellency followed by Neem azal T/S (44.08%) and Cidial (36.7%).After the 4th application, all tested formulations achieved 100% repellency to the insect pest. In addition, there is no leaves infestation /tree. After the fourth applications at interval, Entomax achieved 85.76% repellency followed by Neem azal T/S (80.57%) and Cidial (78.72%).

Neem seed kernel extracts (NSKE) have been shown to possess pronounced anti-feeding, growth and development inhibiting activity (Ascher, 1993; Mordue & Blackwell, 1993) against a wide spectrum of insect species. Neem-based insecticides deter oviposition for some lepidopteran, homopteran, dipteran and coleopteran pests (Saxena, 1989; Schmutterer, 1990, 1995; Butler et al., 1991; Mordue & Blackwell, 1993; Singh & Singh, 1998; Akey & Henneberry, 1999; Abd El-Salam et al., 2012). However, azadirachtin has no deterrent oviposition effect on *Helicoverpa armigera* (Saxena & Rembold, 1984). Other researchers stated that the neem extracts might be responsible for oviposition deterrent effects for containing azadirachtin as active ingredient (Saxena and Basit, 1982; Abd El-Salam *et al.*, 2012). Chen et al., (1996) suggested that neem components had no volatile because of containing primarily azadirachtin that it was no volatile. Neem insecticides deterred feeding effects for beet armyworm larvae compared with the control (Isman, 1993; Ma et al., 2000; Greenberg et al., 2005). An antifeedant effect on *Plutella xylostella* larvae was observed on cabbage leaves treated Agroneem, Ecozin and Neemix and larvae that fed on neem treated leaves were smaller than those fed on non-treated controls (Liang et al., 2003).

Direct contact with the neem compounds as for Agroneem, Ecozin, and Neemix were decreased eggs survival and the diamondback larvae that fed on neem treated leaves had lower survivorship compared to the control after a week of exposure (Mordue & Blackwell, 1993; Ma et al., 2000; Liang et al., 2003).

Dimetry and Abd El-Salam (2005) found that Entomax was superior to all other treatments for the control of *Aphis durantae* infesting pomegranate trees. The percentage of reduction in population after one week of the first application was 92.3 % compared with 91 % and 69.7 % for Pirimiphos methyl followed by pirimicarb and Entomax-plus after 4 days, respectively. Schmutterer (1988) demonstrated that the neem extracts of residual effect were usually lasted after four – six days depends on treated plant species and the environmental conditions. Abd El-Salam and Teixeira da Silva (2010) determine the efficacy of two biorational insecticides against the potato tuber worm, *Phthorimaea operculella*. Nimbecidine was more effective than Bio-power after three applications. Mesbah *et a*l., (2018) indicated that Nimbecidine achieved 77.7% reduction in larval infestation of *Palpita unionalis.* These results indicate that triple application with neem formulation could reduce the *P. operculella* population. This study also showed that Nimbecidine and Bio-power could be taken into an integrated pest management program of potato tuber moth. Control of jasmine moth is usually achieved by application of insecticides such as some organophosphorus and carbamate (Lopez-Villalta, 1999). In Egypt, Hegazi et al., (2007) stated that the chemical control strategy carried out 7–8 insecticide applications. The method is effective for the jasmine moth and the first generation of olive moth (> 90 percentage mortality). It resulted in successful control of the pest and it is no detected in olive and oil samples tested after analyzing the active substances (Parlatti et al., 2000). In addition, Mesbah *et a*l., (2018) indicated that Deltachem Super achieved 52.1 % reduction in larval infestation of *Palpita unionalis.* Hamadah *et al*., (2017) studied the effects of Methoxyfenozide on adult longevity, pre-oviposition period and post-oviposition period of *Palpita unionalis.* The authors found that 10.0-ppm concentration was affected on the oviposition period that slightly shortened. Oviposition efficiency of the successfully emerged females was pronouncedly inhibited. Fecundity and fertility were tremendously reduced. The embryonic development was drastically retarded, since the incubation period was significantly prolonged.

The results clearly demonstrate the importance of the use of the eco-friendly botanical insecticides such as Entomax and Neem azal T/S in controlling the jasmine moth *Palpita unionalis* and the olive fruit fly, *Bactrocera oleae* on the olive trees. Neem can be effectively used as an excellent alternative to synthetic insecticides. Neem is safe to mammals (Niemann et al., 2002) and to non-targeted biological systems (Schmutterer, 1990; Pavela, 2009; Demitry et al., 2012).

III -Toxic and repellent effect of neem and cidial formulations against Leopard Moth Borer, *Zeuzera pyrina.*

The results in Table (5) indicated that Neem Azal T/S was the highest efficacy followed by Entomax and the Cidial was the least reduction in alive larvae of *Z. pyrina*. Results showed that four consecutive sprays per week resulted in a reduction in numbers of live larval / 10 branches to 86.7, 83.8and 82.3 % for Entomax, Neem Azal T/S and Cidial, respectively. The eco-friendly compounds have confirmed that they are no less efficient than conventional chemical compounds.

The repellent effect was studied (Table 6) and found that Entomax achieved 81.4% repellency, Neem Azal T/S (79.2%) and Cidial (62.3%). The branches infestation / tree were decreased to 0.0 infestation in the plots treated in comparison 15.8 branches infestation in control. The results confirmed that the repeated spraying for 4 weeks (four applications) led to a reduction in the percentage of branches infestation.

Merghem and Abd El-Ghany (2017) stated that ethanolic neem extracts revealed average reductions in infestations with *Anobium punctatum* and *Nicobium castaneum* (Boring Beetles of Furniture) reached 19.6 and 13.3%, respectively while the infestation reduction with Nemazal was 37.67 and 40.33 % on average. Cidial treatments resulted in the highest levels of infestation reduction achieving 81.79 and 82.3 % against *A. punctatum* and *N.castaneum*, respectively and its treatments at P>0.05 revealed the highest average significant reduction level.

Table (3): Toxic effect of neem and cidial formulations against the jasmine moth, *Palpita unionalis.*

Formulations	Rate of application ml/l	1st spray			2nd spray		3rd spray		4th spray		Avg.% Reduction after 4 sprays
		Mean No. alive larvae/10 leaves /tree ± SE & % Reduction									
		Before spray	After 1st spray by week	% Reduction	After 2nd spray by week	% Reduction	After 3rd spray by week	% Reduction	After 4th spray by week	% Reduction	
Entomax	3.0	3.0±0.39a	0.5±0.22b	89.4	0.01±0.1b	99.9	0.0±0.0b	100	0.0±0.0b	100	97.32
Neem azal T/S	1.0	3.6±0.61a	0.8±0.24b	85.8	0.01±0.13b	99.7	0.0±0.0b	100	0.0±0.0b	100	96.37
Cidial	1.5	3.5±0.4a	0.7±0.26b	87.2	0.01±0.1b	99.8	0.0±0.0b	100	00±0.0b	100	96.75
Cont.	0.0	3.4±0.42a	5.3±0.44a	---	6.2±0.38a	-----	6.6±0.38a	----	5.2±0.24a	---	----
F	----	0.31 UN	56.49*	---	194.8*	-----	254.3*	----	434.57*	----	-----
$LSD_{0.5}$	----	1.34	0.88	----	0.62	-----	0.55	-----	0.35	-----	-----

Table (4): Repellent effect of neem and cidial formulations against the jasmine moth, *Palpita unionalis.*

Formulations	Rate of application ml/l	1st spray			2nd spray		3rd spray		4th spray		Avg. % Repellent after 4th sprays
		Mean No. leaves infestation /tree ± SE &% Repellent									
		Before spray	After 1st spray by week	% Repellent	After 2nd spray by week	% Repellent	After3rd spray By week	% Repellent	After 4thspray by week	% Repellent	
Entomax	3.0	4.4±0.58a	2.1±0.4b	52.27	0.4±0.22b	90.8	0.0±0.0b	100	0.0±0.0b	100	85.76
Neem azal T/S	1.0	4.6±0.63a	2.6±0.52b	44.08	0.8±0.32b	82.4	0.2±0.13b	95.8	0.0±0.0b	100	80.57
Cidial	1.5	5.7±0.53a	3.1±0.43b	36.7	0.7±0.26b	84.4	0.3±0.15b	93.8	0.0±0.0b	100	78.72
Cont.	0.0	4.9±0.65a	6.7±0.55a	-----	8.3±0.49a	----	9.5±0.3a	-----	8.8±0.35a	-----	----
F	---	0.89 UN	18.65*	----	125.6*	----	634.08*	----	600.8*	----	----
$LSD_{0.5}$	---	1.73	1.38	----	0.98	----	0.52	----	0.51	----	----

Means followed by the same letters are not significant ($P \leq 0.05$).

Table (5): Toxic effect of neem and cidial formulations against the leopard moth borer, *Zeuzera pyrina*

Formulations	Rate of application ml/l	1st spray			2nd spray		3rd spray		4th spray		Avg.% Reduction After 4 sprays
		Mean No. alive larvae/10 branches /tree ± SE & % Reduction									
		Before spray	After 1st spray by week	% Reduction	After 2nd spray by week	% Reduction	After 3rd spray by week	% Reduction	After 4th spray by week	% Reduction	
Entomax	3.0	5.0±0.8a	2.0±1.0b	66.7	1.0±0.0b	83.3	0.2±0.0.2b	96.7	0.0±0.0b	100	86.7
Neem azal T/S	1.0	5.6±1.4a	2.4±0.5b	64.3	1.6±0.24b	77.0	0.4±0.24b	94.0	0.0±0.0b	100	83.8
Cidial	1.5	5.4±1.6a	1.4±0.24b	78.4	2.2±0.4b	66.0	1.0±0.28b	84.6	00±0.0b	100	82.3
Cont.	0.0	5.0±1.7a	6.0±0.7a	---	9.2±0.86a	-----	11.6±1.2a	----	14.2±1.68a	---	----
F	----	0.042 UN	15.36*	---	62.46*	-----	74.05*	----	71.0*	----	-----
$LSD_{0.5}$	----	4.34	1.58	----	1.45	-----	1.93	-----	2.52	-----	-----

Means followed by the same letters are not significant (P ≤ 0.05).

Table (6): Repellent effect of neem and cidial formulations against the leopard moth borer**, *Zeuzera pyrina.***

Formulations	Rate Of application ml/l	1st spray			2nd spray		3rd spray		4th spray		Avg. % Repellent after 4th sprays
		Mean No. branches infestation /tree ± SE &% Repellent									
		Before spray	After 1st spray by week	% Repellent	After 2nd spray by week	% Repellent	After 3rd spray by week	% Repellent	After 4th spray by week	% Repellent	
Entomax	3.0	5.6±0.4a	3.2±0.6b	36.0	0.4±0.20c	92.6	0.2±0.2c	96.9	0.0±0.0b	100	81.4
Neem azal T/S	1.0	5.6±1.4a	3.6±0.51b	30.8	0.6±0.30c	89.1	0.2±0.2c	96.9	0.0±0.0b	100	79.2
Cidial	1.5	5.8±1.3a	4.2±0.8b	23.6	2.8±0.60b	57.6	2.4±0.5b	68.0	0.0±0.0b	100	62.3
Cont.	0.0	5.0±1.7a	6.8±0.6a	-----	10.4±0.9a	----	12.6±1.1a	-----	15.8±1.4a	-----	----
F	---	0.06 UN	6.24UN	----	62.07*	----	93.6*	----	122.37*	----	----
$LSD_{0.5}$	---	4.06	1.94	----	1.78	----	1.83	----	2.14	----	----

Means followed by the same letters are not significant (P ≤ 0.05).

CONCLUSION

The results clearly demonstrated the importance of the use of the eco-friendly botanical insecticides such as Entomax and Neem azal T/S in controlling the jasmine moth, *Palpita unionalis* (Hübner) (Lepidoptera: Pyralidae), the olive fruit fly, *Bactrocera oleae* Gmelin and the leopard moth *Zeuzera pyrina* L. the three main insects in commercial olive trees in Egypt.. Neem can be effectively used as an excellent alternative to synthetic insecticides. Neem is safe to mammals (Niemann et al., 2002) and to non-targeted biological systems (Schmutterer, 1990; Pavela, 2009; Demitry et al., 2012).

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

. Abd El-Salam, A. M. E designed and performed the experiments and wrote the manuscript, El-Kholy, M.Y. reviewed the manuscript, collection data, and also published it, Salem, S.A designed the experiments and analysis data and Abdel-Rahman, R.S. designed and performed the experiments. All authors read and approved the final version.

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