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ECOLOGICAL AND TOXICOLOGICAL STUDIES ON COTTONY OLIVE PSYLLA *EUPHYLLURA STRAMINEA* LOGINOVA (HOMOPTERA : APHALARIDAE) INFESTING OLIVE TREES AT WEST-NORTH COAST, EGYPT

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ABSTRACT

Ecological studies was carried out on cottony olive psylla *Euphyllura straminea* Loginova to estimate population density, Quotient of insect, population age structure, number of generations per year and parasitism percentages during two successive years in two locations under dry conditions (Burg el-Arab, Alexandria Governorate and El-Hammam, Matrouh Governorate). There were two overlapping generations of *E. straminea* occurred in olive trees orchard according to the nymphal stage during March-April and May-June under dry conditions in both studied areas, nymphal stage represented about 65%, while adult stage recorded about 35% of grand total count of insect/year and nymphs were parasitized by a hymenopterous parasitoid *Diversinervus elegans* Silvestri belongs to family: Encyrtidae where all parasitism percentages recorded 13.5%.

Toxicological studies was carried out to evaluate the efficiency of three light mineral oils, neonicotinoids insecticide and Bio-insecticide as a single or binary mixture [by two spraying techniques, (Knapsack sprayer CP3) and a registered at WHO Portable Thermal Fogging machine (pulsFog K-10-SP)], against the nymphal and adult stages of *E straminea* infested olive trees in the same areas. All treatments concerning the positive joint of action of the mineral combinations with other chemicals in controlling *E. straminea* on olive trees and decreased nymphal parasitism percentges.

Using of pulse fogger technique for controlling cottony olive psylla *E.straminea* not only dissolve the main important problem in dry farms (lack of water) which was a real success under dry field conditions, but also it is effective in reducing the number of the tested insect stages, save more than 80% of working time, improve environmental protection (the spray as an aerosols do not run off into soil as

cohesive liquids do), full-scale interior treatment (leaves concealed pests without a chance) and have no deterioration of crops value.

INTRODUCTION

Olive (*Olea europaea* L.), is widely cultivated in the Mediterranean Basin where it is one of the most distinctive trees to be found. The olive tree is cultivated for both fruits and oil derived. Olive cultivation was introduced in 1935 at Burg El-Arab region and then spread successfully along the North Coast, Alexandria, Egypt (Kassas, 1979). Unfortunately, olive trees, attack by many pests which reduce the yield, due to the dropping of premature fruits, destruction bulps, reduction of marketing value of the infested olive fruits and the increase in the acidity of the oil, i.e. scale insects, mealy bugs, fruit flies, stem borers, cottony olive psylla …etc (Moursi and Mesbah, 1985; El-Gendy *et al.,* 2002 and El Nasr and Abd-Rabou, 2012).

Cottony olive psylla, *Euphyllura straminea* Loginova (Homoptera: Aphalaridae) is one of the most important insect pests of olive orchards in Egypt and most Mediterranean countries. The damage of olive tree caused by *E. straminea* may result from the feeding of both nymphal and adult stages by sucking the sap of buds, inflorescence; young leaves, small twigs and fruit pedicels but never feeding on the fruits. Insect feeding on the premature fruits causes dropping off resulting high loss in the yield. The nymphs secrete flocculent whitish wax filaments “snow-like infestation” from the end of the abdomen to cover their bodies, where the tree seems to be covered with cotton, so the insect is called the olive cottony insect. The insect also secrets a large amount of honey-dew which cover the buds, leaves, flowers, twigs and fruits and prevents many of vital processes (photosynthesis and respiration) in the plant, encourage the growth of sooty mould fungi especially black fungi (black mould), cause the death of terminal twigs, reducing the fertility rate of flowers and cause fruit dropping reducing the tree production (Chermiti, 1983 & 1992; Mustafa, 1984 Mustafa, 1989; Abo Arkob, 1998, Hussein, 2000 and Youssef *et al.,* 2011).

E. straminea Loginova was first collected and identified from olive trees at El Arish and Rafah during 1988, then at El-Fayoum (Nada, 1994) and at Burg El-Arab area, during 1997 (Moursi, 1999, El-Gendy *et al.,* 2002).

Entomopathogenic fungi is another group which infects insects being the fungal group exploited commercially for biological control. Homopteran piercing sucking insects including scale insects (Hajek and St. Leger, 1994 and Humber, 2008). It also typically cause diseases in insects (Pedrini *et al*., 2007).

The proper spraying technique has to produce the Optimum Droplet Size (ODS) [spectrum droplet size of TFT varies from 1 Micron up to 50 Microns] for control of any insects, which give the maximum efficiency of pesticides by using the lowest quantity and minimum environmental pollution. Lack of experience and knowledge about pest control and spraying technique around the world have created several problems such as: severe environmental pollution, deterioration in community public health systems, great loss in agricultural crops as well as the resistance of insects and parasite to pesticides and medicine, Gamal, (2008). Better coverage generally results from the creation of smaller droplets, which cover more surface area, resulting in less runoff and, often, less solution needed to spray the greenhouse, (Kurt, 2008). Pesticides must be diluted either with diesel or kerosene or mineral oil, to be applied by a Portable Thermal Fogger (PTF), El-Gendy *et al.,* (2002).

This work aimed to study current distribution of cottony olive psylla *E. straminea* in Egyptian North-West Coast area and evaluate the efficacy of some local summer light mineral oils, bio-insecticide and neonicotinoid insecticide (single or in mixtures) on reducing its population of nymphs and adults stages by two different spraying techniques.

MATERIAL AND METHODS

Ecological studies (Survey and seasonal Abundance of *Euphyllura straminea*)

Ecological study was carried out to determine the following parameters: Mean number of insects /tree as a population density, Quotient of insect increase, monthly percentage of insect grand total count, population age structure of the insect, number of generations per year and Parasitism percentages associated with, *Euphyllura straminea* Loginova during two seasons 2012 and 2013.

This study took place at two locations, [Burg el-Arab (60 Km west of Alexandria, 2 Km south of the seacoast - Alexandria Governorate) and El-Hammam (80 Km west of Alexandria, 2 Km south of the seacoast - Matrouh Governorate)] representing the same olive variety (Shemlali). In order to estimate the population density of the olive psylla, ten highly

infested trees of the same age and similar in size, shape, height, vigour and similar in infestation were chosen. From each tree, five small branches (15 cm in length) were randomly picked from each direction, from the two farms for each sampling interval. During the flowering and fruiting periods, the total of 50 clusters and 100 fruits were inspected from each farm. Sampling were carried out monthly from January 2012 till December, 2013. The picked samples were put in marked (labeled) cloth bags and transferred to the laboratory for counting stages of that insect using the stereoscopic binocular microscope. The increasing rate of the population densities of the psylla infestation was calculated where the upper and lower surfaces of the leaves and all the branches were examined (pre-adult, adult of the inspected insect were counted and recorded). The population dynamics was compared along the season. The population age structure was calculated as percentage of every stage from total population for nymphs, adults and parasitized nymphs.

Toxicological studies :

Two field experiments were carried out at four private farms under dry conditions during flowering stage (Febrauary, 2014) representing the same olive cultivar (Shemlali) at Burg El-Arab (by CP3 sprayer) and El-Hamam (by pulsFog K-10-SP sprayer) areas (in about six acres for each experiment) to evaluate and compare the efficacy of some recommended chemical and non-chemical insecticides (Table 1) against the tested insect (*E. straminea*). The tested insecticides were applied by two spraying techniques, [Knapsack sprayer (CP3) 20 litter and a registered at WHO Portable Thermal Fogging machine (pulsFog K-10-SP). Fogger generate ultra-fine droplets as a visible fog clouds with 5 litter solution tank (droplet size spectrum by No. 12 nozzle depending on spray solution viscosity: 25 µm for oil, 60 µm for oil/water and 150 µm for water (Replacing the standard fogging tube by a High Performance Fogging Tube for water-based fogging mixture which produces an excellent droplet spectrum, Lucien, 2012) by the rate of 2 letter spray solution/acer (Hussein, 2000 and Stahl, *et al.*, 2009)]. The application occurred by walking speed 35 m/min., effective swath width 40 m and dosage 2 L/acre (Hoffmann, *et al.,* 2008 and Lucien, 2012) and fogging dosage were calculated according to Stahl, *et al.*, (2009) as in Table (1).

Twelve treatments including control [replicated three times, 16 trees per replicate (Protocols for assessing the effectiveness of pesticides, Committee of Pesticides, Ministry of Agriculture and Land

Reclamation)] were applied. Sixty small branches from each treatment were collected at random (from the four directions). Counts were calculated just before treatments, and 2, 4, 6 and 8 weeks after application. The collected samples were transferred to the laboratory and examined immediately using binocular microscope to determine the average number of the alive individuals and parasitized nymphs.
To evaluate the efficiency of the tested insecticides, percentage of reduction was determined according to Henderson and Tilton equation (1955). Analysis of variance and L.S.D value for comparing the mean of each treatment were adopted as mentioned by (Snedecor, 1961).
Table (1) Tested compounds and their rates.

Treatments		Trade names	Rate	
			CP3	K-10-SP
1)	light summer oil	Star oil® 98% EC (S)	1.5% oil/water	Mineral oil
2)		Diver oil® 97% EC (D)		
3)		Super misrona oil® 94% EC (SM)		
4)	neonicotinoids	Imidacloprid (Best® 25% WP)	0.1% in water	100 g/acres in water
5)	Bio-insecticide	Biosect® (32 million spores *Beauveria bassiana*/g) WP	200 g/acres in water	
6)	Mixture 1 + 4	Star oil® + Best®	1.5% + 0.05%	50 g/acres in mineral oil
7)	Mixture 2 + 4	Diver oil® + Best®		
8)	Mixture 3 + 4	Super misrona oil® + Best®		
9)	Mixture 1 + 5	Star oil® + Biosect®	1.5% + 100 g/acres	100 g/acres in mineral oil
10	Mixture 2 + 5	Diver oil® + Biosect®		
11	Mixture 3 + 5	Super misrona oil® + Biosect®		
12	Control	-	-	-

RESULTS AND DISCUSSION

Ecological studies (Survey and seasonal Abundance of *Euphyllura straminea*)

The obtained results indicated that, there were two overlapping generations of *E. straminea* occurred in olive trees orchard according to the nymphal stage during March-April and May-June under dry conditions in both of studied areas, Figure (1 A and B).
In the present study a hymenopterous parasitoid was collected from parasitizing nymphal stage of *E. straminea* in olive farms. This parasitoid named *Diversinervus elegans* Silvestri belongs to family: Encyrtidae. The parasitized nymphs seem to be a mummy shaped, light brown in colour, fixed on branches or leaves specially on the lower surface with a sticky material and covered with, honey and waxy

secretion remain on the plant from the survival period of the nymphs. The obtained data indicate that parasitism with *D. elegans* contributes slightly in regulating the cottony olive insect population in the tested areas.

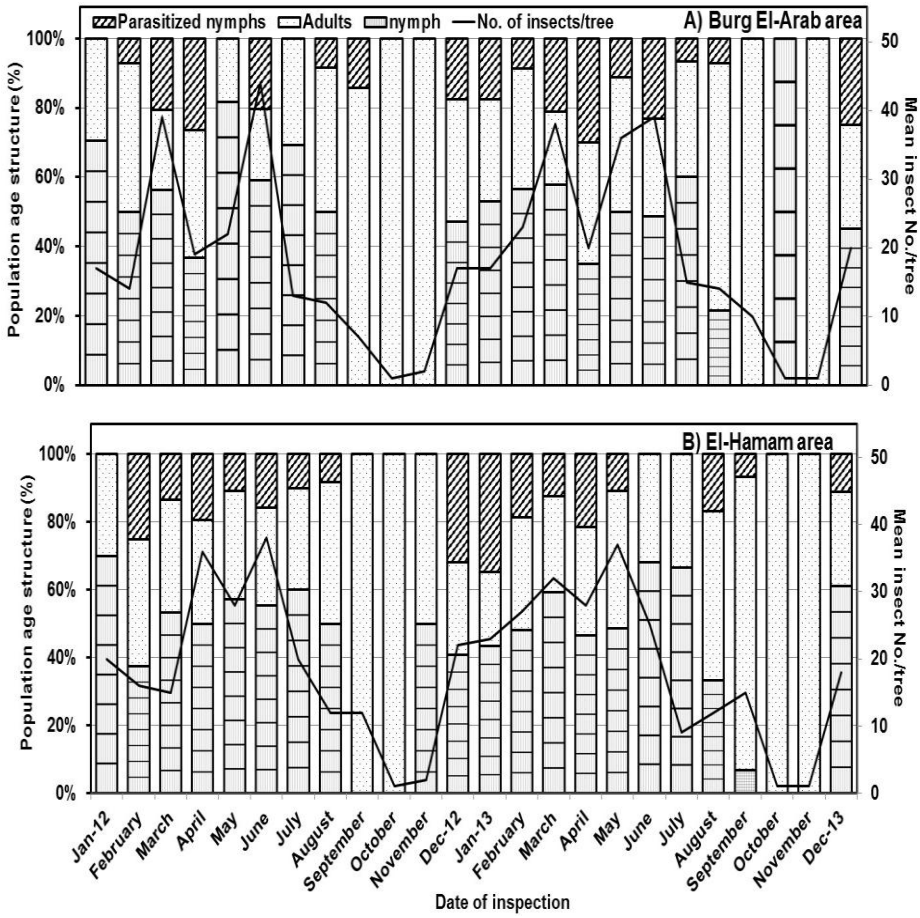


Fig. (1) Monthly variations in mean insect number/tree, and population age structure of *Euphyllura straminea* infested olive trees under dry conditions at Burg El-Arab (A) and El-Hamam (B) areas during 2012 – 2013 seasons.

The adult stage of *E. straminea* recorded 31% and 36% of total of grand count of insect/year during 2012 and 2013 at Burg El-Arab area respectively (Fig. 1A), but the nymphal stage represented 69% and 64% with parasitism percentages with *D. elegans* 13% and 14%, respectively. On the other hand, at El-Hamam area the adult stage of *E. straminea* recorded 36% and 37% of total of grand total count of

insect/year respectively, but the nymphal stage represented 64% and 63% during 2012 and 2013 with parasitism percentages 14% for each (Fig. 1B).

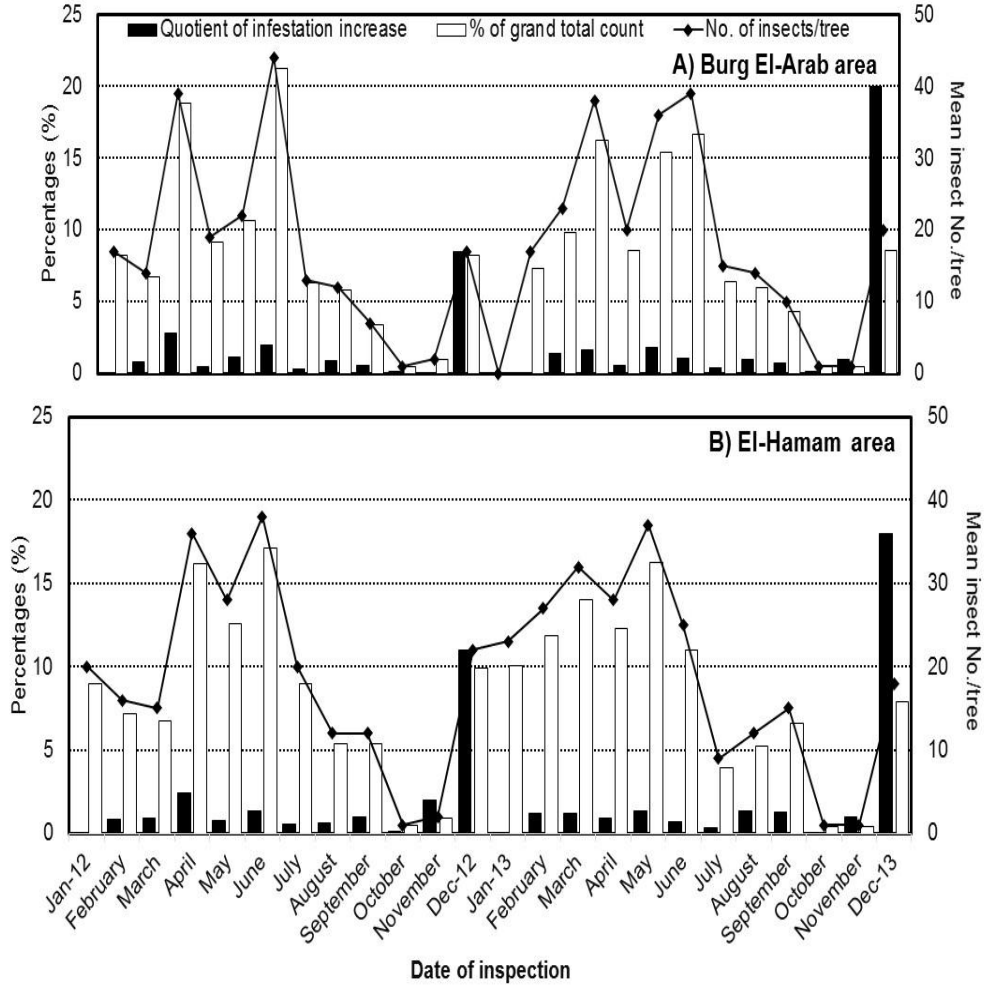


Fig. (2) Mean number of insects /tree, Quotient of insect increase percentage and monthly percentage of insect/tree to grand total count/year of *Euphyllura straminea* infested olive trees under dry conditions at Burg El-Arab (A) and El-Hamam areas (B) during 2012 – 2013 .

The nymphal stage population increased during summer months and disappeared during October-November of 2012 and 2013 at Burg El-Arab and El-Hamam areas. The calculated data showed

that parasitism by *D. elegans* on *E. straminea* increased during early spring and summer at the two tested areas during the experimental period. It was clear that the population density and the total of grand count of insects/tree/year of the *E. straminea* infested olive trees was similar in the two experimental locations, Burg El-Arab and El-Hamam areas during 2012 and 2013 insignificant differences in between.

Data in Fig. (2 A & B) illustrated the monthly percentage of insect/tree according to grand total count of olive psylla/year had been linked to the consists of the generations and most of quotient of insect percentage under 1% except early summer months, it raised to double or triple and had a big jump in December to more than ten times, where the nymphal stage population disappeared during October-November of 2012 and 2013 at Burg El-Arab area and El-Hamam areas.

The above mentioned ecological results are in accordance with the findings of Baki and Ahmed (1985) in Iraq reported that adults of *E. straminea* had its peaks in March and June. Also Radwan (1996) and Hussein (2000) reported two generation per year for *E. straminea* in Fayoum and Alexandria Governorates, Egypt.

Toxicological studies :

Three light mineral oils, neonicotinoids and Bio-insecticide were treated as a single or combined as binary mixture. Tested materials efficacy was evaluated against the nymphal and adult stages of olive psylla *E straminea* infested olive trees at two Egyptian Governorates (Alexandria and Matrouh). Experiments were carried out during olive flowering stage using two sprayer techniques under field condition.

A) Using Knapsack sprayer (CP3)

The data presented in Figures 3 and 4 illustrate the efficacy of tested materials which were applied by Knapsack sprayer (CP3) against nymphs and adult stages of *E. straminea* in a private olive orchard at Burg El-Arab area.

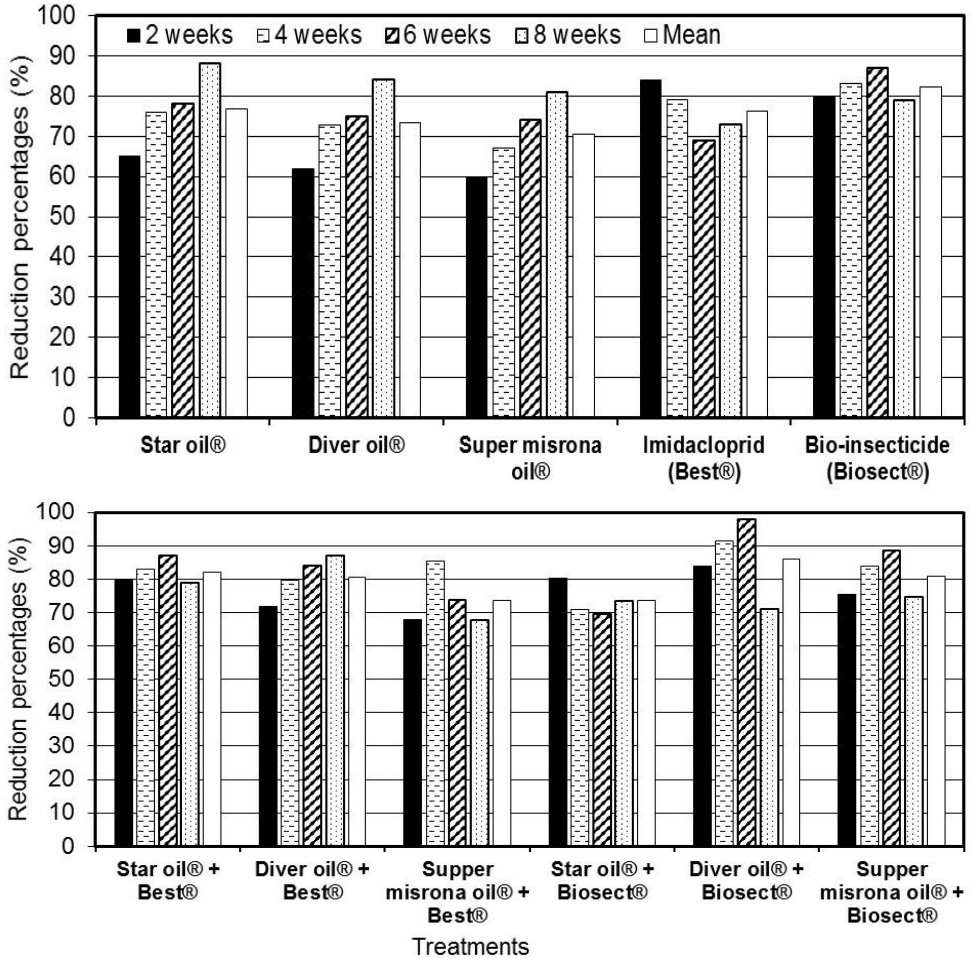


Fig. (3) : Effect of tested materials (light mineral oils, bio-insecticide, neonicotinoids and their binary mixtures) against *E.straminea* nymphs infested olive trees at Burg El-Arab area using Knapsack sprayer (CP3) under dry condition.

Data in Fig. (3) indicated that, the binary mixtures of the tested materials were generally more effective than the single treatment except the mixture of (Star oil® + Biosect®) caused reduction effect less than single treatment of Star oil® and so the mixtures of Biosect® with mineral oils caused reduction effect less than its single treatment except its binary mixture with Diver oil®. The mixture of (Diver oil® + Biosect®) was the most effective treatment where it caused mean reduction effect (86.6%) followed by the bio-insecticide Biosect® and the mixture of (Star oil® + Best®) which caused reduction effect

(82.2%) for each and analysis of variance for reduction percentage in population of nymphal stage showed significant differences between other treatments and the mixture of (Diver oil® + Biosect®). The mixtures of (Supper misrona oil® + Biosect®) and (Diver oil® + Best®) caused reduction effect 80.7% and 80.6% and did not differ significantly with the mixture (Star oil® + Best®) and Bio-insecticide (Biosect®) but differ significantly with Star oil® and Imidacloprid (Best®) which caused mean reduction effects 76.7% and 76.3%.

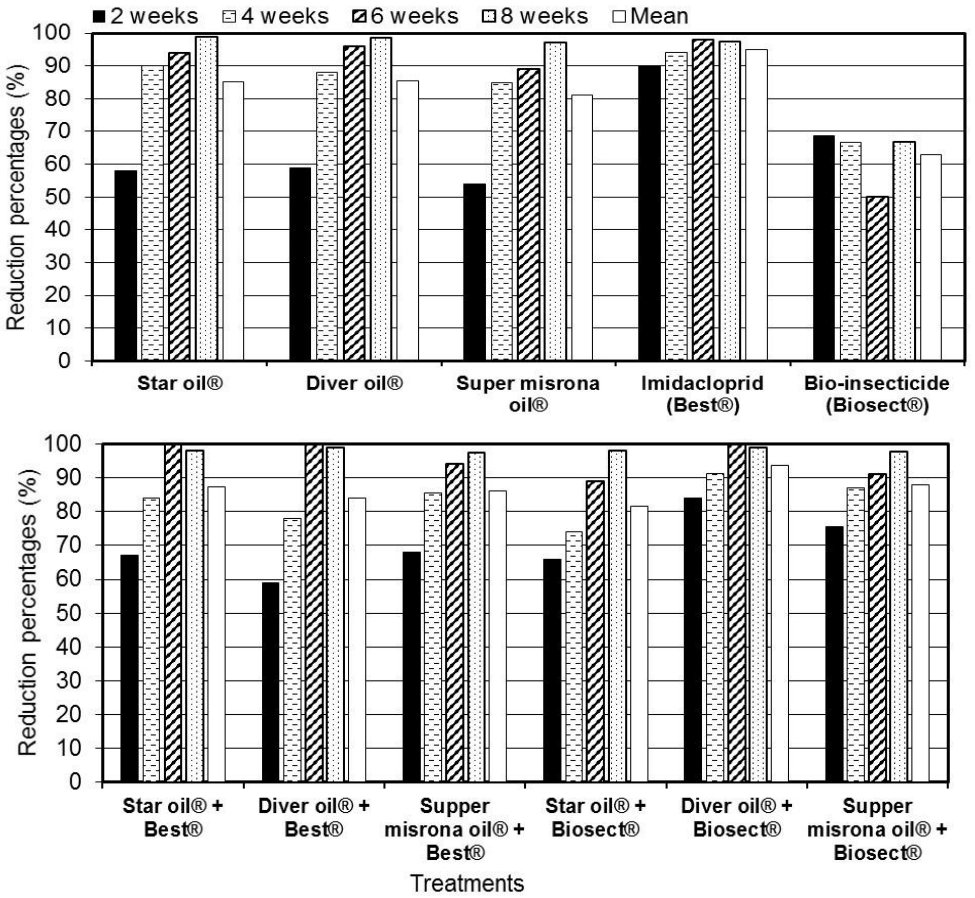


Fig. (4) : Effect of tested materials (light mineral oils, bio-insecticide, neonicotinoids and their binary mixtures) against *E. straminea* adults infested olive trees at Burg El-Arab area using Knapsack sprayer (CP3) under dry condition.

There were not only no significant differences were found between the mixtures (Supper misrona oil® + Best®), (Star oil® + Biosect®) and Diver oil® (single treatment) where they caused reduction effect

73.7%, 73.6% and 73.5% respectively, but also differed significantly with Star oil® and Imidacloprid (Best®). Super misrona oil® single treatment caused the least reduction effect against *E. straminea* nymphs (70.5%) which differ significantly with the other treatments.

The obtained data in Fig. (4) of this figure showed that the effect of all treatments as a single treatment or in a binary mixtures against the adult stage of cottony olive psylla were increased with time, except treatment of neonicotinoids (Imidacloprid, Best®) and Bio-insecticide (Biosect®). The combination mixtures of the tested materials showed higher activity when compared with the single treatments except Imidacloprid (Best®) which was the most effective treatment where it caused reduction percentage (94.4%) and did not differ significantly with the mixture (Diver oil® + Biosect®) which caused reduction percentage (93.6%), followed by the mixtures (Supper misrona oil® + Biosect®), (Star oil® + Best®) and (Supper misrona oil® + Best®) which caused reduction percentage (87.9%), (87.3%) and (86.2%) respectively without significant differences in between but differed significantly with the mixture (Diver oil® + Best®) (84.0%). Also there were no significant differences between the effect of mixture (Diver oil® + Best®), single treatments of Diver oil® and Star oil® where they caused reduction percentage 84.0%, 85.4% and 85.2% respectively. The effect of mixture (Star oil® + Biosect®) did not differ significantly with the single treatment of Super misrona oil® where they caused reduction effect 81.8% and 81.3% respectively. The Bio-insecticide (Biosect®) caused the least reduction effect against the adult of *E. straminea* (63.0%) while in the same time it caused reduction effect (82.2%) against nymphal stage, that may be refer to movement of adult stage, these results in agree with the finding of Hussien (2000) and El-Gendy *et al.,* (2002).

Comparing the effect of tested materials against the nymphal and adult stages, it was observed that bio-insecticide (biosect®) was very effective against the nymphal stage while it was the least effective one against the adult stage, supper misrona oil® (single) and mixture (star oil® + biosect®) treatments were very low effective against the nymph and adult stages, treatments diver oil®, best® and mixtures (supper misrona oil® + biosect® or best®) were more effective against the adult stage than the nymphal stage, on the other hand star oil®, (single and mixture with best®) and mixture (diver oil® + best® or biosect®) were more effective against nymphal stage than adult stage.

B) Using Thermal Fogging Technique (PulsFOG® K-10-SP)

The data presented in Figures 5 and 6 illustrate the efficacy of tested materials which were applied by Thermal Fogging machine (PulsFOG® K-10-SP) against nymphs, and adult stages of *E. straminea* in a private olive orchard at El-Hamam area.

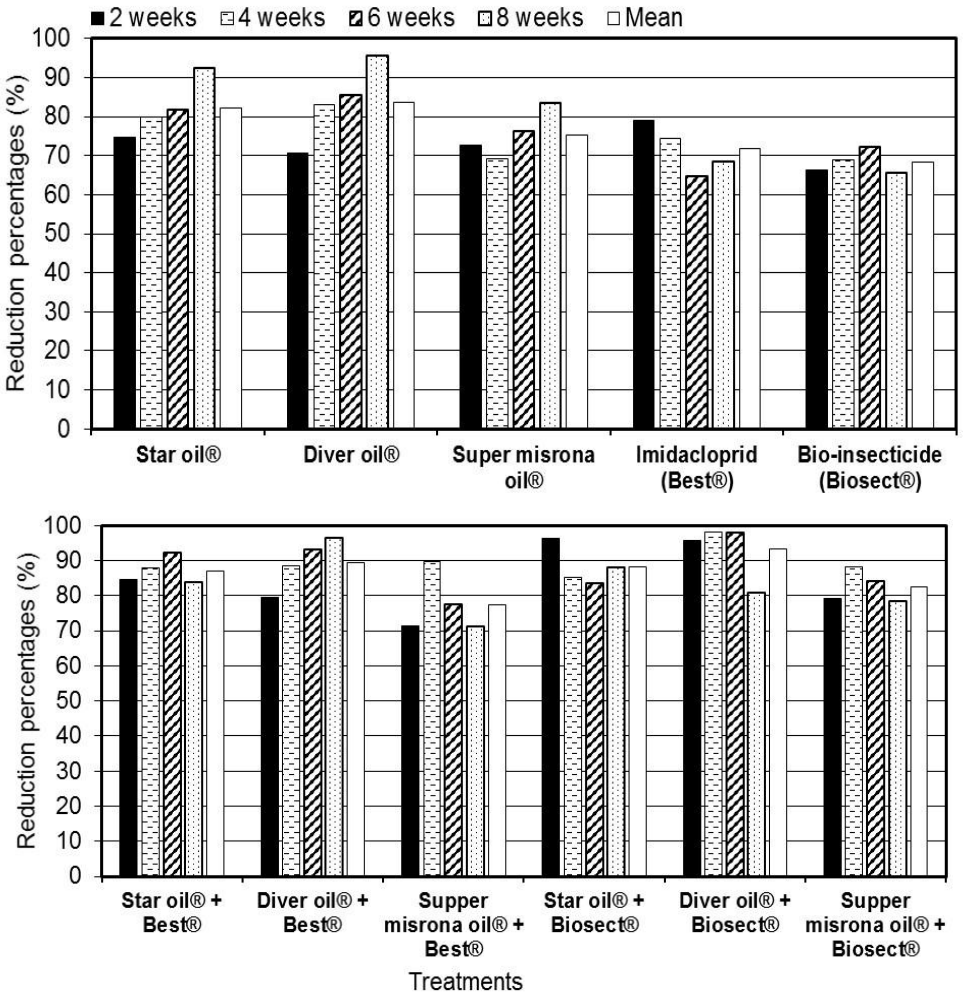


Fig. (5) : Effect of tested materials (light mineral oils, bio-insecticide, neonicotinoids and their binary mixtures) against *E.straminea* (nymphs) infested olive trees at El-Hamam area using Thermal Fogging machine (pulsFog K-10-SP)under dry condition.

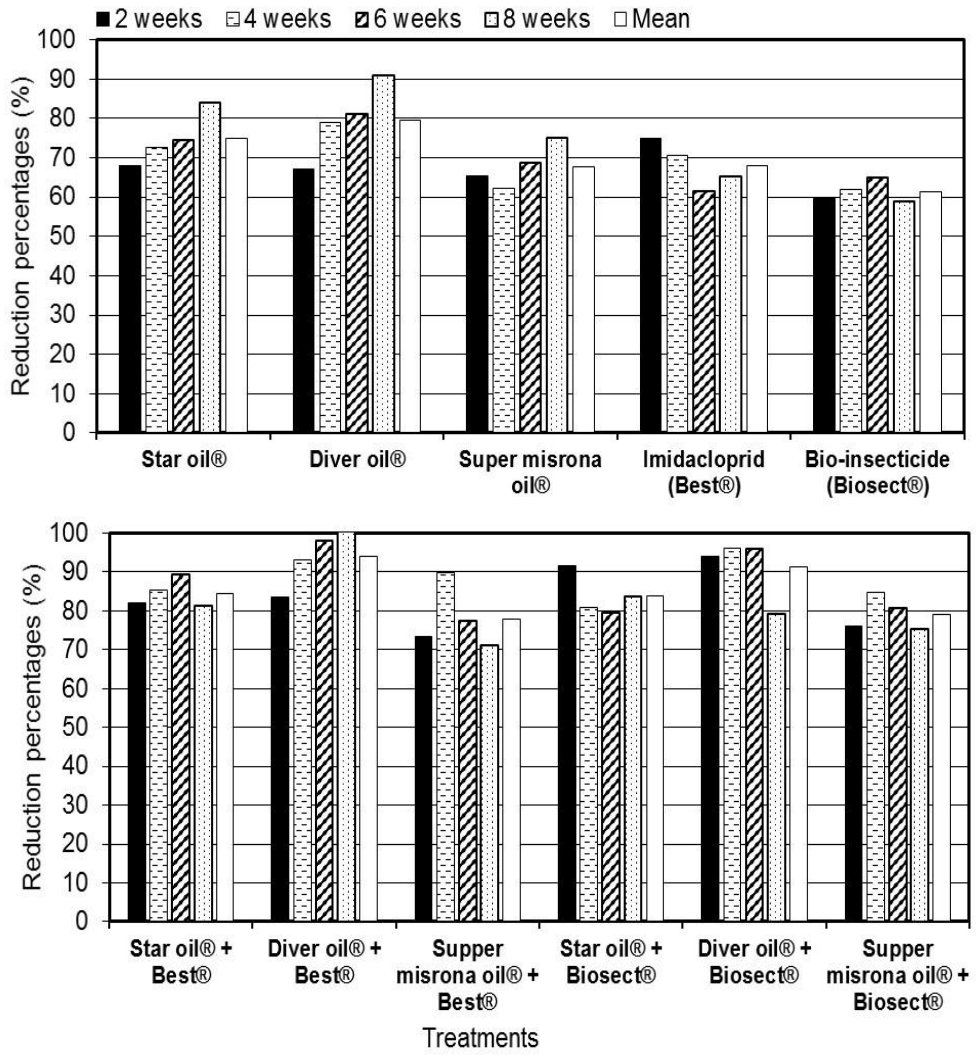


Fig. (6) : Effect of tested materials (light mineral oils, bio-insecticide, neonicotinoids and their binary mixtures) against *E.straminea* (adults) infested olive trees at El-Hamam area using Thermal Fogging machine (pulsFOG® K-10-SP)under dry condition.

Data in Fig. (5) indicated that mixtures of Diver oil® with Biosect® or Best® were the most effective treatments against nymphal stage where they caused mean reduction effects 93.2% and 89.5% respectively with significant differences in between, followed by mixtures Star oil® with Biosect® or Best® which caused reduction

effects 88.3% and 87.1% respectively, without significant differences in between, followed by Diver oil®, mixture (Supper misrona oil® + Biosect®) and Star oil® without significant differences in between where they caused mean reduction effects 83.8%, 82.5% and 82.2% respectively, followed by mixture (Supper misrona oil® + Best®) 77.4%, Super misrona oil® 75.4% and Imidacloprid (Best®) 71.7% then the least effective treatment Bio-insecticide (Biosect®) caused nymphal reduction effect 68.2% without significant differences in between.

Results in Fig. (6) showed that mixtures of Diver oil® with Best® and Biosect® were the most effective treatments against adult stage where they caused mean reduction effects 94.0% and 91.3% respectively without significant differences in between, followed by mixtures Star oil® with Best® and Biosect® which caused reduction effects 84.5% and 83.9% respectively, without significant differences in between, followed by Diver oil®, mixture (Supper misrona oil® + Biosect® and Best®) where they caused mean reduction effects 79.6%, 79.2% and 78.0% respectively without significant differences in between, and followed by Star oil® caused 74.8% reduction effect with significant differences with the other treatments. On the other hand Imidacloprid (Best®) and Supper misrona oil® caused mean reduction effects 68.1% and 67.8% respectively without significant differences in between, then the least effective treatment Bio-insecticide (Biosect®) caused adult reduction effect 61.4% which differ significantly with other treatments.

It was observed that mixtures of Biosect® with Star oil® or Diver oil®, Star oil® (single treatment) and Supper misrona oil® were more effective against nymphal stage than adult stage, while Imidacloprid (Best®) as a single treatment or combining with mineral oils (Star oil® or Diver oil®) were more effective against adult stage than nymphal stage.

Finally, it was observed that all the tested treatments reduced the parasitism by *D. elegans* to be negligible all over the experiment units comparing with control treatments in the two experiment, that is may be due to killing *E. straminea* nymphs by the insecticides which it feed on or the side effects of the tested chemicals on the parasitoid.

The present trend in the tested materials concerning the positive joint of action of the mineral combinations was reported by Mostafa and Attal (1985). Similarly, Radwan (1996) showed that all tested mixtures of mineral oils with other chemicals were effective in controlling *E.straminea* on olive trees. Also, the obtained results on tested bio-

insecticide, or its mixtures with mineral oils agree with those obtained by Latch and Fallon (1976), Muller-Kugler and Stein (1976) and Van Emden (1996).

The obtained results indicated that using of pulse fogger technique for controlling cottony olive psylla *E.straminea* not only solve the main important problem in dry farms (lack of water) which was a real success under dry field conditions, but also was effective in reducing the number of the tested insect stages, saved more than 80% of working time, improved environmental protection (the spray as an aerosols do not run off into soil as cohesive liquids do), full-scale interior treatment (leaves concealed pests without a chance) and had no deterioration of crop value. These findings are in agreement with the results of Green *et al.,* (1987), Helmy *et al*., (1997), Hindy *et al.,* (1997) and Hussein (2000) where the ULV aerial spray was better than the Knapsack ground sprayer.

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الملخص العربى

دراسات بيئية وسمية على حشرة الزيتون القطنية ***Euphyllura straminea*** **Loginova (Homoptera : Aphalaridae) التى تصيب اشجار الزيتون فى الساحل الشمالى الغربى لمصر**

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أجريت دراسة إيكولوجية على حشرة الزيتون القطنية التى تصيب أشجار الزيتون لتقدير الكثافة العددية، والتركيب العمرى وعدد أجيال الحشرة في السنة، والنسبة المئوية للتطفل على الحشرة، وذلك خلال سنتين متتاليتين ٢٠١٢ ، ٢٠١٣ في موقعين تحت الظروف الحقلية الجافة فى منطقة برج العرب بمحافظة الاسكندرية ومنطقة الحمام بمحافظة مطروح.

أوضحت النتائج أن للحشرة جيلين متداخلان على أشجار الزيتون وفقا لطور الحورية خلال مارس-ابريل ومايو-يونيو تحت الظروف الحقلية الجافة فى منطقتى الدراسة. وكان تعداد طور الحورية يمثل حوالى ٦٥% من تعداد الحشرة الكلى خلال العام/شجرة متضمناً حوالى ١٣.٥% حوريات متطفل عليها، بينما كان تعداد طور الحشرة الكاملة حوالى ٣٥% من التعداد الكلى خلال العام/شجرة.

كما أجريت دراسة تكسوكولوجية لاختبار كفاءة ثلاثة زيوت معدنية خفيفة ومبيد من مجموعة نيونيكوتونويد ومبيد حيوى (معاملات منفردة او فى صورة مخاليط ثنائية) ضد حشرة الزيتون القطنية، وتم تطبيقها بواسطة نوعين من طرق الرش (رشاشة ظهرية، ومولد للضباب) فى نفس مناطق الاختبار. وأوضحت النتائج أن جميع المعاملات أثبتت الفعل التنشيطى الإيجابى لمخاليط الزيوت المعدنية مع باقى الكيماويات فى مكافحة أطوار الحشرة، كما إنها أدت إلى إنخفاض نسبة التطفل.

استخدام تقنية تطبيق المبيدات المختبرة بمولد الضباب ضد حشرة الزيتون القطنية لم يؤد فقط لحل المشكلة الرئيسية الهامة في الظروف الحقلية الجافة (نقص المياه) التي تعتبر نجاحا حقيقيا بل أيضا أعطت كفاءة عالية فى خفض تعداد جميع أطوار الحشرة ووفرت أكثر من ٨٠% من الوقت المستهلك فى تطبيق المعاملات وقللت من تلوث البيئة (حيث أن الايروسولات لا تسقط كلها على التربة كما تفعل السوائل) وتؤدى إلى ضمان وصول المبيد لجميع أجزاء النبات والآفات الموجودة عليها ولا تؤدى إلى أى تدهور فى قيمة المحصول.