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Population dynamics of the white olive scale, *Leucaspis riccae* (Hemiptera: Diaspididae) and its parasitoid *Aphytis libanicus* (Hymenoptera: Aphelinidae) as well as control measure of this scale insect

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Abstract
The white olive scale, *Leucaspis riccae* Targioni Tozzetti (Hemiptera: Diaspididae) is one of the most important pests attacking olive. The present paper includes some ecological aspects of the white olive scale, *L. riccae* and its parasitoid. Dynamics of *L. riccae* and its parasitoid on olive trees was carried out in Fayoum governorate, during 2020 and 2021. Only one parasitoid recorded in this work was *Aphytis libanicus* Traboulsi (Hymenoptera: Aphelinidae). Statistical analysis of the effect of weather factors on the population of *L. riccae* and its parasitoid during the two years under consideration was explained. It is concluded that maximum and minimum temperatures was significant on the population of *L. riccae* and its parasitoid, *A. libanicus* while percent of relative humidity it is nonsignificant. Obtained trend over both years indicated the occurrence of two activities per year for *L. riccae* on olive in Fayoum. In this study, it is evaluated the insecticidal effects of insecticides and botanical oils against the white olive scale infested olive and its parasitoid *A. libanicus* in Faiyum Governorate, throughout the experiment period 2020 and 2021. The results indicated that the *actellic* was the most effective treatment against *L. riccae* and its parasitoid *A. libanicus*. Citrus oil compound caused the lowest reduction against *L. riccae* and its parasitoid *A. libanicus*. It is concluded that essential oil and plant extract are promising compounds to control *L. riccae* and are safe to survive the parasitoid *A. libanicus*.

Keywords: white olive scale, *Leucaspis riccae*, *Aphytis libanicus*, seasonal abundance, insecticides, control measure, Egypt

Introduction

Olive (*Olea europaea* L.) is evergreen tree in the family Oleaceae, native to the coastal areas of the eastern Mediterranean Region, from Lebanon and the coastal parts of Asia. The tree is considered one of the most important crops related to the superior nutritional and medicinal value of its edible oil (Oteros *et al*., 2014) [26]. The Mediterranean basin is the largest olive production area worldwide, arthropod species including scale insects attack olive trees and cause quantitative and qualitative losses of yield (Haniotakis, 2003) [18].

The white olive scale, *Leucaspis riccae* Targioni Tozzetti (Hemiptera: Diaspididae) is one of the most important pests of olive. *L. riccae* is regarded as a serious pest in different parts of the world (Danzig and Pellizzari, 1998; Claps *et al*., 2001 and Foldi, 2001) [8, 6, 15]. This species recorded in Egypt by Abd-Rabou (2001) [22] infested olive trees. It is a major pest of olives in the Egyptian Western Desert (Moursi *et al*., 2012) and Fayoum governorate (Nada and Mohammed, 1984 and Abd-Rabou and Ahmed, 2011) [24, 1].

It is a polyphagous species that has been recorded from hosts belonging to 45 genera in 11 plant families including, olive and mango (Pellizzari *et al*., 2011). It attacks leaves, trunk and fruit (Davidson and Miller, 1990) [9]. Heavy infestation causes chlorosis of the leaves, defoliation, discoloration and poor maturation of the fruit and desiccation, weakening and dieback of the branches or even entire trees. Damage to fruit occurs in heavy infestations, where spotting and often deformity of fruits affects market value. Areas surrounding scales on fruit remain green long after the rest of the fruit ripens. The areas surrounding the scale insects on leaves turn yellow and when severely infested the entire leaf may be discolored prematurely and be shed (Cohic, 1955 and Gill, 1997) [7, 16].

It is widely distributed throughout the tropical and subtropical regions of the world (Davidson and Miller, 1990; DeBach and Rosen, 1991 and Danzig and Pellizzari, 1998) [9, 10, 8]. It is distributed in Argentina, Algeria, Cyprus, France, Greece, Iran, Malta, Sicily, Syria, Tunisia, Turkey, Uzbekistan and Yugoslavia (Newstead, 1913) [25].

Natural enemies of *L. riccae* studied by Priesner and Hosny, 1940; Rosen, 1979 and Abd-Rabou, 1999 [28, 30, 2]. They recorded the predator *Cybocephalus* sp. (Coleoptera: Nitidulidae), *Aphytis libanicus* Traboulsi (Hymenoptera: Aphelinidae). and *Aphytis* sp., respectively. Later, Moursi *et al*. (2012) recorded the aphelinid parasitoid *Aphytis coheni* DeBach (Hymenoptera: Aphelinidae). attacks the pest in western Egypt. *A. libanicus* one of the most important bioagent for controlling the olive scale in different parts of the world including Egypt (Abd-Rabou and Ahmed, 2011) [1].

Chemical control plays an important agent in controlling armored scale insects e.g. white scale insect. It is guaranteed agent when natural enemies and other control measurements are insufficient to prevent plant damage and maintain produce quality. Till now no special measures, except removal of infested tree parts, are recommended at this time for this pest.

The aim of present work is to study some ecological aspects of the olive scale, *L. riccae* its parasitoid, *A. libanicus* on olive trees in Egypt. Also, in this study, evaluated the insecticidal effects of insecticides and botanical oils against this pest and its parasitoid.

Materials and methods

1. Population dynamics of the white olive scale, *Leucaspis riccae* and its parasitoid *Aphytis libanicus* infested olive trees

Dynamics of *L. riccae* on olive trees was carried out in Fayoum, governorate, during 2020 and 2021. The selected orchard did not receive any chemical control for two years before starting these studies and within studying period. All trees received the same horticultural practices.

Twenty trees were selected at each grove infested with this scale insects. Selected trees were similar in size, shape, height and vegetation. Samples were picked up at two-week intervals throughout the study. Samples random size was 60 leaves presenting from all directions. The samples were packed in polyethylene bags with minute holes and transferred to the laboratory for examination, using stereoscopic microscope binocular. All alive insects found on each leaf surface was assorted and recorded as: Nymphs and adults. Obtained data was pooled for each inspection, direction and leaf surface.

The abundance of parasitoid of the olive scale was carried out 2020 and 2021 on olive trees in Fayoum. The location was heavily infested by the olive scale, *L. riccae* was selected to achieve investigations and was sampled monthly. During the study, no chemical control for the pest was performed on these trees. In the location 20 trees were selected randomly for sampling. Units of sampling consisted of 60 leaves. These were detached off and brought to the laboratory for inspection. Each leave was stored in a well-ventilated emergence glass tube and monitored daily for parasitoid emergence. Rate of parasitism was determined by dividing the number of emerging parasitoids from each by the number of hosts scale existing.

Simple correlation and regression values were calculated to obtain information about the relationships between the three tested weather factors and the population of the olive scale and its parasitoid.

2. Efficacy of insecticides and botanical oils against the white olive scale, *Leucaspis riccae* and its parasitoid *Aphytis libanicus*

The current study was carried out to evaluate the field performance of eight insecticides in their respective commercial formulations available on the market. The concentrations used were based on the recommendations of the Egyptian Ministry of Agriculture for each insecticide to control the pest insects under field conditions.

A field trial was conducted on olive orchards located in Fayoum Governorate, during two consecutive summer seasons of 2020 and 2021. The infested olive trees with the white olive scale *L. riccae* was identified, selected, and labeled before the application of insecticides. This area did not receive any insecticidal treatments before the start of the experiment. The trial of nine treatments (Eight insecticides + control) these are: Mineral oil (1 Litre oil/ 100 Liter water), *Beauveria bassiana* (200 gm / 100 L.), *Metarhizium anisopliae* (200 ml/100 L.), *Azadirachtin indica* (5 ml/Lw), citrus oil (5 cm/1L), buprofezin (IGR) (600 cm3 /fed.), garlic oil (5 cm/1L) and actellic 50 (Organophosphate) **(**75 cm /100L.), was laid out in a randomized complete block design with three replicates. A spray was applied with a CP3 knapsack sprayer (Cooper Pegler Co. Ltd., Northumberland, England). The insecticides were used in the commercial formulation and the concentrations were prepared using water as a diluent. Insecticides were sprayed in the early morning when the insects were active, and the environmental conditions minimize the potential risk of spray drift and evaporation. Control plots were sprayed with water only. Twnty trees with a heavy infestation of white scale associated the parasitoid were randomly selected in the field. Tree to tree distance was 3 meters. Each ten trees acted as a replicate. The spray application was done on 10th of October during 2020 and 2021. Data were recorded on the selected trees before spraying and 15, 30 and 45 days after application. The mean numbers of the scale per leaf and associated parasitoid were recorded.

3. Statistical analysis

The data were subjected to analys-is of variance (ANOVA) and the means were compared with LSD test at 0.05 level, using the SAS. The percent reduction of the whitefly population and associated parasitoid in all treatments compared to the control were calculated according to the Henderson and Tilton (1955) [19] formula.

Results and discussion

1. Population dynamics of the white olive scale, *Leucaspis riccae* and its parasitoid *Aphytis libanicus* infested olive trees

1.1 The white olive scale, *Leucaspis riccae*

The results of *L. riccae* population dynamics on olive trees over 2020 and 2021 years are presented in Figures (1 and 8). The mean number of individuals were 800.0 and 276.1 individuals for nymphs and adults of *L. riccae*, respectively. Nymphs density reached its maximum on June 15th and October 15th during 2020, with two peaks, showing 1823 and 1468 Nymphs/sample, respectively. Lowest Nymphs density occurred during the period of January 1st showing 145 Nymphs/sample. Adults density was highest on July 1st and November 1st during 2020, with two peaks, showing 711 and 640 Adults/sample, respectively. Lowest Adults density occurred during the period of January 1st showing 57 Adults/sample (Figures 2 and 4).

The mean number of individuals were 945.5 and 346.5 individuals for nymphs and adults of *L. riccae*, respectively. Nymphs density reached its maximum on June 15th and October 15th during 2021, with two peaks, showing 2110 and 1560 Nymphs/sample, respectively. Lowest Nymphs density occurred during the period of January 1st showing 178 Nymphs/sample. Adults density was highest on July 1st and November 1st during 2021, with two peaks, showing 810 and 780 Adults/sample, respectively. Lowest Adults density occurred during the period of January 1st showing 57 Adults/sample (Figures 6 and 8).

Statistical analysis of the effect of weather factors on the population of *L. riccae* during the two years under consideration was explained. It is concluded that maximum and minimum temperatures was significant on the population of *L. riccae* (Simple correlation "r" ranged from 0.90 to 0.92 and regression ranged 0.23-0.45) while percent of relative humidity (Simple correlation "r" ranged from 0.22 to 0.42 and regression ranged from 0.21 to 0.34, it is nonsignificant during 2020. In the same trend during 2021 the maximum and minimum temperatures was significant on the population of *L. riccae* (Simple correlation "r" ranged from 0.83 to 0.88 and regression ranged 0.26-0.38) while percent of relative humidity (Simple correlation "r" ranged

from 0. 37 to 0.49 and regression ranged from 0.24 to 0.31, it is nonsignificant.

In the present work the results indicated that the occurrence of two highest periods per year for *L. riccae* on olive in Fayoum. These results observed nymphs density reached its maximum on June 15th and October 15th and adults density was highest on July 1st and November 1st during the two years under consideration.

Surveys of scale insects attacking olive trees in Egypt have been conducted by many researchers and scientists, e.g., Ezzat (1957) [14], Amin (1966) [5] and Abd-Rabou and Ahmed (2011) [1]. The present results are agreement in Egypt with Moursi and Hegazi (1983). *L. riccae* had 2 overlapping generations a year In Iraq, Rizk and Mohammad (1985) [29] reported *L. riccae* infesting olive in for the first time. They added two generations were observed, the first from the end of April until mid-August, and the second from mid-August to the second half of April. Populations were highest in June and September. No crawlers were observed in winter. These results were contradicting with the data observed by Moursi and Mesbah (1985) [21], they stated that the population dynamics of *L. riccae*, on olive trees in Alexandria. They observed *L. riccae* had three overlapping generations a year. Later, the results of Abd-Rabou and Ahmed (2011) [1] indicated that the seasonal abundance of *L. riccae* on olive trees reached maximum during November and February in first and second years, respectively.

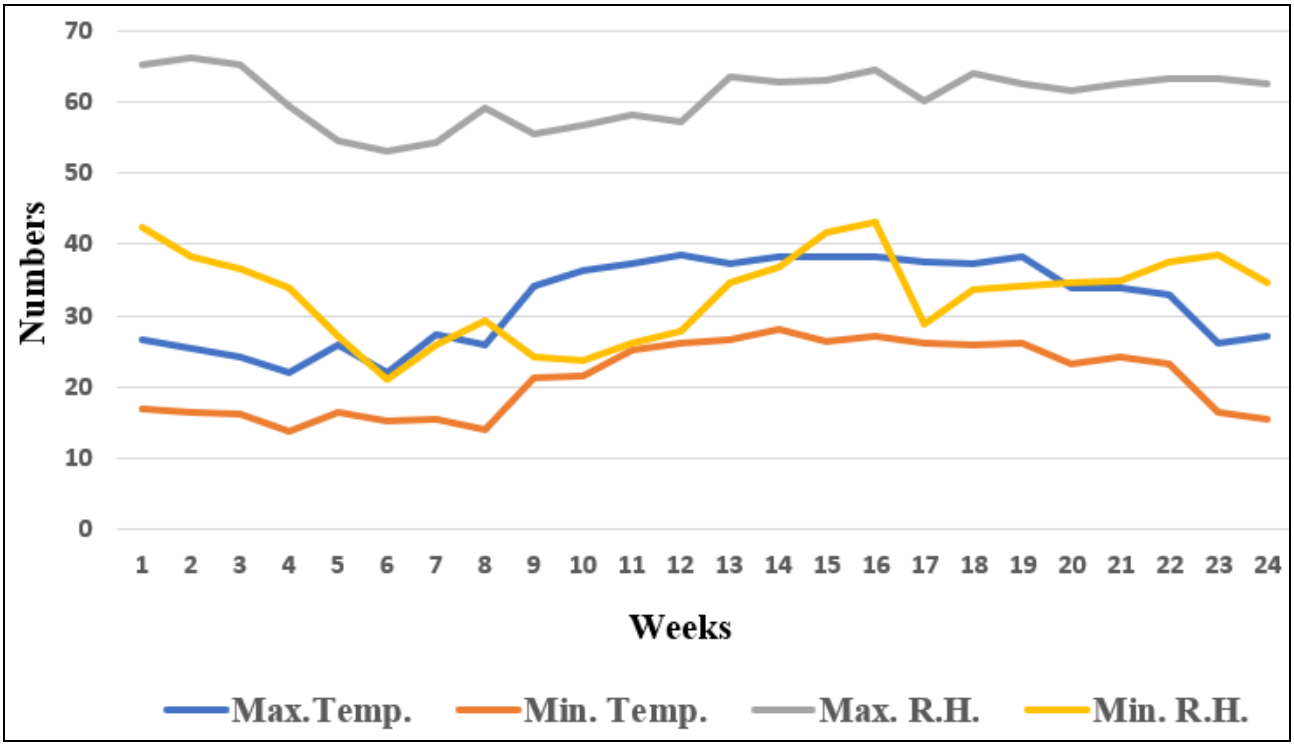

Fig 1: Biweekly weather factors of Fayoum Governorate during 2020

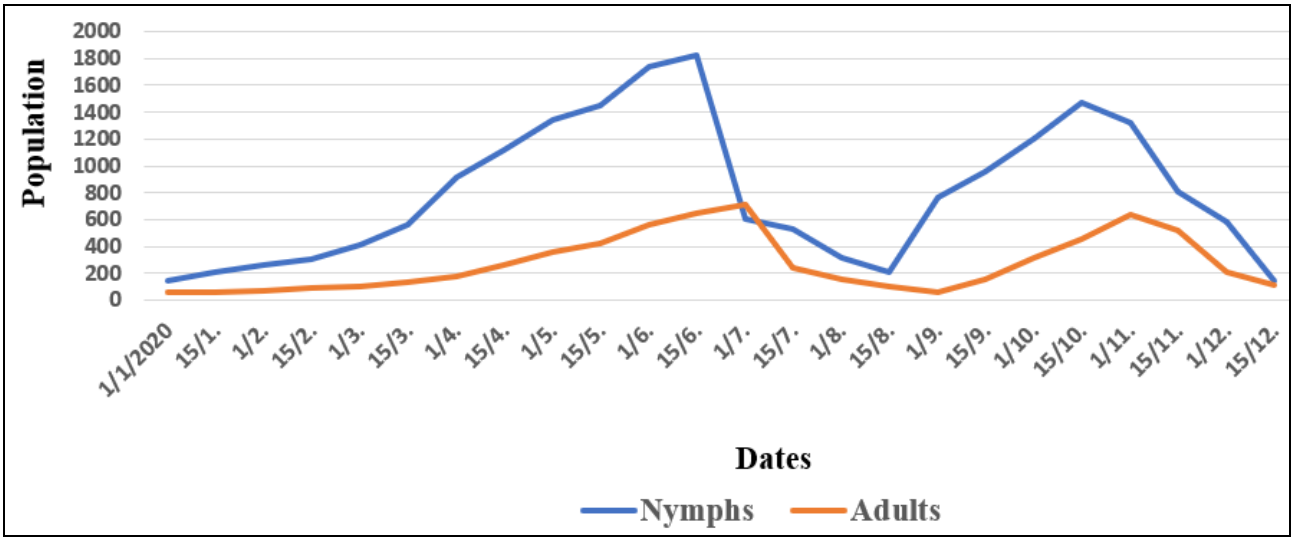

Fig 2: Population dynamics of the olive scale, *Leucaspis riccae* on olive trees in Fayoum Governorate during 2020 season

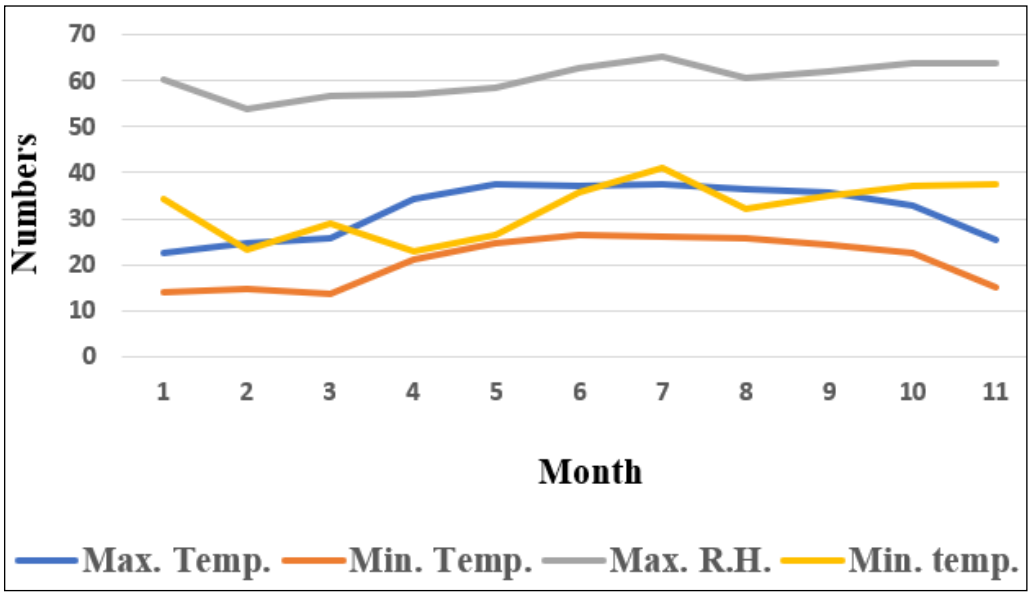

Fig 3: Monthly weather factors of Fayoum Governorate during 2020

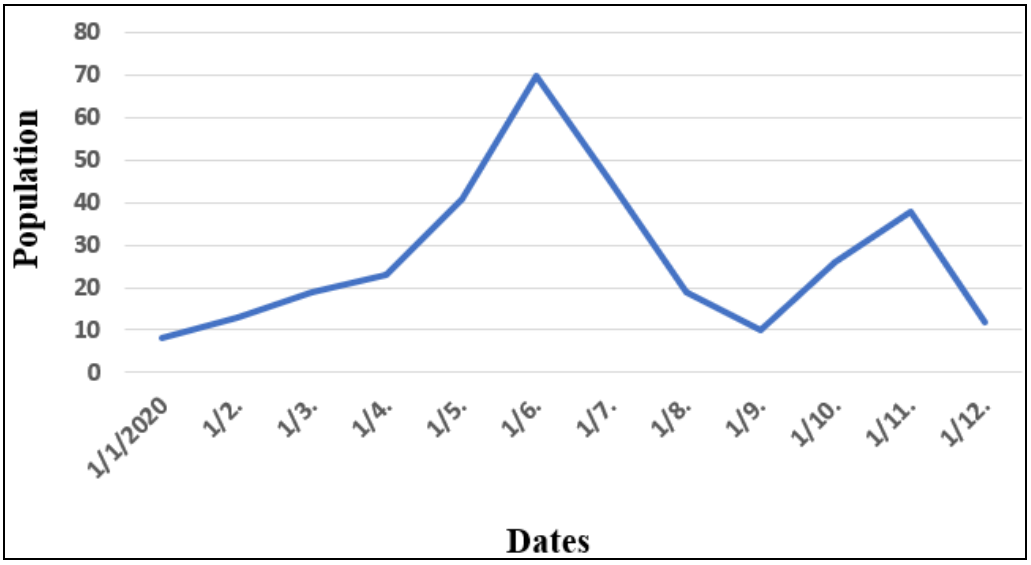

Fig 4: Population dynamics of the parasitoid, *Aphytis libanicus* associated with the olive scale, *Leucaspis riccae* on olive trees in Giza Governorate during 2020 season

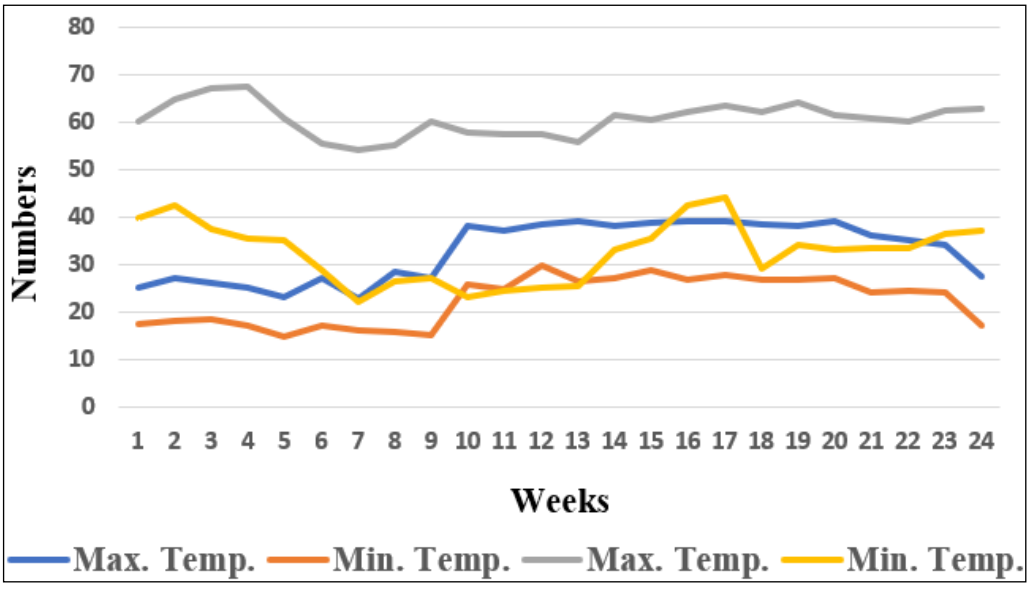

Fig 5: Biweekly weather factors of Fayoum Governorate during 2021

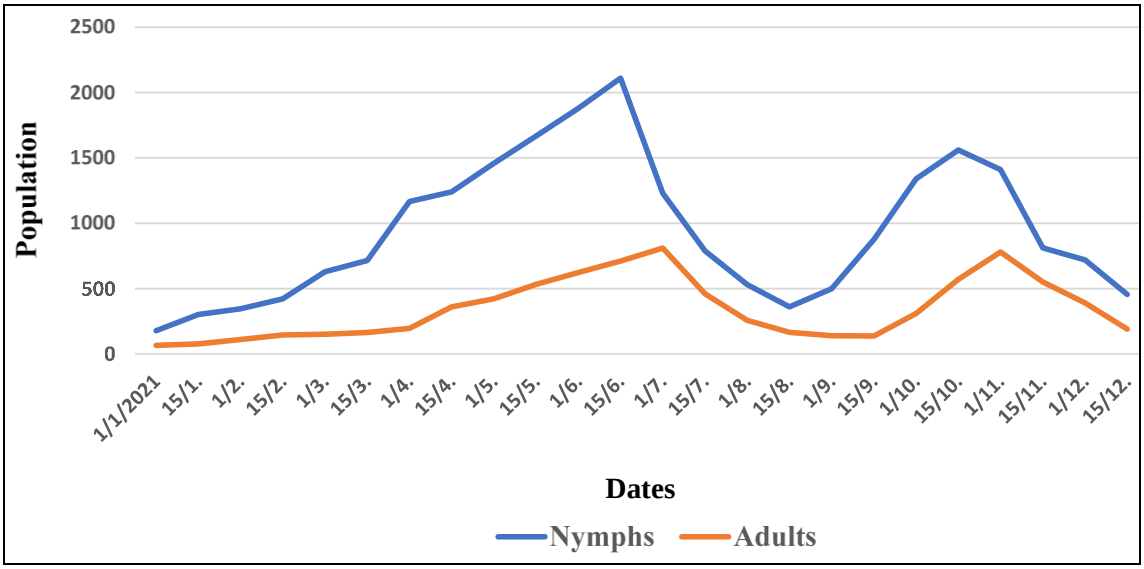

Fig 6: Population dynamics of the olive scale, *Leucaspis riccae* on olive trees in Fayoum Governorate during 2021 season

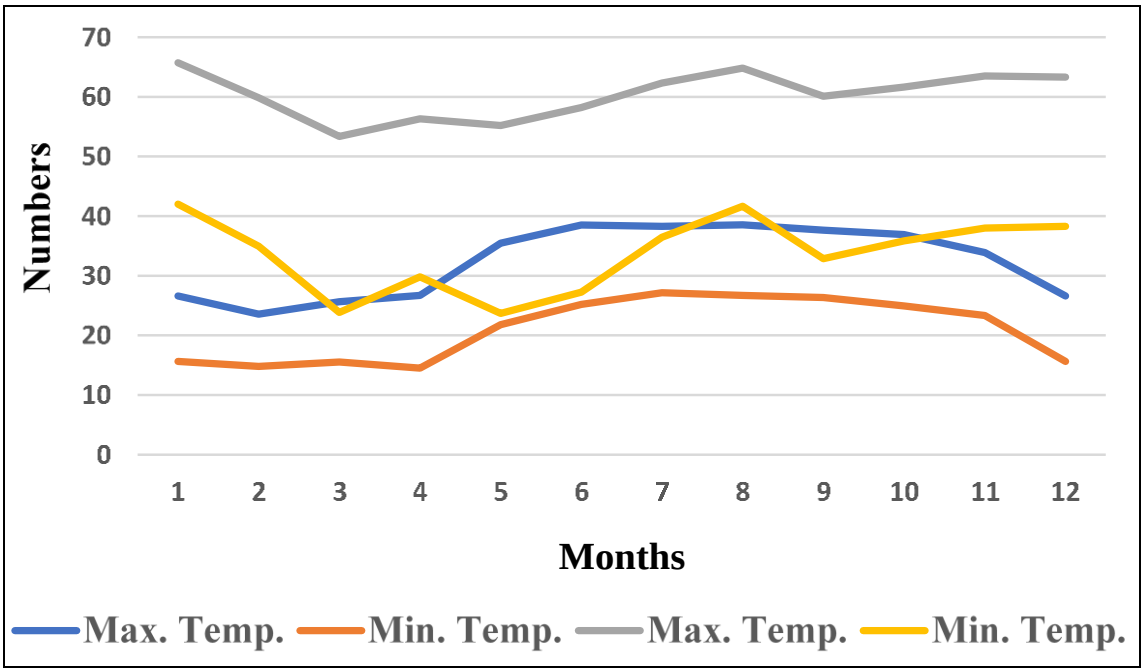

Fig 7: Monthly weather factors of Fayoum Governorate during 2021

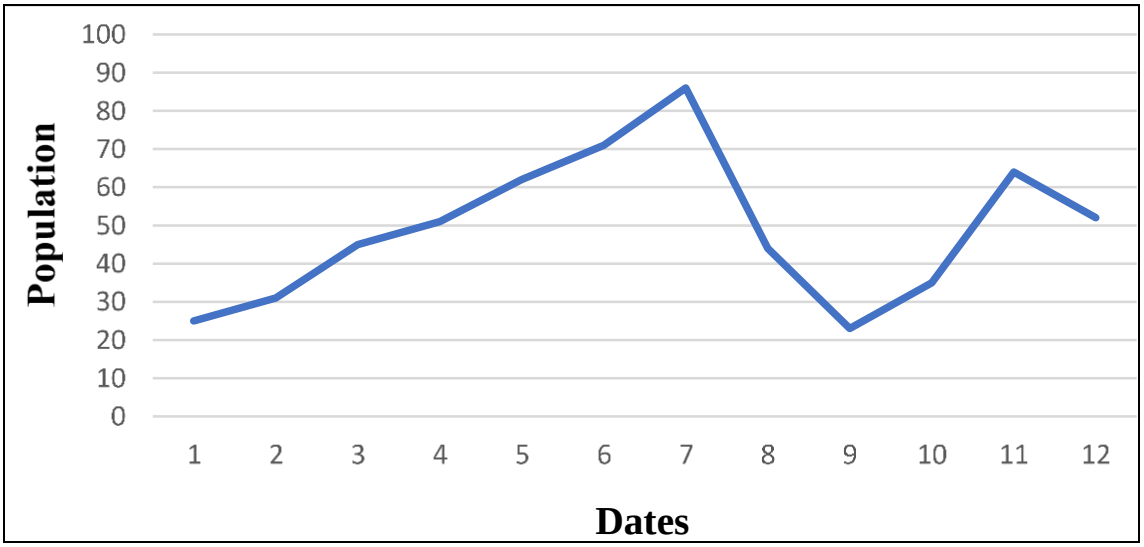

Fig 8: Population dynamics of the parasitoid, *Aphytis libanicus* associated with the olive scale, *Leucaspis riccae* on olive trees in Giza Governorate during 2021season

1.2. The parasitoid *Aphytis libanicus*

During the present work in 2020 year, number of parasitoids started was small numbers during January, February, March and increased gradually till maximum in June with 70 individuals/ 60 leaves. After that decreased gradually during August, September and increased till maximum again in November with 38 individuals/ 60 leaves. Also, the mean number of parasitoids during the first year was 27 individuals/ 60 leaves. In 2021, number of parasitoids started was small numbers during January, February, March and increased gradually till maximum in July with 86 individuals/ 60 leaves. After that decreased gradually during August, September and increased till maximum again in November with 64 individuals/ 60 leaves. Also, the mean number of parasitoids during the first year was 49.1 individuals/ 60 leaves.

Statistical analysis of the effect of weather factors on the population of the parasitoid during the two years under consideration was explained. It is concluded that maximum and minimum temperatures was significant on the population of the parasitoid (Simple correlation "r" ranged from 0.89 to 0.94 and regression ranged 0.85-0.88) while percent of relative humidity (Simple correlation "r" ranged from 0.31 to 0.46 and regression ranged from 0.33 to 0.36, it is nonsignificant during 2020. In the same trend during 2021 the maximum and minimum temperatures was significant on the population of the parasitoid *(*Simple correlation "r" ranged from 0.87 to 0.90 and regression ranged 0.87-0.89) while percent of relative humidity (Simple correlation "r" ranged from 0.27 to 0.41 and regression ranged from 0.27 to 0.41, it is nonsignificant.

The present work the parasitoid *A. libanicus* reached maximum in June November during 2020 and in 2021 reached maximum in July and November. Parasitism by a species of *Aphytis* was observed only during the rainy season, when relative humidity was high; it thus had little influence in regulating populations of *L. riccae* on rain-fed olive (Moursi and Hegazi, 1985) [21]. The aphelinid parasitoid *Aphytis* sp. was found attacking *L. riccae* (Moursi and Mesbah, 1985 and El-Khawas *et al*., 2000) [13]. Moursi *et al.* (2012) showed that *A. coheni* a parasitoid of *L. riccae* was found on olive trees at Burg el-Arab under rain-fed system during January-May, June, September and November. The results of Abd-Rabou and Ahmed (2011) [1], indicated that percent parasitism by *A. libanicus* reached maximum during December with percent parasitism 11.1 and 12.2 %, during the two years under considerations, respectively.

2. Efficacy of insecticides and botanical oils against the white olive scale, *Leucaspis riccae* and its parasitoid *Aphytis libanicus* infested olive trees during 2020-2021

The obtained data shown in (Tables 1-4) revealed that the actellic was the most effective treatments against *L. riccae* throughout the experiment period 2020 and 2021. Whereas the reduction percentage for actellic was 92.58 and 93.20, respectively. In addition, mineral oil gave (90.09 and 91.75%) reduction followed by buprofezin (86.21 and 83.92%), garlic oil (86.12 and 86.95%), *Metarhizium anisopliae* (83.65 and 81.93%), *Beauveria bassiana* (82.03 and 80.32%),, *Azadirachtin indica* (81.17 and 83.65), and citrus oil (78.48 and 79.71), respectively. Considering the probable occurring side effects of the tested compounds on the non-targeted parasitoid *A. libanicus* during 2020 and 2021, the data shown in (Tables 1 to 4) illustrate that citrus oil compound caused a lowest reduction effect (57.98 and 59.33%) followed by ascending by *Azadirachtin indica* (61.02 and 63.07%), *Metarhizium anisopliae* (62.26 and 61.98%), *Beauveria bassiana* (61.52 and 63.0%), with no significant differences between them. Then actellic, mineral oil, garlic oil and buprofezin where they caused highest parasite reduction percentage reached (75.06 and 76.50%), (71.69 and 72.1%), (71.25 and 70.50 %) and (70.41 and 65.56%) in respect without no significant differences between them. Results of statistical analysis (F value and L.S.D.) (Tables, 2 and 4) showed that seven treatments had significant effect on populations.

Results of statistical analysis (F value and L.S.D.) (Tables, 7 and 9) showed that seven treatments had a significant effect on populations.

The efficacy of four organophosphorus compounds (Dimethoate, Malathion, Sumithion and Selecron) on *L. riccae* in Fayoum governorate, gave satisfactory control against the scale insect (Nada *et al.,* 1990) [23]. Blank *et al.* (1995) and Abdel-Razak (2007) suggested that the use of mineral oil treatment at 1- 1.5% is the preferred choice in integrated pest management program. The obtained results agree with El-Deeb (2004) and Abo-Shanab (2005) [4] whose stated that the use of insect growth regulators IGRS and oils mixtures increase and facilitate efficient control of scale insect pest due to the significant inhibition of the enzymes activity. Unfortunately, the obtained results were not agreed with them in the probability of using IGRs in the integrated pest management program (IPM) because it gives adverse side effect on the parasitoid of the scale insect. El-Hakim *et al.* (2008) [12] eleven control programmers were tested during the seasons of 2004/2005 and 2005/2006 to control scale insects on olive trees at EI-Fayoum Governorate. Moreover, our data was in agree with Grafton-Cardwall *et al.* (2006) [17] who stated that using of IGRs reduced the scale as well as its parasitoid.

Finally, it could be concluded that the most effective treatments for controlling the white olive scale, *L. riccae* during winter months where the parasitoid wasps population occur in a low level, is using the mixture of Star oil+ Admiral and/or Star oil + Nimbecidine. On the other hand, when the parasitoid population is high during summer and spring months, we recommended the spraying with Mospilan which gives low reduction percentages to the aphelinid parasitoid with more effect on the target insect pest.

Table 1: Average numbers of the white olive scale, *Leucaspis riccae* and its parasitoid *Aphytis libanicus* on olive trees in Fayoum Governorate during October 2020

Treatment	Rate of Applic. /L.W.	Pre-spraying count			Post spraying count after:									Average number			
					7			15			21						
		A	N	P	A	N	P	A	N	P	A	N	P	A	N	T	P
Mineral oil	1 Litre oil/ 100 Liter water	90.9	439.3	95.1	16.2	52.1	37.0	12.6	31.9	27.8	10.7	15.1	23.9	13.16	33.03	23.09	29.56
Beauveria bassiana	200 gm / 100 L.	86.3	389.7	90.2	21.3	80.9	38.9	19.9	70.1	36.7	16.8	55.5	35.8	19.33	68.83	44.08	37.13
Metarhizium anisopliae	200 ml/100 L.	92.8	452.2	108.1	23.9	83.1	47.1	20.0	65.5	44.2	17.1	48.6	40.0	20.33	65.73	43.03	43.76
Azadirachtin indica	5 ml/Lw	89.5	404.2	96.0	24.2	88.9	43.3	21.0	75.3	39.9	18.1	59.1	36.8	21.1	74.43	47.65	40.0
Citrus oil	5 cm/1L	83.9	321.7	81.9	22.9	75.9	40.2	24.2	66.1	37.2	17.9	52.3	34.2	23.33	64.76	44.04	37.2
Buprofezin	600 cm3 /fed.	91.2	448.7	99.7	22.3	62.3	35.4	18.7	44.7	31.2	16.3	25.2	28.1	19.1	44.06	31.58	31.56
Garlic oil	5 cm/1L	94.3	472.2	116.5	17.9	64.8	39.1	17.0	52.2	35.3	15.8	37.1	33.0	16.9	51.36	34.13	35.8
Actellic 50EC	30 cm /100L	81.1	303.0	74.4	11.1	30.2	22.7	8.3	20.2	19.8	4.7	8.1	16.7	8.03	19.5	13.76	19.73
Control		93.0	460.3	112.0	97.7	488.1	116.3	105.9	51.3	119.8	114.1	531.2	124.6	105.9	510.76	308.33	120.23

A. Adult N.Nymph P. Parasitoid T. Total

Table 2: Reduction percentage of different compounds the white olive scale, *Leucaspis riccae* and its parasitoid *Aphytis libanicus* on olive trees in Fayoum Governorate during October 2020

Treatment	Rate of Applic. /L.W.	% Reduction after:									Average % reduction			
		15			30			45						
		A	N	P	A	N	P	A	N	P	A	N	T	P
Mineral oil	1 Litre oil/ 100 Liter water	83.04	88.75	65.0	87.83	93.49	72.68	90.41	97.03	77.41	87.09	93.09	90.09 a	71.69 a
Beauveria bassiana	200 gm / 100 L.	76.51	80.31	48.47	79.75	83.86	61.78	84.14	87.66	64.33	80.13	83.94	82.03 bc	58.19 c
Metarhizium anisopliae	200 ml/100 L.	75.49	82.67	58.12	81.08	87.01	61.86	84.99	90.69	66.81	80.52	86.79	83.65 bc	62.26 bc
Azadirachtin indica	5 ml/Lw	74.27	79.26	56.57	79.4	83.29	61.15	83.52	87.34	65.55	79.06	83.29	81.17 bc	61.09 c
Citrus oil	5 cm/1L	68.35	77.76	52.74	74.67	81.57	57.54	82.62	85.92	62.47	75.21	81.75	78.48 c	57.58 c
Buprofezin	600 cm3 /fed.	76.73	86.91	65.81	82.0	91.06	70.75	85.44	95.14	74.67	81.39	91.03	86.21 ab	70.41 ab
Garlic oil	5 cm/1L	81.94	86.98	67.68	84.17	90.09	71.53	86.35	93.2	74.54	84.15	90.09	87.12 ab	71.25 ab
Actellic 50EC	30 cm /100L	86.98	90.55	70.62	91.02	94.02	74.75	95.28	97.69	79.83	91.09	94.08	92.58 a	75.06 a
F value													3.86	5.00
L.S.D.													7.22	9.23

A. Adult N.Nymph P. Parasitoid T. Total

A b c d letters indicating significantly differences between treatments

Table 3: Average numbers of the white olive scale, *Leucaspis riccae* and its parasitoid *Aphytis libanicus* on olive trees in Fayoum Governorate during October 2021

Treatment	Rate of Applic. /L.W.	Pre-spraying count			Post spraying count after:									Average number			
					15			30			45						
		A	N	P	A	N	P	A	N	P	A	N	P	A	N	T	P
Mineral oil	1 Litre oil/ 100 Liter water	89.9	422.1	93.0	13.7	49.3	30.7	11.1	31.7	29.1	7.3	20.5	26.9	10.7	33.83	22.26	28.9
Beauveria bassiana	200 gm / 100 L.	93.3	481.1	109.2	24.1	110	46.6	23.3	99.9	45.0	22.1	87.7	43.4	23.1	99.2	61.18	45.0
Metarhizium anisopliae	200 ml/100 L.	87.7	400.0	86.4	21.2	86.2	31.9	19.3	78.1	36.6	18.0	68.9	35.4	19.5	77.73	48.61	36.63
Azadirachtin indica	5 ml/Lw	83.3	356.2	82.9	18.7	71.1	36.1	18.0	68.1	34.3	16.9	59.9	31.9	17.86	66.3	42.11	34.1
Citrus oil	5 cm/1L	80.2	342.2	75.1	24.0	69.9	34.9	22.4	66.7	34.5	20.3	59.7	32.8	22.23	65.43	48.83	34.06
Buprofezin	600 cm3 /fed.	90.2	447.1	92.3	26.9	50.7	36.3	25.7	41.0	35.7	23.9	27.2	34.4	25.5	39.63	32.56	35.46
Garlic oil	5 cm/1L	79.9	330.0	69.9	15.1	49.8	23.7	13.7	42.2	23.0	12.5	35.0	21.9	13.76	42.33	28.04	22.68
Actellic 50EC	30 cm /100L	92.3	466.7	101.0	12.1	39.9	28.9	8.9	26.8	26.3	6.3	11.3	24.0	9.1	26.0	17.55	26.4
Control		86.7	389.3	84.7	92.4	419.3	89.0	101.3	44.87	94.0	111.1	481.3	101.4	101.6	409.6	275.68	94.86

A. Adult N.Nymph P. Parasitoid T. Total

Table 4: Reduction percentage of different compounds on the white olive scale, *Leucaspis riccae* and its parasitoid *Aphytis libanicus* on olive trees in Fayoum Governorate during October 2020

Treatment	Rate of Applic. /L.W.	% Reduction after:									Average % reduction			
		15			30			45						
		A	N	P	A	N	P	A	N	P	A	N	T	P
Mineral oil	1 Litre oil/ 100 Liter water	85.4	89.16	68.95	89.44	93.49	71.87	93.67	96.08	75.48	89.60	92.91	91.75 ab	72.1 a
Beauveria bassiana	200 gm / 100 L.	75.77	78.78	59.39	78.63	81.99	62.95	81.52	85.26	66.68	78.64	82.01	80.32 d	63.0 c
Metarhizium anisopliae	200 ml/100 L.	77.32	80.0	58.26	81.17	83.06	61.92	83.99	86.07	65.78	80.82	83.04	81.93 cd	61.98 c
Azadirachtin indica	5 ml/Lw	78.49	81.47	58.56	81.51	83.42	62.8	84.17	86.4	67.86	81.54	83.76	82.65 cd	63.07 c
Citrus oil	5 cm/1L	71.93	81.04	55.78	76.1	83.09	58.7	80.25	85.89	63.52	76.09	83.34	79.71 d	59.33 c
Buprofezin	600 cm3 /fed.	72.03	89.48	62.58	75.62	92.05	65.23	79.33	95.08	68.87	75.65	92.20	83.92 cd	65.56 bc
Garlic oil	5 cm/1L	82.27	85.99	67.74	85.33	88.91	70.42	87.8	91.43	73.83	85.13	88.77	86.95 bc	70.66 ab
Actellic 50EC	30 cm /100L	87.7	92.07	72.77	91.75	95.02	76.59	94.68	98.05	80.16	91.37	95.04	93.20 a	76.50 a
F value													7.51	7.79
L.S.D.													5.49	6.36

A. Adult N. Nymph P. Parasitoid T. Total

A b c d letters indicating significantly differences between treatments

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