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Bioscience Research

Print ISSN: 1811-9506 Online ISSN: 2218-3973

Journal by Innovative Scientific Information & Services Network

RESEARCH ARTICLE BIOSCIENCE RESEARCH, 2019 16(1):741-748. **OPEN ACCESS**

Enumeration and sensitivity of some olive varieties to scale insects infestations and their effect on the productions

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The present studies were carried out to evaluate susceptibility of six olive varieties (Eggezi Shami, Kalamata, Eggezi Aqss, Baladi, Picual , and Manzanilla) to the identified three species of scale insects infestation (White scale *Aspidiotus nerii* (Bauchee), olive scale *Parlatoria oleae* (Colvee), and Black scale *Saissetia oleae* (Olivier). Results indicated that the most susceptible variety was Kalamata that infested with the three species of the scale insects, while Manzanilla variety was the most resistance one. The peak of infestations was recorded at August and September. The most common species were the black scale followed by white scale then olive scale insects. There was a negative correlation between scale insect infestation and percentage of fruit olive production for all variety of olive trees.

Keywords: scale insects, olive varieties, Assessment infestation, production, field studies

INTRODUCTION

The Olive tree is blessing tree which mentioned in the holey books and act as symbol of love and peace. The olive (*Olea europaea L*) a long-lived evergreen, is a worldwide economically important horticulture crop. Most olive growing countries are located in the Mediterranean basin which has more than 90% of the world's cultivated olive trees (Mansour et al., 2011). Olive tree can often be attacked by fungi, bacteria, viruses, weeds, nematodes and insects, inducing substantial economic losses. Several insect pests are known to cause great damages to olive fruits. Olive fruit fly, *Bactrocera oleae* (Gmeline), is considered to be the most important insect pest of olive worldwide (Daane& Johonson, 2010), other scale insects, could also have a negative impact on olive trees production and productivity throughout olive growing area. In the Mediterranean region about 14-20 occasional pests on the olive tree and, of these approximately 10 belonging to Super family Coccoidea (Scale insects (Pellizzari, 1997). Among scale insect pests, the black scale *Saissetia oleae* (Olivier) (O/ Hemiptera:F/ Coccidae), which is to be native to South Africa (De Lotto, 1976), is one of the most economically important species attacking olives throughout the world and especially in the Mediterranean area (Stratopoulou & Kapatos, 1991; Tena et al., 2008 ; Delrio&Foxi, 2010). When feeding on olives (leaves and twigs), that species excrete honeydew which a reason to the growth of the black sooty mold fungi, hindering the photosynthesis capacity of the plant and resulting in reduction of the tree vigor and twig dieback in the case of heavy infestation. Very few studies involving surveys of scale insects attacking olive trees have been until recently carried out. In Egypt, olive trees were cultivated at the most of the governorates and expected to increase the area of its plantation in the near future. Depending on the species and population level, scale insects can be found on all parts of the plant

(kosztarab1990, Yaşar1995, Miller, Davidson 2005).

The objective of the present research was especially focused on determining the scale insect fauna on different varieties of olive trees through a field survey of the existing species and their frequency throughout the year and to estimate the correlation between the insect infestation and the quantity of olive production. Such a study would be important for implementing suitable IPM program against the insects within Egypt fields.

MATERIALS AND METHODS

The experiment was carried out to test population fluctuation and susceptibility of six olive varieties namely (Eggezi shami – Kalamata - Eggezi Aqss - Baladi – Picual - Manzanilla) to scale insect infestation in special farm near Dina farms at 157k from desert Egypt-Alexandria road, the survey of scale insects was carried out from January to December 2016. The total cultivated area with olive trees were 15 Fadden (100 tree/ Fadden). Every month samples were collected in plastic bags from (100 leaves or/and 10 shoots 30 cm length or /and fruits) in each of the four direction (North, West, East, South) within each olive tree, also the samples were collected randomly from different tree levels. In the laboratory, each collected sample was examined under dissecting stereomicroscope. The test was replicated three times and total of tested trees was 30/variety. The tested tree was isolated from any treatment by insecticide. The net weight of the olive crop was recorded after the time. The correlation between the percentage of scale insect infestation and the percentage of the crop production was estimated.

The information report around the climatic conditions (temperature and humidity of airs) during the experiments was obtained from central laboratory for agriculture Meteorological Station, Egypt, Dokki. The relation between climatic condition and enumeration of scale insects was calculated monthly/year.

Statistical analysis:

All data were subjected to analysis of variance (ANOVA) and the means were compared by LSD test at 0.05 levels, using SAS computer program (SAS, 2009).

RESULTS AND DISCUSSION

Results at (Tables 1, 2 &3) indicated that all tested varieties of olive trees were attacked by three species of scale insects (namely: *Aspidiotus nerii* (Bauchee), *Parlatoria oleae* (Colvée 1880)and *Saissetia oleae* (Olivier 1791)) at deferent levels. Kalamata variety was recorded the most significant (P > 0.01) susceptible one infested with the three species of scale insects. The most resistance one was Manzanilla variety followed by Baladi and Eggezi Shami.

The total infestation by scale insects was graduated to reach the peak of infestation at September for *A. nerii* and *S. oleae* while *P. oleae* was recorded high peak at August as described at (Fig1, 2 and 3). Regarding to the air temperature and relative humidity and their correlation to the scale insect infestation, could be concluded that there were positive correlation between total numbers of scale insects / month and the average of temperature degrees, while a negative correlation was elicited with average RH /month.

Data in (Table 4) recorded the percentage of reduction in flower setting during fruiting season. The lower fruits setting tree belong to Kalamata variety and the best fruit setting was Baladi and Eggezi shami which was recorded 45, 21.2 and 21.7 % damaged fruits / 10 branches, respectively.

Correlation between scale insect infestation and percentage of olive trees varieties production were illustrated negative value (i.e. when insect infestation was increased, the olive tree production was decreased) (Table 5).

Generally, the above mention results were confirmed that all tested olive varieties were attached by scale insects with different levels of infestation, some of them was more susceptible than others. Host acceptance depended on the palatability of the food, which is a function of the ratio of positive to negative sensory factors. Once the food plant is accepted by the insect, the plant is considered suitable for infestation. However, several chemical constituents of plant cultivars serve as olfactory and gustatory stimuli to insect attack, like sugar or amino acids. Such stimuli are specific and are crucial in evoking the behavioral response of insect preference or antixe-nosis to plant (Panda and Khush, 1995 and Moawad et al., 2011). The variability in olive infestation by the recognized different species of scale insect may related to the various constituents of the olive variety in different climatic conditions (temperature and RH), the palatability of each species to that plant constituents which enabling the insect for infestation and complete their life cycle and increase the population density of the insect. Correlation between the insect infestation and climatic factors introduced expectation on the

Table (1): Susceptibility of six olive varieties to white scale insect *Aspidiotus nerii* (Bauchee) infestation during season (2016).

Variety / Date	Mean no. of insect individuals/ 100 leaves						Mean no. of insect individuals/10 branches/length 30 cm						Total no. of scale insects/ month	Aver. Air temp./ month	Aver. Relative Humidity/ month
	Eggezi -shami	Kalamata	Eggezi-Aqss	Baladi (oily)	Picual	Manzanilla	Eggezi -shami	Kalamata	Eggezi-Aqss	Baladi (oily)	Picual	Manzanilla			
January	**19**	**35**	**8**	**26**	**10**	**11**	**18**	**102**	**6**	**16**	**36**	**17**	**304**	**22.95**	**80.4**
February	**15**	**22**	**15**	**34**	**24**	**23**	**40**	**140**	**13**	**17**	**31**	**13**	**387**	**28.5**	**64.6**
March	**31**	**73**	**17**	**24**	**46**	**35**	**44**	**238**	**10**	**23**	**49**	**7**	**597**	**32.3**	**49.8**
April	**23**	**126**	**19**	**30**	**48**	**25**	**66**	**309**	**25**	**21**	**102**	**25**	**819**	**37.05**	**42.7**
May	**17**	**104**	**27**	**44**	**26**	**31**	**102**	**417**	**19**	**69**	**89**	**31**	**976**	**38.45**	**46.6**
June	**26**	**189**	**34**	**50**	**117**	**30**	**56**	**345**	**37**	**32**	**221**	**43**	**1180**	**44.35**	**41.3**
July	**33**	**124**	**21**	**26**	**29**	**67**	**44**	**225**	**25**	**47**	**155**	**105**	**901**	**46.6**	**51.9**
August	**39**	**164**	**41**	**37**	**38**	**49**	**46**	**386**	**8**	**55**	**192**	**39**	**1094**	**44.85**	**55.5**
September	**61**	**243**	**39**	**55**	**144**	**71**	**60**	**673**	**13**	**84**	**161**	**17**	**1621**	**42.65**	**56.2**
October	**33**	**108**	**42**	**35**	**26**	**49**	**122**	**373**	**9**	**32**	**141**	**37**	**1007**	**36.7**	**74.5**
November	**35**	**167**	**21**	**48**	**61**	**39**	**48**	**454**	**9**	**53**	**131**	**41**	**1107**	**31.75**	**58.8**
December	**11**	**61**	**19**	**15**	**21**	**44**	**25**	**159**	**14**	**14**	**42**	**22**	**447**	**22.3**	**65.4**
Total	**343**	**1416**	**303**	**424**	**590**	**474**	**671**	**3821**	**188**	**463**	**1350**	**397**	**correlation**	**0.8**	**-0.4**
Average	**28.6^{a}**	**$118^{dd'}$**	**25.3^{a}**	**35.3^{a}**	**$49.2^{aa'}$**	**39.5^{a}**	**55.9^{a}**	**$318.4^{dd'}$**	**15.7^{a}**	**38.6^{a}**	**$112.5^{c}_{a'}$**	**33.1^{a}**			
Statistical analysis	**$L.S.D_{0.05}$=30.69** **$L.S.D._{0.01}$=45.7**						**$L.S.D_{0.05}$=66.95** **$L.S.D._{0.01}$=99.83**								

Means with the same letters have no significant difference ($P < 0.05$)

Table (2): Susceptibility of six olive varieties to olive scale insect *Parlatoria oleae* (Colvée 1880) infestation during season (2016).

Variety / Date	Mean no. of insect individuals/ 100 leaves						Mean no. of insect individuals/10 branches/length 30 cm						Total no. of scale insects/month	Aver. Air temp./ month	Aver. Relative Humidity/ month
	Eggezi -shami	Kalamata	Eggezi-Aqss	Baladi (oily)	Picual	Manzanilla	Eggezi -shami	Kalamata	Eggezi-Aqss	Baladi (oily)	Picual	Manzanilla			
January	15	26	13	17	15	25	3	18	12	6	14	0	164	22.95	80.4
February	23	20	10	23	20	14	41	26	6	8	13	29	233	28.5	64.6
March	19	21	13	33	47	19	11	59	6	0.0	36	12	276	32.3	49.8
April	37	77	27	34	18	13	5	46	22	2	43	0	324	37.05	42.7
May	49	17	53	55	53	41	10	86	26	0	39	5	434	38.45	46.6
June	43	61	10	15	88	33	0	27	37	14	59	6	393	44.35	41.3
July	35	27	13	18	45	19	5	49	20	29	25	0	285	46.6	51.9
August	49	31	77	38	154	65	0	66	15	0.0	19	0	514	44.85	55.5
Septamber	69	133	43	47	24	7	2	121	36	0.0	24	0	506	42.65	56.2
October	35	29	34	33	34	19	0	85	30	5	15	0	319	36.7	74.5
November	38	124	29	25	15	28	0	53	42	17	18	0	389	31.75	58.8
December	25	50	27	18	17	24	7	16	25	9	15	0	233	22.3	65.4
Total	437	616	349	356	530	307	84	652	277	90	320	52	correlation	0.7	-0.5
Mean± S.E	36.4^{a}	51.3^{b*}	29.1^{a*}	29.7^{a}	44.2^{a}	25.6^{a}	7^{a}	$54.3^{dc'}$	$23.1^{ba'}$	7.5^{a}	$26.7^{ca'}$	4.3^{a}			
Statistical analysis	$L.S.D_{0.05}=24.7$ $L.S.D._{0.01}=36.7$						$L.S.D_{0.05}=15.2$ $L.S.D._{0.01}=22.58$								

Means with the same letters have no significant difference (P < 0.05)

Table (3): Susceptibility of six olive varieties to olive black scale insect *Saissetia oleae* (Olivier 1791) infestation during season (2016).

Variety / Date	Mean no. of insect individuals/ 100 leaves						Mean no. of insect individuals/10 branches/length 30 cm						Total no. of scale insects/ month	Aver. Air temp. /month	Aver. Relative Humidity/ month
	Eggezi -shami	Kalamata	Eggezi-Aqss	Baladi (oily)	Picual	Manzanilla	Eggezi -shami	Kalamata	Eggezi-Aqss	Baladi (oily)	Picual	Manzanilla			
January	10	7	16	18	18	61	4	8	7	8	16	7	180	22.95	80.4
February	17	15	19	20	20	73	16	6	12	9	11	6	224	28.5	64.6
March	20	49	33	36	29	143	15	9	17	4	24	6	385	32.3	49.8
April	18	125	37	30	26	141	23	21	19	4	32	9	485	37.05	42.7
May	25	87	57	84	17	112	48	11	13	6	5	17	482	38.45	46.6
June	34	145	48	64	15	129	15	35	23	3	23	25	559	44.35	41.3
July	29	122	50	44	14	120	11	17	8	9	11	13	448	46.6	51.9
August	32	160	79	57	20	157	15	30	13	11	23	19	616	44.85	55.5
September	21	223	51	107	26	249	17	37	22	7	5	43	808	42.65	56.2
October	37	115	63	75	60	184	23	43	17	5	14	9	645	36.7	74.5
November 315	15	37	45	58	9	255	18	20	7	10	24	21	519	31.75	58.8
December	11	36	22	30	13	138	10	18	5	8	16	8	315	22.3	65.4
Total	269	1121	520	623	267	1762	215	265	163	84	194	183	correlation	0.7	-0.3
Average	22.4 [a]	93.4 [ca']	43.3 [a]	51.9 [a]	22.3 [a]	146.8 [dc']	17.9 [b]	21.3 [c]	13.6 [a]	7 [a]	17 [b]	15.3 [b]			
Statistical analysis	$L.S.D_{0.05}$=36.13 $L.S.D._{0.01}$=53.6						$L.S.D_{0.05}$=8.39 $L.S.D._{0.01}$=12.46								

Means with the same letters have no significant difference ($P < 0.05$)

Table 4: Effects of insect infestation on rate of fruit setting damaged during fruiting seasons.

Variety / Date	Percentage of flower setting damaged / 10 branches					
	Eggezi-shami	Kalamata	Eggezi –Aqss	Baladi(oily)	Picual	Manzanilla
March	25.3	42.3	18.3	20	30.3	18
April	20	49.7	19.7	22	33.3	29
May	29.4	43	27	22.3	28	24.3
Total	74.7	135	65	64.3	91.6	71.3
Average	24.9^{a}	$45^{dc'}$	21.7^{a}	21.4^{a}	$27.3^{aa'}$	23.8^{a}
Statistical analysis	$L.S.D_{0.05}$=7.5 $L.S.D._{0.01}$=11.1					

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Means with the same letters have no significant difference (P < 0.05)

Table (5): Relation between the scale insect infestation and percentage of olive tree variety production.

Olive varieties	Total of means numbers of scale insects on (leaf+branches)	Mean of production (kg) /feddan	Correlation Coefficient (r)	Regression Coefficient	P value
Eggezi-shami	168.2	5520	-0.74	-0.096	0.089
Kalamata	656.7	2216			
Eggezi -Aqss	150.1	7656			
Baladi (oily)	170	4160			
Picual	271.9	6696			
Manzanilla	264.6	3520			

Fig (1): monthly abundance of *Aspiditous nerii* on six olive varieties during season 2016

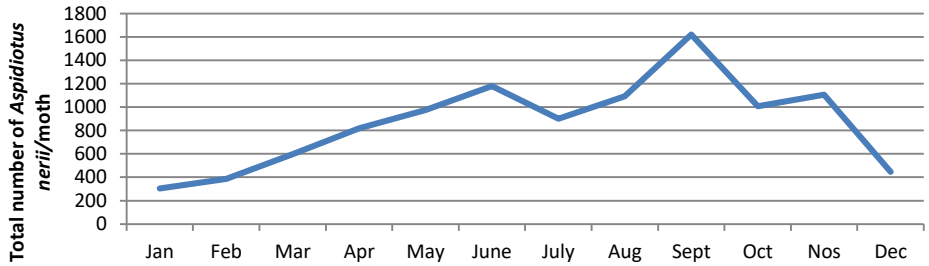


Fig (2): monthly abundance *Parlatoria oleae* on six olive varieties during season 2016

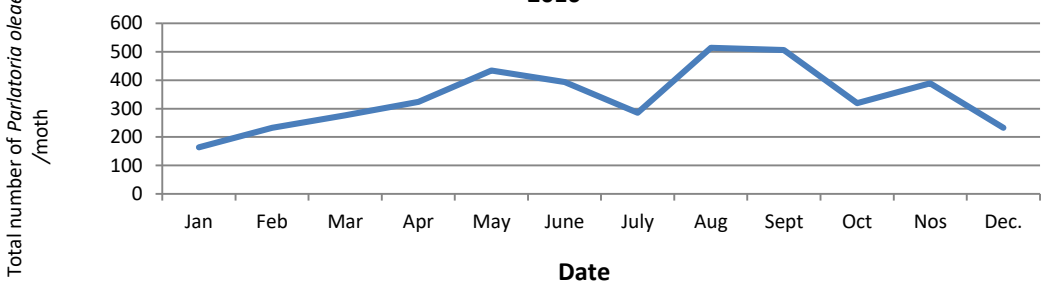
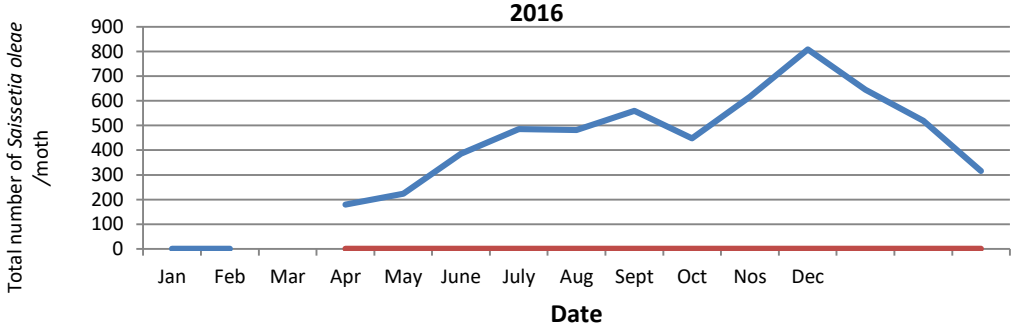


Fig (3): monthly abundance *Saissetia oleae* on six olive varieties during season 2016



degree of the infestation sheds light on the way to prepare a good control program.

The foregoing results may shed a light for implementing suitable IPM program for olive trees against the insects within Egypt fields.

CONCLUSION

Results indicated that the most susceptible olive variety was Kalamata that infested with the three species of the scale insects (White scale, Olive scale and Black scale insects.), while Manzanilla variety was the most resistance one. The peak of infestations was recorded at August and September, the most common species was the black scaled followed by white scale then olive scale insects. The infestation with scale insects increased with the increase the percentage of RH. There was a negative correlation between scale insect infestation and percentage of fruit olive production for all varieties of olive trees.

CONFLICT OF INTEREST

No conflict of interest

ACKNOWLEGEMENT

Authors greatly acknowledge to Meteorological Station for their valuable support and collaboration.

AUTHOR CONTRIBUTIONS

Sawsan S. Moawad, and I.M. A. Ebadah suggested the idea, and designed the research. Sawsan S. Moawad, I.M. A. Ebadah and Hanaa E. Sadek conducted the experiments and statistical analysis. Sharaby A. conducted the writing, revision and her valuable advises. All authors shared in the fee of publication.

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