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Effect of Some Insecticides and Their Side Effects in Controlling the California Red Scale, *Aonidiella aurantii* (Maskell)

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ABSTRACT: The California red scale, *Aonidiella aurantii* (Maskell) is one of the most important insect pests infested citrus trees in Egypt. Field experiments were conducted during two years (2020 and 2021) on *A. aurantii* on sweet orange trees at Nubaria district, Beheira Governorate, Egypt. The results indicated that, the population of *A. aurantii* recorded four peaks of abundance (four generations / year). During the 1st year, 2020 the outbreaks of the pest were occurred in April 8th, July 8th, the third one appeared in September 15th and the fourth was recorded in November 15th. In the 2nd year, 2021 the total number of *A. aurantii* scales also showed four peaks of abundance recorded in April 22nd, July 1st, September 1st and November 1st. The results also clearly shown that the insect prefer the upper leaf surface, the eastern direction and the middle strata than the other direction and strata of the sweet orange trees. During the 1st season, 2020, the parasitism rates with *Aphytis* sp ranged from 4.62% (on mid-January) to 19% (on mid-June). During the 2nd year 2021, the parasitism rates ranged between 6.36% (on January 1st, 2021) and 25.71% (on June 8th, 2021). The tested insecticides can be arranged according to their effect on *A. aurantii* as follows, Sulfoxaflor, Pyriproxyfen, Azadirachtin, Acetamiprid and Kz oil, respectively when the crawlers was the target and Kz oil, Sulfoxaflor, Azadirachtin, Pyriproxyfen and Acetamiprid when the adults were the target.

Keywords: *Aonidiella aurantii*, *Aphytis* sp, cardinal direction, Kz oil, Sulfoxaflor, Azadirachtin, Pyriproxyfen, Acetamiprid

INTRODUCTION

The scale insects (Hemiptera: Coccomorpha: Coccoidea) are one of the most important insect group in agricultural crops. The Coccoidea is divided into two major groups, the neococcoids and the archaeococcoids. The three largest families of neococcoids are the Pseudococcidae (mealybugs), Coccidae (soft scales), Diaspididae (armored scales). Family Diaspididae encompassing a number of important scale insects (2650 species in 400 genera) (Alford, 2002, 2007 and García *et al*., 2016) occur on a wide variety of host plants includes more than 1380 plant genera in 182 plant families (Miller and Davidson, 2005). The California red scale, *Aonidiella aurantii* (Maskell) (one of the species of family Diaspididae) is a highly polyphagus insect pest with a high preference for citrus species (Sorribas *et al*., 2010; El-Otmani, *et al*., 2011; Tena, and Garcia-Marí, 2011; Mohammed, 2020). *A. aurantii* attacks all the above-ground parts of the tree including fruits, leaves, branches and twigs and sucking the sap of the plant tissue with their long, piercing-sucking mouthparts causing significant production losses (Beardsley Jr and Gonzalez 1975). Branches and twigs substrate are less preferred for the California red scale while the fruit is the preferred plant part, followed by leaves (Hare, *et al*., 1990). *A. aurantii* infests foliage and fruits and is of serious concern to citrus production. Its feeding on leaves may cause them to yellow and the heavy infestations can cause stems and branches to dieback. The presence of the scales on fruit (particularly if infestations occur when fruit are developing) may cause them to be blemished or distorted considerably reduces their market value (Flint *et al.*, 1991; Vacas, 2010). The survey studies are very vital for update and population dynamics data documentation (Jendoubi, 2018**)**. Keeping in view the above mentioned information, it is necessary to test several insecticides with different mode of action against red scale insects because of its rapid ability to develop resistance. Therefore the aim of the present work was to estimate the population dynamic, numbers of generation, infestations percentages, horizontal and vertical distribution, parasitism rates and effect of of the main climatic factors on the population density of *A. aurantii*, as well as for well understanding and establishing IPM strategies against this pest. Also, the current experiments aimed to study the efficiency of five insecticides (Pyriproxyphen 10% EC, Acetamiprid 20% SP; sulfoxaflor 24%, SC, Azadirachtin 0.03% EC and Kz oil 95% EC) against *A. aurantii* in different dates according to the life stage composition.

MATERIALS AND METHODS

The present study was planned to determine the changes in the relative abundance of *A. aurantii* population. The experiments were carried out between the beginning of January 2020 and the end of December 2021 at a sweet orange private farm in Nubaria district, Beheira Governorate, Egypt. Samples of seventy five leaves of 5 sweet orange trees were weekly picked throughout the two years. The selected trees were in the same age (twelve years old), size, height and vegetative growth. The leave samples were kept in 15 labeled poly ethylene bags; each bag represents a particular direction or a specific layer of the experimental trees. Each bag contains five leaves. The samples transferred to the laboratory and carefully inspected using a stereomicroscope. Among each inspection, the individuals of *A. aurantii* in the sample leaves (on upper and lower surfaces) were divided into pre-adult (immature) and adult stages. All the different stages of *A. aurantii* were precisely counted and recorded. The infestation percentage of leaves also was recorded by dividing number of infested leaves by the total number of leaves in each investigation date. The weekly counts of the total population of were accumulated along the whole year, arranged and illustrated graphically on semigassian paper (scale gausses) to estimate the number and duration of generations of *A. aurantii* (Audemard and Milaire, 1975 and Iacob, 1977).

Population dynamic and rate of parasitism of *A. aurantii* parasitoids:

This work was planned to study the parasitism rates and population dynamic of the parasite *Aphytis* sp during two successive years (beginning of January 2020 and the end of December 2021). Weekly specimens of 8 sweet orange leaves infested with *A. aurantii* were collected from sweet orange trees and transferred to the laboratory. The leave samples put in 4 glass jars after removing all the other scale insects except *A. aurantii*. The jars were 15 cm diameter and 25 cm height and covered with muslin held by a rubber band and kept under laboratory conditions for securing any emerging parasitoids. Numbers of emerging parasites were daily recorded and the rate of parasitism was calculated by dividing the number of emerging parasitoid by the number of existing scales.

Efficiency of different insecticides in two different dates on the California red scale

Five insecticides were evaluated against *A. aurantii* populations on sweet orange trees in two different spraying dates. In each spraying date, twenty four trees (plots) in the same age, size, height and vegetative growth were used. Every 4 trees (plots) were considered for each applied treatment in addition to the 4 trees for control plots. Application of the five treatments was in March 1st and April 8th in the two years. Five leaves from each trees were examined and the number of alive individuals of *A. aurantii* were counted before treatment and after 1, 2, 4 and 6 weeks of the treatment. The spraying dates were determined based on the life stage composition. One of them was in the nymph abundance time and the other was in the time of adult abundance. The percentages of population reduction were calculated according the equation of Henderson and Tilton (1955) as following:

$$\% \text{ Reduction} = 100 \times 1 - \frac{Ta \times Cb}{Tb \times Ca}$$

Where:

Cb = mean of population density in control plots before application

Ta = mean of population density in treatment plots after application

Ca = mean of population density in control plots after application

Tb = mean of population density in treatment plots before application

The tested insecticides were

Mineral oil (Star oil) 95% EC provided by International Company for Chemical Industries (GINTRA Egypt), 15 Cm^3 L^{-1}

Pyriproxyphen (Admiral) 10% EC provided by Sumitomo Chemical Australia Pty Ltd, 0.5 ml/L^{-1}

Azadirachtin (Nimbecidine) 0.03% EC provided by T. Stanes and Company Limited, 5 Cm^3l^{-1}

Acetamiprid (Mospilan) 20% SP provided by Nippon Soda Ltd, 25 mg L^{-1}.

Sulfoxaflor (Closer) 24%, SC provided by DowAgro Sciences Co., Ltd, 0.5L^{-1}

Data analysis: Statistically significant mean values (P <0.05) were calculated as mean ± SD (standard deviation) using analysis of variance (ANOVA) and separated by least significant differences (LSD) test (SAS Statistical software, 1999).

RESULTS AND DISCUSSION

The population dynamic of California red scale, *A. aurantii*:

The results represented in Tables (1 & 2) show the weekly average numbers of different stages as well as the fluctuations in the total population of the California red scale insect, *A. aurantii* on sweet orange trees during the first (2020) and second (2021) years in Nubaria district, Beheira Governorate. During the course of this study, the total population of *A. aurantii* had four peaks of abundance in the first year. The first peak occurred in April 8th (24.04 individuals/ leaf), the second in July 8th (22.77 individuals/leaf), the third one appeared in September 15th (31.04) and the fourth was recorded in November 15th (35.31). In respect to the 2nd year, 2021 the total number of *A. aurantii* scales also showed four peaks of abundance recorded in April 22nd (25.2), July 1st (19.67), September 1st (40.43) and November 1st (47.09). Also, the results presented in Fig 1&2 illustrated that the California red scale had four overlapping generations. The 1st generation extended from the mid-Feb to May 22nd, the 2nd extended from Jun 1st to Jul 22nd, the 3rd extended from Aug 1st to Oct 8th and the 4th extended from mid-Oct to mod-Dec. In 2021, the 1st generation extended from mid-Feb to Jun 8th, the 2nd extended from mid-Jun to Aug 1st, the 3rd extended from Aug 8th to Oct 1st and the 4th extended from Oct 8th to Dec 22nd. The current results are in agreement with the results of Selim (2014) at Giza governorate, Egypt who found that the population of *A. aurantii* had three annual generations (peaks) on Balady orange and four generations (peaks) on Succari orange during the two successive seasons. In slightly different results Farghaly *et al* . in 2016 (in Middle Egypt) and Balboul and Helmy, 2019 (in Giza Governorate) recorded three overlapping generations per year for the California red scale during two years of study. On another hand the results of Nabil and Shahein in 2014 in Ismailia Governorate revealed that *A. aurantii* had only two to three annual generations on navel orange trees. Abd-Elghaffar *et al*. 2017 at Sharkia Governorate showed that the sweet orange appeared to be the most susceptible citrus tree hosts to infestation by *A. aurantia*

followed by navel orange and mandarin. They found that the population density of *A. aurantii* had three generation on the three citrus tree hosts during the two study years (2013 and 2014).

Table (1): The population dynamic and the infestation percentages of the California red scale, *A. aurantii* on sweet orange trees at Beheira Governorate during the 1st year, 2020

Investigation date	Preimmature	Adult females	Total population	Infestation percentages %	Accumulated weekly count	% of accumulated weekly count
01-Jan	6.07	1.07	7.13	20	7.13	0.916
08-Jan	5.75	1.79	7.53	25.33	14.67	1.88
15-Jan	6.73	1.83	8.56	28	23.23	2.98
22-Jan	4.73	2.33	7.07	34.67	30.29	3.89
01-Feb	3.75	2.63	6.37	33.33	36.67	4.71
08-Feb	4.51	3.2	7.71	29.33	44.37	5.7
15-Feb	4.79	2.76	7.55	28	51.92	6.67
22-Feb	7.73	3.28	11.01	32	62.93	8.08
01-Mar	9.23	2.78	12	44	74.93	9.62
08-Mar	11.24	3.03	14.27	38.67	89.2	11.45
15-Mar	11.03	3.8	14.83	38.67	104.03	13.35
22-Mar	14.53	3	17.53	42.67	121.56	15.61
01-Apr	16.49	2.28	18.77	40	140.33	18.02
08-Apr	22.27	1.77	24.04	48	164.37	21.1
15-Apr	17.01	1.8	18.81	44	183.19	23.52
22-Apr	10.76	3.01	13.77	48	196.96	25.28
01-May	9	2.77	11.77	38.67	208.73	26.8
08-May	8.03	2.52	10.55	26.67	219.28	28.15
15-May	5.27	2.27	7.53	22.67	226.81	29.12
22-May	4.7	1.49	6.23	20	233.04	29.92
01-Jun	4.28	1.8	6.08	20	239.12	30.7
08-Jun	5.52	3.95	9.47	22.67	248.59	31.91
15-Jun	9.52	2.76	12.28	26.67	260.87	33.49
22-Jun	9.27	3.01	12.28	25.33	273.15	35.07
01-Jul	11.27	3.27	14.53	28	287.68	36.93
08-Jul	19	3.77	22.77	33.33	310.45	39.85
15-Jul	12.51	3.28	15.79	34.67	326.24	41.88
22-Jul	11.47	2.77	14.24	42.67	340.48	43.71
01-Aug	12.55	3.27	15.81	41.33	356.29	45.74
08-Aug	12.01	3.79	15.8	44	372.09	47.77
15-Aug	13.03	3.87	16.89	52	388.99	49.94
22-Aug	13.8	5.33	19.13	56	408.12	52.39
01-Sep	14.52	6.33	20.85	60	428.97	55.07
08-Sep	20.49	5.03	25.52	66.67	454.49	58.35
15-Sep	27.77	3.27	31.04	65.33	485.53	62.33
22-Sep	22	2.29	24.29	52	509.83	65.45
01-Oct	20.28	2.27	22.55	53.33	532.37	68.34
08-Oct	16.81	2.77	19.59	58.67	551.96	70.86
15-Oct	16.28	3.01	19.29	62.67	571.25	73.34
22-Oct	15.27	3.96	19.23	65.33	590.48	75.8
01-Nov	16.85	4.03	20.88	61.33	611.36	78.48
08-Nov	21.49	4.79	26.28	62.67	637.64	81.86
15-Nov	31.77	3.53	35.31	66.67	672.95	86.39
22-Nov	22.21	4	26.21	62.67	699.16	89.76
01-Dec	22.76	2.77	25.53	64	724.69	93.03
08-Dec	17.83	2.35	20.17	61.33	744.87	95.62
15-Dec	15.28	2.95	18.23	53.33	763.09	97.96
22-Dec	12.36	3.51	15.87	52	778.96	100

Table (2): The population dynamic and the infestation percentages of the California red scale, *A. aurantii* on sweet orange trees at Beheira Governorate during the 2nd year, 2021

Investigation date	Preimmature	Adult females	Total population	Infestation percentages	Accumulated weekly count	% of accumulated weekly count
01-Jan	10.63	3.27	13.89	48	13.89	1.34
08-Jan	9.24	1.55	10.79	46.67	24.68	2.38
15-Jan	6.6	1.83	8.43	49.33	33.11	3.19
22-Jan	6.67	2.97	9.64	41.33	42.75	4.12
01-Feb	6.59	2.71	9.29	46.67	52.04	5.02
08-Feb	5.92	3.05	8.97	45.33	61.01	5.88
15-Feb	5.6	2.93	8.533	49.33	69.55	6.71
22-Feb	7.03	3	10.03	45.33	79.57	7.67
01-Mar	7.15	4.31	11.45	45.33	91.03	8.78
08-Mar	9.43	3.73	13.16	48	104.19	10.05
15-Mar	12.01	3.67	15.68	50.67	119.87	11.56
22-Mar	16.27	3.36	19.63	49.33	139.49	13.45
01-Apr	17.21	2	19.21	49.33	158.71	15.31
08-Apr	18.05	2.6	20.65	49.33	179.36	17.3
15-Apr	22.61	2.37	24.99	53.33	204.35	19.71
22-Apr	22.37	2.83	25.2	54.67	229.55	22.14
01-May	18.39	2.69	21.08	53.33	250.63	24.17
08-May	13.93	2.59	16.52	50.67	267.15	25.77
15-May	12.37	3.76	16.13	52	283.28	27.32
22-May	10.35	4.56	14.91	57.33	298.19	28.76
01-Jun	8.69	3.31	12	56	310.19	29.92
08-Jun	5.92	2.61	8.53	53.33	318.72	30.74
15-Jun	8.55	2.72	11.27	56	329.99	31.83
22-Jun	10.36	3.24	13.6	58.67	343.59	33.14
01-Jul	15.69	3.97	19.67	61.33	363.25	35.04
08-Jul	13.41	3.35	16.76	54.67	380.01	36.65
15-Jul	12.17	3.43	15.6	58.67	395.61	38.16
22-Jul	10	3.69	13.69	60	409.31	39.48
01-Aug	10.65	3.65	14.31	56	423.61	40.86
08-Aug	9.6	3.97	13.57	54.67	437.19	42.17
15-Aug	13.99	4.16	18.15	53.33	455.33	43.92
22-Aug	27.89	7.08	34.97	64	490.31	47.29
01-Sep	34.16	6.27	40.43	76	530.73	51.19
08-Sep	34	5.89	39.89	65.33	570.63	55.04
15-Sep	27.19	3.63	30.81	69.33	601.44	58.01
22-Sep	24.4	3.27	27.67	70.67	629.11	60.68
01-Oct	24.07	2.95	27.01	66.67	656.12	63.28
08-Oct	23.89	4.17	28.07	69.33	684.19	65.99
15-Oct	26.25	4.76	31.01	73.33	715.2	68.98
22-Oct	36.72	5.59	42.31	77.33	757.51	73.06
01-Nov	41.16	5.93	47.09	78.67	804.6	77.6
08-Nov	32.89	6.36	39.25	74.67	843.85	81.39
15-Nov	32.69	7.23	39.92	70.67	883.77	85.24
22-Nov	29	5.69	34.69	66.67	918.47	88.58
01-Dec	29.57	4	33.57	68	952.04	91.82
08-Dec	26.12	4.59	30.71	70.67	982.75	94.78
15-Dec	25.88	3.69	29.57	69.33	1012.32	97.64
22-Dec	20.4	4.01	24.51	66. 67	1036.83	100

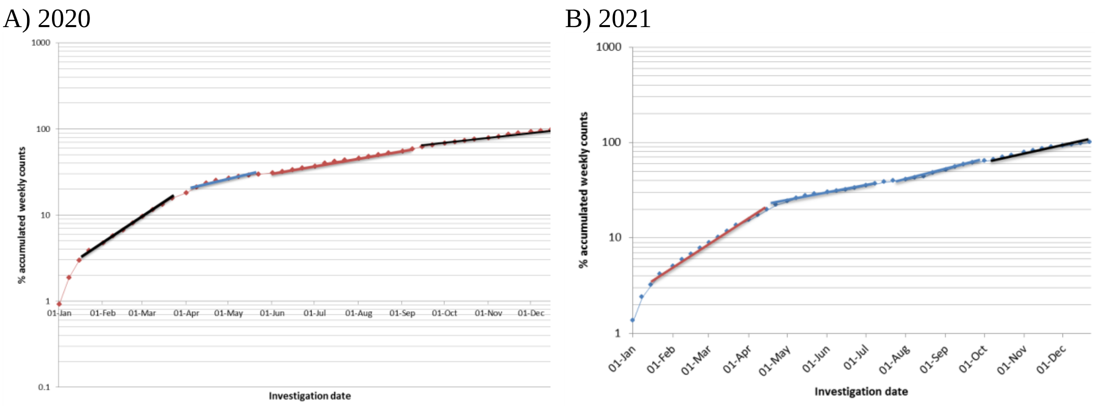


Fig. 1. The number of generation and generation duration of the California red scale, *A. aurantii* on sweet orange trees at Beheira Governorate during 2020 and 2021 years:

The horizontal and vertical distribution of *A. aurantii*:

Concerning the horizontal distribution of the California red scale, the results of analysis of variance showed that there were significant differences between the different cardinal directions of the sweet orange trees during the two years of study. As shown in Figs. 3&4, the seasonal average of *A. aurantii* population was higher for the eastern direction (21.73±9.33 and 26.8± 13.23 individuals per leaf), followed by southern direction (14.71± 6.41 and 19.72± 10.14 individuals per leaf). In contrast, the leaves in the tree core were the least infested leaves with *A. aurantii* (13.17 ± 5.79 and 15.33 ± 9.38 individuals per leaf). The leaves in west (14.72± 6.41 and 19.72± 10.14) and north directions (14.35±6.36 and 21.22±10.82) were moderately infested with the insect. On the other hand, the results of analysis of variance clearly indicated that there were significant differences in the population means of the California red scale among the three strata of sweet orange tree for each season. The leaves in middle stratum was the most preferred by the California red scale, *A. aurantii* with a general average of 22.58 ±10.76 and 27.51 ± 13.81 individuals per leaf per year during the 1st and 2nd years, respectively, followed by the leaves in top stratum (17.07 ± 7.13 and 20.59 ±10.65 individuals / leaf / year), while the leaves in bottom stratum was the least infested by the insect with a general mean of 9.04 ± 3.43 and 16.7 ±8.18 of scale per leaf, during the two tested years 2020 and 2021, respectively.

We may therefore conclude that *A. aurantii* prefer to concentrate on the eastsouthern side and the middle stratum of the sweet orange tree. The results of the horizontal and vertical distribution of the California red scale insect must be taken into consideration when planning for the integrated pest management programs particularly the chemical control for this insect. The present results were agreement with the results of Darwish, 2016 who found that the black parlatoria, *Parlatoria ziziphi* prefer to the existing leaves on the southern and eastern branches of mandarin tree. Nabil and Shahein, 2014 found that the population of *A. aurantii* on navel orange trees were occurred in north western direction in the 1st season (2011-2012), while during the 2nd season (2012-2013) the population was concentrated in the north eastern side of the trees.

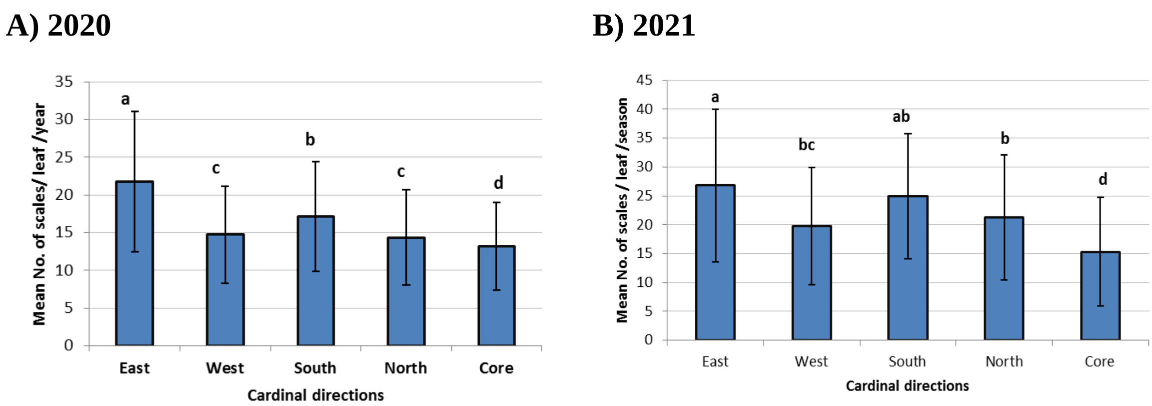
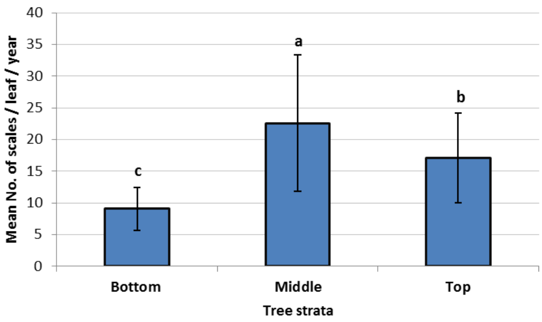


Fig.2 General means of the insdividuals of the California red scale, *A. aurantii* on the cardinal direction of the sweet orange trees throughout 2020 and 2021 years

Means followed by the same letter(s) are not significantly different (p≤0.05)



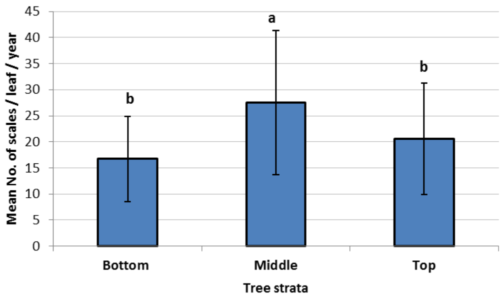


Fig. 3. General means of the insdividuals of the California red scale, *A. aurantii* on the different strata at the sweet orange trees throughout 2020 and 2021 years
Means followed by the same letter(s) are not significantly different (p≤0.05)

Regarding preferable leaf surface of *A. aurantii*, data illustrated in Fig. (-) indicated that in the first and second years of the study, the total population of *A. aurantii* was higher on the upper leaf surface than the lower one with values of 9.701 individuals on the upper surface and 6.53 individuals on the lower surface during the 1st season, 2020 and 14.59 individuals on the upper leaf surface and 7.01 on the lower surface in the 2nd season, 2021. The current results also are in agreement with the results of Darwish, 2020 who found that the scale insect, Lepidosaphes beckii prefer the upper surface of Valencia orange leaves than the lower surface.

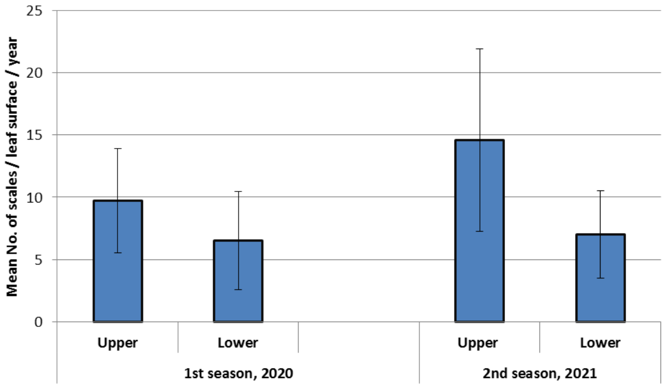


Fig. 4. General means of the insdividuals of the California red scale, *A. aurantii* per a sweet orange leaf throughout 2020 and 2021 years on upper and lower leaf surfaces. Means followed by the same letter(s) are not significantly different (p≤0.05)

The higher infestation percentages of sweet orange leaves with *A. aurantii* were 48, 33.33, 65.33 and 66.67 % in April 8th, July 8th, September 15th and November 15th, respectively during the 1st season in synchronized with the account peaks of the population dynamic. These percentages reach 54.67, 61.33, 76 and 78.67 in April 22nd, July 1st, September 1st and November 1st, respectively in the 2nd year, 2021.

Parasitization rates

During the 1st season, 2020, the parasitization level ranged from 4.62% (on mid-January) to 19% (on mid-June) (Fig. 4). During the 2nd year 2021 (Fig. 5), the parasitization rates ranged between 6.36% (on January 1st, 2021) and 25.71% (on June 8th, 2021). As a general the percentage of parasitism reached its maximum level during the third generation of the California red scale (at the summer generation of the insect). During the first year of study 2020, the activity of parasitism had five peaks five representing overlapping generations per year. In the second year, 2021 (as illustrated in Fig. 5), six peaks had been observed. At probability level 0.05 the simple correlation values were positive and highly significant in the two years of study. The correlation coefficient values were 0.674** and 0.805** for 2020 and 2021 years, respectively.

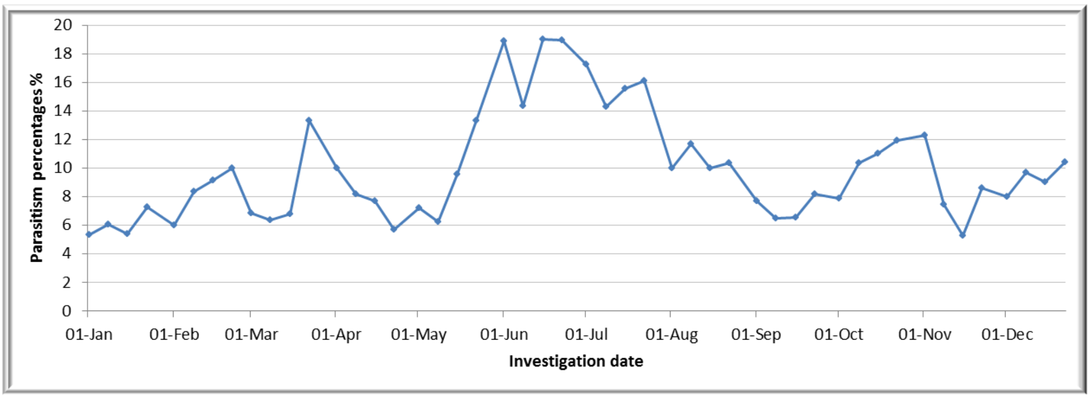


Fig. 5. Parasitism percentages of *Aonidiella aurantii* parasitoid (*Aphytis* sp) on sweet orange trees during the 1st year, 2020

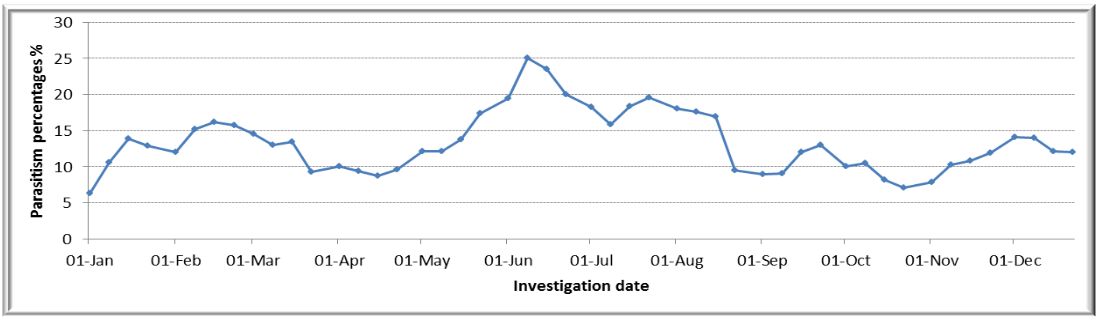


Fig. 6. Parasitism percentages of *Aonidiella aurantii* parasitoid (*Aphytis* sp) on sweet orange trees during the 2nd year, 2021

The efficiency of five insecticides against *A. aurantii*

The 1st date, when the crawlers were the target: As shown in Table (3 a&b), among the tested insecticides, the insecticide Sulfoxaflor was the most effective insecticide with a general mean of reduction percentage of 88.63±13.02 followed by Pyriproxyfen, Azadirachtin, Acetamiprid and Kz oil with reduction percentages of 80.93±11.64, 72.33±17.21, 67.05±22.66 and 58.91±26.08, respectively in the 1st season, 2020. During the 2nd season, 2021 these percentages recorded 84.41±13.74, 75.98±9.31, 69.42±11.42, 63.64±17.66 and 56.92±19.78 for Sulfoxaflor, Pyriproxyfen, Azadirachtin, Acetamiprid and Kz oil, respectively.

The 2nd date, when the adults were the target: Data presented in Tables (4 b) refer to the insecticide Sulfoxaflor was the most effective insecticide with a reduction percentage of 84.41±13.74 followed by Kz oil (80.12±9.41), Azadirachtin (73.33±11.37), Pyriproxyfen (71.57±8.08) and Acetamiprid (66.98±13.93). During the 2nd season 2021, these results were repeated with a slightly different whereas the Kz oil was the most effective insecticide followed by Sulfoxaflor, Azadirachtin, Pyriproxyfen and Acetamiprid with reduction percentages of 79.48±8.78, 78.8±7.37, 73.02±9.3, 71.53±5.43 and 67.96±13.23.

Finally, it could be concluded that the most effective insecticide for controlling the California scale insect, *A. aurantii* depend on the time of the control. In the times when the crawlers are prevalent and abundant, use of the insecticide Sulfoxaflor is preferred while the insecticide Kz oil is preferred when the adult is prevalent. Rezk, et al., 2021 tested pyriproxyphen, imidacloprid, spirotetramat, sulfoxaflor and a mineral oil **against** *A. aurantii* on navel orange trees. They found that among the tested insecticides, Kz oil was the most effective in reducing the treated population.

Table. 3. Efficiency of five insecticides in control of California red scale, *A. aurantii* population at 1, 2, 4 and 6 weeks after treatment during 2020 season under field conditions: (mean number of scales/leaf and % reduction between brackets)

A) The 1st date, when the crawlers were the target:

Insecticides	Pre-spray	Weeks post treatment				General means
		One week	Two weeks	Four weeks	Sex weeks	
Control	107.2±10.85	94.4±7.5	89.6±7.37	83.2±10.33	64±9.62	
Pyriproxyfen	115.6±12.3	21.4±9.29 (78.77±10.04)	6.8±5.45 (92.72±6.56)	15.6±6.27 (81.67±9.49)	19.8±5.76 (70.57±9.76)	(80.93±11.64)^{ab}
Sulfoxaflor	118.6±13.37	4.6±4.28 (95.77±3.84)	2.2±2.68 (97.95±2.45)	13.4±8.85 (85.2±9.54)	15.8±7.98 (75.58±17.13)	(88.63±13.02)^{a}
Acetamiprid	116.2±11.2	15.2±5.89 (85.38±4.71)	13.4±5.59 (86.09±5.98)	33.4±5.73 (62.18±9.43)	45.±5.83 (34.56±8.35)	(67.05±22.66)^{cd}
Kz oil	108.2±11.77	22.2±7.33 (75.98±10.38)	19.6±7.02 (78.61±6.63)	32.4±11.7 (59.22±21)	50.6±10.29 (21.82±8.34)	(58.91±26.08)^{d}
Azadirachtin	107±8.34	12.8±5.36 (86.72±4.41)	15.6±2.7 (82.39±3.91)	23±5.34 (71.52±10.17)	32±5.43 (48.68±13.54)	(72.33±17.21)^{bc}
F values		5.620	10.570	4.049	18.563	7.520
L.S.D.		9.602	7.08125	16.8375	15.73215	11.89465

B) The 2nd date, when the adults were the target:

Insecticides	Pre-spray	Weeks post treatment				General means
		One week	Two weeks	Four weeks	Sex weeks	
Control	30.2±2.59	36±3.61	41±3.81	61.8±5.26	72.8±3.96	
Pyriproxyfen	29.8±2.77	11±1.41 (68.6±5.81)	8.2±2.59 (79.27±7.81)	15.6±3.43 (74.2±6.03)	25.8±4.21 (64.21±4.22)	(71.57±8.08)^{b}
Sulfoxaflor	27±4.06	4.2±2.05 (86.91±6.64)	3.6±1.14 (90.39±1.81)	12.4±4.51 (78.01±5.74)	19.4±6.07 (70.31±8.16)	(81.4±9.77)^{a}
Acetamiprid	30.2±3.56	8.6±2.41 (76.38±4.17)	9±2.55 (77.95±6.03)	19.8±3.49 (67.94±4.4)	39.6±5.18 (45.65±4.22)	(66.98±13.93)^{b}
Kz oil	32.4±3.29	7.6±4.04 (81.25±7.9)	4.8±1.3 (89.06±3.01)	12.4±4.83 (81.3±7.11)	24.2±4.32 (68.87±6.11)	(80.12±9.41)^{a}
Azadirachtin	28.2±3.9	4.2±1.3 (87.6±2.97)	9.6±1.52 (74.4±5.89)	16.6±3.21 (70.18±9.58)	26.4±4.39 (61.13±4.99)	(73.33±11.37)^{b}
F values		9.386	8.717	3.254	14.796	6.353
L.S.D.		7.61205	7.0914	8.96655	7.5645	6.7196

Table. 4. Efficiency of five insecticides in control of California red scale, *A. aurantii* population at 1, 2, 4 and 6 weeks after treatment during 2020 season under field conditions: (mean number of scales/leaf and % reduction between brackets)

A) The 1st date, when the crawlers were the target:

Insecticides	Pre-spray	Weeks post treatment				General means
		One week	Two weeks	Four weeks	Sex weeks	
Control	55.2±6.19	64.2±4.66	63.4±3.65	67.4±6.67	77±5.24	
Pyriproxyfen	56.2±4.97	17.6±4.16 (72.8±7.98)	7.8±2.59 (87.73±4.76)	17±2.92 (75.06±4.96)	24.4±1.67 (68.35±6.48)	(75.98±9.31)^{ab}
Sulfoxaflor	54±4.47	3.6±3.2 (94.29±3.54)	2.8±1.3 (95.5±2.16)	13.4±8.85 (79.28±14.86)	23.6±3.91 (68.59±6.14)	(84.41±13.74)^{a}
Acetamiprid	52.8±5.12	15.2±5.89 (75.74±8.24)	12.2±3.49 (80.12±4.48)	25.6±3.65 (59.72±8.45)	45.2±6.22 (38.97±4.46)	(63.64±17.66)^{cd}
Kz oil	53.2±4.66	18.2±3.56 (70.83±4.2)	17.8±5.67 (70.07±13.13)	26.6±6.19 (59.21±7.87)	53.6±3.36 (27.56±8.09)	(56.92±19.78)^{d}
Azadirachtin	55.2±5.4	12±2.74 (80.99±5.81)	15.2±2.28 (75.83±4.7)	22.6±4.39 (66.18±7.35)	35.2±5.4 (54.68±2.38)	(69.42±11.42)^{bc}
F values		11.306	10.310	4.709	48.198	10.266
L.S.D.		8.24715	9.17475	12.2734	7.7076	9.3508

B) The 2nd date, when the adults were the target:

Insecticides	Pre-spray	Weeks post treatment				General means
		One week	Two weeks	Four weeks	Sex weeks	
Control	141±8.4	123.8±4.92	104.4±5.94	74.8±6.06	58.25±7.5	
Pyriproxyfen	149.6±9.07	37.6±5.37 (71.43±3.59)	24.4±2.97 (77.88±3.35)	24.2±3.27 (69.48±3.53)	20.25±1.7 (67.33±5.06)	(71.53±5.43)[b]
Sulfoxaflor	154.2±4.97	23±2.92 (82.94±2.78)	15.8±3.42 (86.2±2.62)	19±2.12 (76.56±4.31)	19.75±4.92 (69.5±4.58)	(78.8±7.37)[a]
Acetamiprid	152.8±6.72	35.6±3.2 (73.4±3.15)	20.4±2.41 (81.88±2.77)	25.6±3.21 (68.52±1.71)	33±6.68 (48.06±5.96)	(67.96±13.23)[b]
Kz oil	152.6±10.88	27.6±4.04 (79.15±4.46)	15.6±3.05 (86.21±2.36)	12.4±2.3 (84.44±4.32)	18.75±3.3 (68.1±8.51)	(79.48±8.78)[a]
Azadirachtin	155±7.07	23±5.15 (83.06±3.89)	25.4±4.28 (77.74±4.47)	25±4 (69.45±5.38)	24±3.74 (61.82±4.54)	(73.02±9.3)[b]
F values		11.055	8.598	14.277	11.127	5.706
L.S.D.		4.77195	4.22395	5.3277	7.8072	5.7701

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الملخص العربي

تأثير بعض مبيدات الحشرات وتأثيراتها الجانبية في مكافحة الحشرة القشرية الحمراء *Aonidiella aurantii* (Maskell)

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الحشرة القشرية الحمراء (Maskell) *Aonidiella aurantii* **تعتبر واحدة من اهم الآفات الحشرية التي تصيب أشجار الموالح في مصر**. في هذ البحث تم اجراء تجارب حقلية لدراسة التغيرات العددية والتوزيع الافقي والرأسي وسطح الورقة المفضل لهذه الحشرة ومعدل التطفل وكذلك تأثير بعض المبيدات الحشرية علي الكثافة العددية للحشرة وذلك علي أشجار البرتقال السكري في منطقة النوبارية في محافظة البحيرة، جمهورية مصر العربية خلال عامي 2020 و 2021. أوضحت النتائج ان المجموع الكلي للحشرة سجل أربع قمم للتعداد وذلك خلال الثامن من ابريل، الثامن من يوليو، منتصف سبتمبر ومنتصف نوفمبر خلال عام الدراسة الاول 2020. اما خلال العام الثاني 2021 كانت هذه القمم في 22 ابريل، اول يوليو، اول سبتمبر والاول من نوفمبر. كذلك اوضحت النتائج أن الحشرة تفضل سطح الورقة العلوي عن السفلي والجانب الشرقي والطبقة الوسطي من شجرة البرتقال السكري عن باقي اتجاهات وطبقات الشجرة. تراوح معدل التطفل بالطفيل الحشري *Aphytis* sp من 4.62% (في منتصف يناير) الي 19% (منتصف يونيو). وفي العام التالي تراوحت نسب التطفل من 6.36% (اول يناير) الي 25.71% (الثامن من يونيو). عندما تم استهداف العمر الاول للحوريات (الزاحفات) يمكن ترتيب المبيدات الحشرية المختبرة حسب فعاليتها كما يلي: السلفوكسافلور ، البيريبروكسفين، الازدراكتين، الاسيتامبريد واخير زيت كفرالزيات. ومن ناحية أخري عندما تم استهداف الحشرات الكاملة فكان ترتيب المبيدات المختبره حسب فعاليتها كما يلي: زيت كفر الزيات، السلفوكسافلور، الازدراكتين، البيريبروكسفين و الاسيتامبريد.