J. Plant Prot. and Path., Mansoura Univ., Vol. 3 (8): 781 - 792, 2012

HOST PLANT – SCALE INSECT, *Parlatoria oleae* (COLVEE) INTERACTION

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ABSTRACT

The present study was carried out at the experimental farm, faculty of Agriculture, Mansoura University during two seasons (2010 and 2011) to evaluate the host plant (blood orange, limon and mandarin) - scale insect, *parlatoria. oleae* (Colvee) interactions.

The olive scale, *P. oleae* Population exhibited three peaks of abundance on blood orange and limon orchards, while, it showed two peaks only on mandarin orchard.

The more favourable host for *P.oleae* was blood orange followed by Limon then mandarin. However, *P. oleae* female showed the highest fecundity on blood orange trees and the lowest on mandarin trees. The average number of offspring for *p.oleae* female was 35.4 ± 4.8, 30.9 ± 5.6 and 18.7 ± 4.2 / female on blood orange, Limon and mandarin leaves, respectively.

Chemical analysis indicated that mandarin leaves had the highest percentage of total protein in comparison with limon and blood orange leaves. On the contrary, the pest exhibited the lowest reproductive rate and population density on mandarin leaves. So, volatile oils produced by the mandarin leaves may play a role in insect biology.

Statistical analysis indicated that there was a positive correlation between the changes of total protein contents and those of *P. oleae* population density in all tested host plants.

INTRODUCTION

Scale insects are very important pests of fruit trees and they suck the sap from the above ground plant parts thereby causing the injury Verma and Dinabandhoo.2005.

The olive parlatoria scale, *P. oleae* (Hemiptera: Diaspididae) is one of the most important scale insect pests (Asfoor 1997). *P.oleae* infests mainly deciduous hosts around the world and few evergreen (lemon, orange and oleander). This insect host range includes more than 200 host plants (Katsoyannos 1992).

Reproduction is connected with trophic relations (host plant). Signals produced by trophic basis induce different reproduction sequences. It is possible to use these relations to protect the crop by using lures (Abd El-Kareim, 1997). These lures are natural mimetic structures or chemical compounds. Such chemicals offer considerable potential as a tool for managing populations (Thyril and Klein, 1982).

Semi chemicals emitted from a diverse group of plants mediate key processes in the behavior of specific insects. Volatile phytochemicals can serve as airborne semi chemicals, promoting or deterring interactions

between plants and herbivore insects. (Quiroz *et al*., 1997). volatiles from host plants enhance the effect of contact stimulants, increasing landing rates and oviposition relative to non-host plants (Feeny *et al*., 1989).

Therefore, the present study aims to add some knowledge to the relation between the pest *P. oleae* and its host plants (blood orange, lemon and mandarin).

MATERIALS AND METHODS

1- Investigation of host plant-*P. oleae* interaction.
(Comstock) interaction:

1.1. Experimental orchard:

The experiments of the present study were carried out on blood orange, lemon and mandarin orchards located at the Experimental Ressearch station of the Faculty of Agriculture, Mansoura University at Mansoura district, Dakahlia governorate during the two seasons of 2010 and 2011.

2. Estimation of *P.olea*e population on host plant trees:

2.1. Sampling program:

Five trees (relatively homogenous in size and age) of each host plant were selected and marked for the present study.

To determine the seasonal abundance of the olive scale, *P. oleae*, samples were collected biweekly from blood orange, lemon and mandarin trees from the 4th of January 2010 until 14th of December 2011.

Five leaves were collected from the four cardinal directions (north, south, east and west) and the center core of each tree. The collected leaves were cut, kept inside polyethylene bags and transferred to the laboratory for investigation.

Scale instars were examined by aid of a stereoscopic- microscope of 40 - 100 times magnification force.

The number of *P. oleae* individuals was counted and recorded and the population density was estimated.

3. Investigation of host plant- *P. oleae* interaction :-

The total actual reproduction in the deferent host plant leaves was estimated three times (in March, July and October) by counting the number of progeny for 20 – 30 females / host plant, which were marked and encircled individually before using tangle- foot as sticky- ring traps.

Statistical analysis was carried out by using one way ANOVA.

To determine the relation between leave components and *P. oleae* population, percentages of protein and carbohydrates were estimated in each host plant leaves (blood orange, lemon and mandarin). This chemical analysis was done in the Horticultural Research Institute, Agricultural Research Center, Ministry of Agriculture during spring (March), summer (July), autumn (October) and winter (December) 2011.

RESULTS AND DISCUSSION

1. Seasonal activity of *P. oleae* in response to host plant species :

To follow up the changes in the population of *P. oleae,* biweekly samples of leaves were taken and the numbers of nymphal and adult stages were counted on the tested host plant (blood orange, limon and mandarin) leaves. Every sample consists of 25 leaves.

1.1. On blood orange trees :

In the first season, *P. oleae* population started on blood orange trees with relatively low number (71 individuals / sample) on the 4th of January and then the population increased gradually till it reached the first peak of abundance on the 15th of March (164 individuals) (Figure, 1.A). Thereafter, the pest population decreased till it reached 45 individuals at the 12th of April then increased again to reach the second peak of abundance on the 24th of May (111 individuals). Then, the population fluctuated during summer months (June, July and August) and increased again to reach the highest peak of abundance on the 14th of September 2010 (317 individuals/sample).

In the second season (2011), *P. oleae* population fluctuated during the season through three obvious peaks. These peaks had been recorded on the 2nd of March, 8th of June and 14th of September with a total number of 93, 147 and 218 individuals\ samples, respectively. (Figure, 1.B)

1.2. On limon trees:

Data shown in figure 1 (A and B) summarized the changes in the relative abundance of the diaspidid species, *P. oleae* on Lemon trees during 2010 and 2011 seasons.

As shown in figure 1 (A and B), the diaspidid species had three distinct peaks of seasonal abundance in both seasons (2010 and 2011). These peaks were recoded on the 12th of April, 19th of July and 25th of October 2010 with an average of 123, 142 and 146 individuals / sample respectively. In the second season, *P. oleae* population peak occurred on the 2nd of March (52 individuals), 8th of June (95 individuals) and 5th of October 2011 (115 individuals).

1.3. On mandarin trees:

As shown in figure (1) the obtained results indicated that *P. olea* population on mandarin trees was relatively low and fluctuated during the season through two obvious peaks. The first peak of abundance recorded on the 10th of May and 22nd of June with a total number of 88 and 75 individuals during 2010 and 2011seasons, respectively. The second peak occurred on the 11th of October (2010) and 5th of October (2011) with a total number of 109 and 84 individuals\ sample during the first and second seasons, respectively

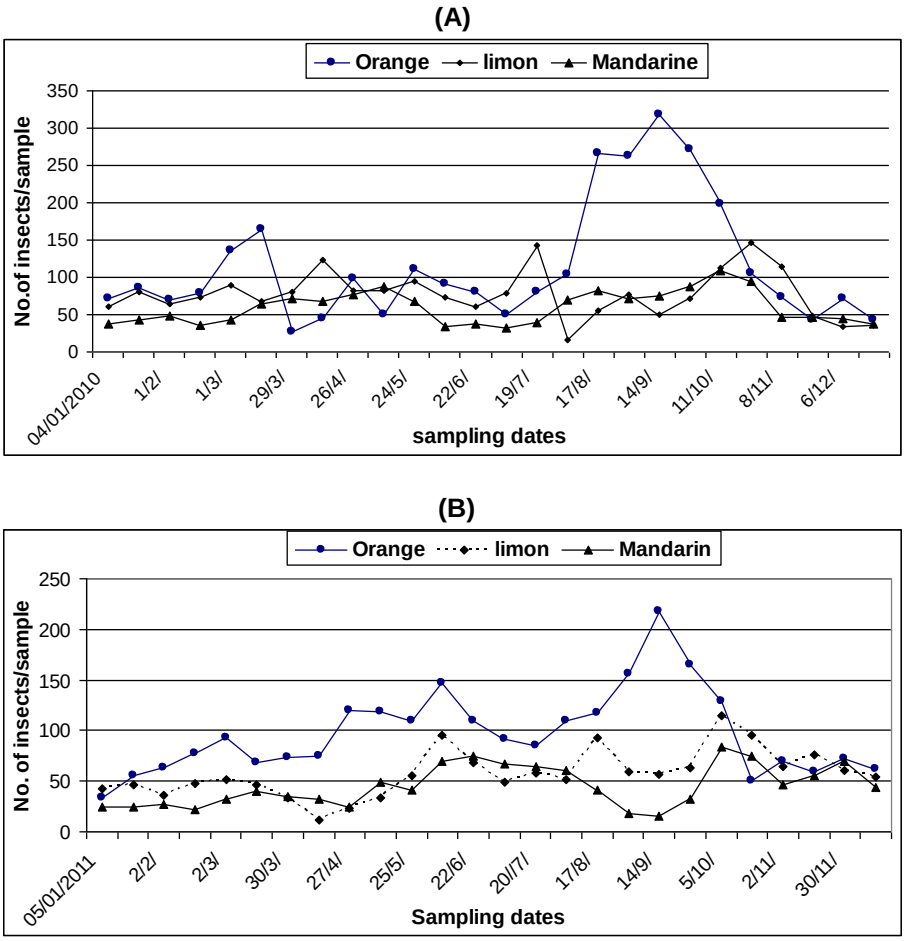


Figure 1: Seasonal abundance of *Parlatoria oleae* (Colvee) population in response to host plant species (blood orange, limon and mandarin) at Mansoura district during 2010 (A) and 2011(B) seasons.

2. Host plant preference to the scale insect, P*. oleae* population.

Data presented in Table 1 showed the population density of *P. oleae* as affected by host plant species during the seasons of the year (spring, summer, autumn and winter) on blood orange, limon and mandarin.

Data illustrated in Table (1) refer that blood orange leaves received the highest number of *P. oleae* throughout the whole period of investigation, while the lowest abundance occurred on mandarin leaves. Limon leaves were of intermediate rank for *P. oleae* population.

The obtained results indicated that the average number of *P.oleae* population ranged between 58.4 individuals (in the second season) and 168.16 individuals (in the first season) on blood orange reached the highest density in autumn (168.16) and summer (116.57 individuals/sample) during

2010 and 2011 seasons. The average number of insects\ sample was 114.96 ± 81.23 and 97.23 ± 41.79 in the first and second seasons, respectively.

The average population density of *P.oleae* on lemon varied between 36.71 and 90.5 individuals/sample and the highest number occurred in autumn in both years (90.5 and 75.85 individuals/sample, respectively). The average number of insects\ sample was 77.42 ± 13.31 and 57.19 ± 23.26 in the first and second seasons, respectively.

On mandarin trees, the average population density varied between 28.4 and 41 individuals/sample and the highest number occurred in autumn (76.5) and summer (56.42 individuals/sample) in the first and second seasons, respectively. Mandarin leaves were comparatively less preferred by *P. oleae* (the average number of insects was 59.69 ± 21.95 and 44.96 ± 20.13 in the first and second seasons, respectively.

Table (1): Average number of *P.olea*e population / sample (25 leaves) during spring, summer, autumn and winter seasons in 2010 (A) and 2011(B).

Season	Orange		Limon		Mandarin	
	A	B	A	B	A	B
Spring	89.85	94	88.28	36.71	68.57	36.28
Summer	133.28	116.57	71.85	67.57	52.42	56.42
Autumn	168.16	108.85	90.5	75.85	76.5	54
winter	69.66	58.4	58.16	45.2	41	28.4
Total mean	114.96 ± 81.23	97.23 ± 41.79	77.42 ± 13.31	57.19 ± 23.26	59.69 ± 21.95	44.96 ± 20.13

3. Seasonal abundance and reproductive rate of *Parlatoria oleae* population as affected by some chemical contents of tested host plant.

In the present work, the protein content as well as carbohydrates contents of leaves were evaluated as possible factors related to olive scale insect infestation.

P. oleae showed different degrees of preference for the different tested host plant species. As shown in Table (2), the obtained data showed that blood orange harboured the highest population of *P. oleae*, followed by lemon and mandarin. On the contrary, the average total protein content was 4.46, 7.24 and 5.89 % in blood orange, limon and mandarin, respectively, while, the average percentages of total carbohydrates was 15.08 ± 2.08, 17.877 ± 3.28 and 20. 825 ± 4.36 in the three host plants, respectively.

Table, 2: General means of *P.oleae* population and reproductive rate in response to total Protein and Carbohydrate contents in blood orange, Limon and mandarin leaves during season 2011 .

Host plant	Av.no.of *P.oleae* population	Av.no.of offspring/ female	Av. Protein%	Av. Carbohydrates%
Orange	97.23± 41.65	35.4	4.46 ± 0.96	15.08 ± 2.08
Limon	57.19 ±23.26	30.9	7.24 ± 1.70	17.88 ± 3.28
Mandarin	44.96± 20.13	16.7	5.89 ± 0.90	20. 83 ± 4.36

The obtained results are presented in Table2. revealed that the tendency of egg production was significantly higher on blood orange and Limon. Regarding the whole period, the reproductive rate of *P. oleae* females was significantly low on mandarin leaves.

Statistical analysis indicated that there was a significant and insignificant negative correlation between both population size and reproductive rate, and the total protein content. However, r,-values was - 0.69 and -0.25. Also, there was a significant negative correlation between both population size and reproductive rate, and the total percentages of carbohydrate (r-value was -0.86 and -0.96, respectively) .

It can be concluded that a kind of inverse relationship was found between the carbohydrate content of leaves and population density of *P. oleae*, as well as reproductive rate From Table (2), it appears that mandarin leaves have the highest carbohydrate content in comparison with lemon and blood orange. However, the lowest population density correlated with the highest carbohydrate content and the reverse was true.

Changes in the percentages of protein and carbohydrate of the tested host plant leaves were estimated on the different seasons (spring, summer, autumn and winter) of 2011.

Population fluctuation of P. oleae was estimated in response to the changes in the chemical contents of host plant leaves (blood orange, lemon and mandarin) during the growing seasons (spring, summer, autumn and winter). Results are summarized and illustrated in Table 2.

A correlation was observed between the chemical contents (a total protein and carbohydrates) of leaves and the calculated population densities of *P. oleae* . However, in summer and autumn seasons, leaves of the tested host plants had a higher value of protein than in spring and winter seasons. Differences in the total protein contents of the tested host plant leaves throughout the different seasons (spring, summer, autumn and winter) may explain the variations of population density during each season.

3-1) In response to protein content

In case of orange leaves (in the second season) the mean numbers of *P. oleae* population was 91.14, 116.57, 108.85 and 66.4 individuals/sample in spring, summer, autumn and winter corresponding with 3.52, 5.7, 4.7 and 3.9 % of protein content.

So, the lowest population of *P. oleae* which recorded in winter season (66.4 insects\ samples), coincides with the lowest percentage of total protein (3.9 %) (Fig.2)

In case of Limon leaves. The mean numbers of *P. oleae* was 36.71, 67.56, 75.85 and 58.5 insects/ sample coincided with 7.2, 8.52, 8.4and 4.84 % total protein during spring, summer and autumn seasons, respectively. It may be concluded that the highest *P. oleae* population was recorded in autumn season (75.85 1insects\ sample) coincided with the lowest percentage of total protein (8.4 %) (Fig.2)

In case of mandarin leaves, the mean numbers of *P. oleae* was 42.42, 64.28, 55.42 and 55.6 insects/ sample coincide with 55.77,7.2, 5.77 and 4.8 % total protein during spring, summer and autumn seasons, respectively. So, the lowest population of *P. oleae* was recorded in spring

season (42.42 insect\ sample) coincided with the lowest percentage of total protein (5.77 %) as shown in (Fig. 2).

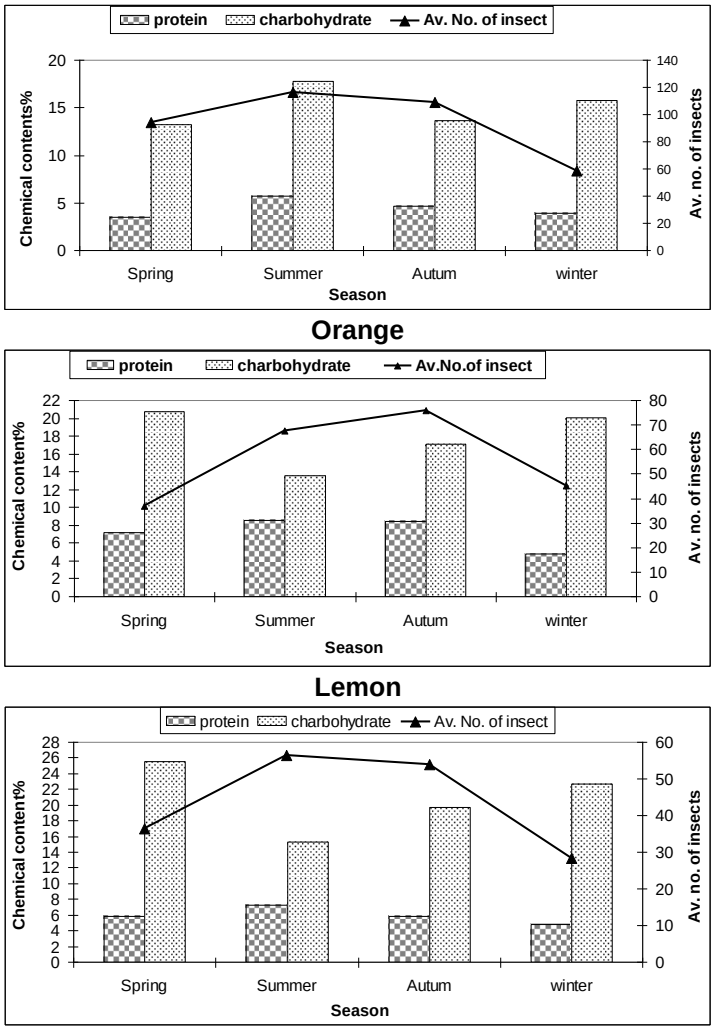


Figure (2). Average number of *P.oleae* / sample in spring, summer, autumn and winter in response to total protein and charpohydrate contents in orange, limon, and mandarin trees during seasons of 2011.

3-2) In response to carbohydrate content

Data illustrated in Figure (2) indicated that the differences between carbohydrate values in the three tested host plants were significant during 2011 season.

The mean number of *P. oleae* was 94, 116.57, 108.85 and 58.4 insects\ sample on blood orange leaves coincide with 13.18, 17.73, 13.7 and 15.73 % carbohydrate contents, respectively.

With respect to the mean number of *P. oleae* on limon leaves, it was 36.71, 67.57, 75.85 and 45.2 insects\ sample coincide with 20.78, 13.59, 17.07 and 20.07 % carbohydrate contents, respectively.

On mandarin leaves the mean number of *P. oleae* was 36.28, 56,42, 54 and 28.4 insect\ sample corresponding with 25.55, 15.35, 19.71 and 22.69 % carbohydrate contents, respectively.

3) The changes of population density of *P.olaea* in response to protein and carbohydrates in host plant leaves.

The obtained data as illustrated in Figure (3) obviously indicated that *P.oleae* population show positive and negative response to the increase of total protein and carbohydrate contents in the tested host plant leaves.

The regression analysis obviously indicated that *P. oleae* population significantly increased by increasing the total protein contents. On the contrary, it significantly decreased with the increase of total carbohydrate percentage in all tested host plants.

As shown in Figure (3A), *P.oleae* population on blood orange leaves had positive response to the increase of total protein contents (r = 0.68). On the contrary, the increase of *P. oleae* population was insignificantly correlated with the increase of total carbohydrate contents (r = 0.100).

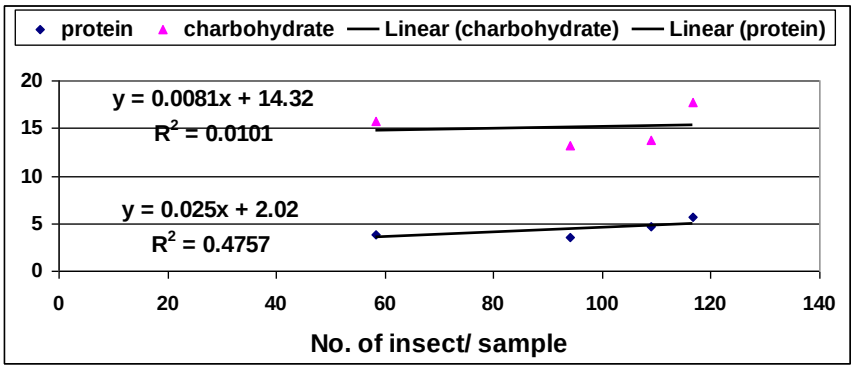
With respect to the relation between *P. oleae* population and chemical contents (protein and carbohydrates) in mandarin leaves, the obtained data indicated that *P.oleae* population exhibited positive and negative response to the increase of protein and carbohydrate percentages, respectively. The comesponding correlation coefficients values were 0.81 and 0.82. The same trend was observed in case of Limon (Fig.3). The relation between *P. oleae* populations and both protein and carbohydrate could be represented by the following sub models.

Protein:

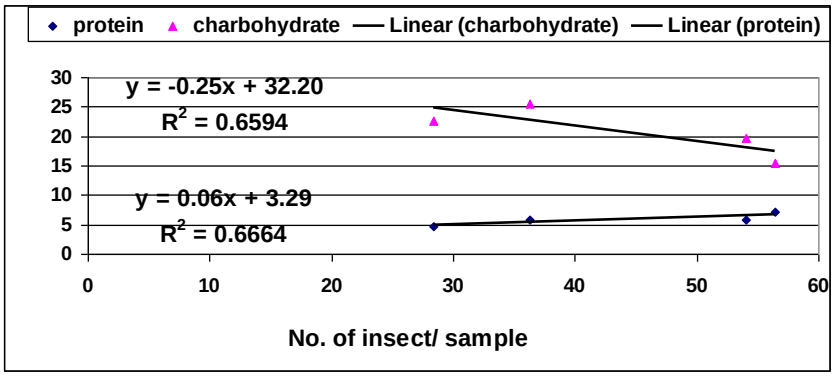
$y = 0.025x + 2.02$ on orange
$y = 0.064x + 3.66$ on limon
$y = 0.06x + 3.29$ on mandarin

Carbohydrate

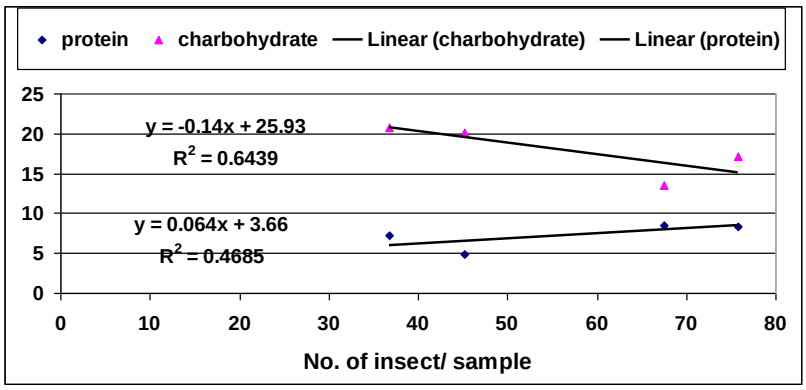
$y = 0.0081x + 14.32$ on orange
$y = -0.14x + 25.93$ on limon
$y = 0.06x + 3.29$ on mandarin



Orange



Limon



Mandarin

Figure (3): Relationship between chemical components (total carbohydrate and portion) of blood orange, limon and mandarin leaves and average number of *P.oleae*\ sample during season of 2011.

DISCUSSION

In the present investigation, *P. olea* population exhibited three peaks in orange and lemon orchards, while it showed two peaks only on mandarin trees. Also, Ezz (1997), reported three generations of *P. olea* annually during May, August and October on Plum, apricot and peach in Wadi – EL- Nattrun, Behira and Qalyobia . In North Delta, two peaks only were recorded on olive trees (Moursi and Mesbah ,1985).Also, Habib, A. (1971) mentioned that *P. oleae* had three annual generations on citrus and its highest population tended to settle on the shady zones of citrus trees.

P. oleae showed different degrees of preferability to blood orange, lemon and mandarin leaves. However, orange leaves proved to be the most preferred host for sheltering *P. oleae* in comparison with lemon and mandarin leaves. The highest abundance of *P. oleae* was recorded in blood orange orchards, while it exhibited the lowest infestation to mandarin

Chemical analysis indicated that mandarin and limon leaves have the highest protein content in comparison with blood orange in all seasons (spring, autumn, summer and winter). The obtained results also indicated that the more favourable substrates for *P.oleae* were blood orange followed by Limon and mandarin. However, the highest population correlated with the lowest protein content and the reverse was true. . According to Bernays and Chapman (1994), preferences for certain plant characteristics may modify insect behavior.

According to Abd El-Kareim (1997), olfactory stimulants produced by the host plant may play a role in host preferability by insect females

Ali (1988) stated that volatile oils of several host plants have one or more of the following effects: Deterrent effect, decreased insect maturity and molting rate and decreased reproduction rate of the insect pest. Also, Amer and Momen (2002) mentioned that essential oils of host plant may be decreased the food consumption rate as well as egg laying. In addition vapour of thirteen oils from host plants have a repellents action, reduce fecundity and adversely influence offspring emergence for some pests (Papachristos and Stamopoulos, 2002).

The quality of food eaten by insect immature stages will affect tracts such as gamete production and fat reserves. So, it resulted in low population of *P.oleae* as well as generation number on mandarin.

The obtained data revealed that olfactory cuses of mandarin leaves acted as a repellent effect for *P. olea* crawlers compared with the lemon and blood orange. However, significant reduction of *P. oleae* population density was estimated on mandarin trees.

The biology of the insects is strongly influenced by the host tissue content. The realized total fecundity depended on the settling substrate (Carroll and luck, 1984). The more favourable substrate had comparatively faster maturation, higher percentage of juvenile survivorship and greater reproductive rates for *Aonidiella aurantii* (Caroll and Luck, 1984).

Youssef, A. A. (2006) showed that concentration of total carbohydrate in more susceptible plant variety was lower than in least susceptible variety. Also, in the present study there was a negative correlation between the concentration of total carbohydrate and the population density of *P. oleae*

The complete system of host plant selection involves a three-link chain of events in which the first link is governed by ceus from volatile plant chemicals, the central link by visual stimuli, and the final link by cues from non-volatile plant chemicals (Finch and Collier, 2000).

Dicke and van Loor (2000) demonstrated that volatile blends released by plants can be specific for some plant-pest interactions, plant tissue and pest species.

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العلاقة بين العائل النباتي وحشرة البرقوق القشرية (*parlatoria oleae* (Colvee) .

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أجريت الدراسة الحالية في مزرعة كلية الزراعة جامعة المنصورة لعامين متتالين (2010/ 2011) بهدف تقييم العوائل النباتية (البرتقال بدمة – الليمون البلدى – اليوسفي) على حشرة البرقوق القشرية parlatoria oleae (Colvee).

أظهرت حشرة البرقوق القشرية *P. oleae* ثلاث ذروات على البرتقال بدمه و الليمون البلدي بينما سجل ذروتين فقط على نبات اليوسفي.

خلال هذه الدراسة أظهرت حشرة البرقوق القشرية *P. oleae* أعلى نسبة تفضيل للبرتقال بدمه يليه الليمون البلدى ثم اليوسفى و كذلك أبدت الأناث أعلى خصوبة لها حيث سجلت 35.4 ± 4.8 ، 30.9 ± 5.6 و 18.7 ±4.2 بيضة / أنثى على البرتقال بدمه – الليمون ثم اليوسفى على التوالى.

أوضح التحليل الكيميائي أن اليوسفي يحتوى على أعلى نسبة بروتين كلى مقارنة بالليمون البلدى والبرتقال بدمة ، و على العكس من ذلك أبدت الآفة أقل صافى معدل للخصوبة و كثافة التعداد على اليوسفي لذا، هناك احتمال بأن الزيوت الطيارة المنتجة من أوراق اليوسفي تلعب دور في بيولوجى حشرة الزيتون القشرية.

أوضح التحليل الإحصائي وجود ارتباط معنوي موجب بين التغيرات فى نسبة البروتين الكلى و التغيرات فى تعداد حشرة البرقوق القشرية على كل العوائل النباتية المختبرة.وعلى العكس كان هناك ارتباط معنوى سالبا بين تعداد حشرة البرقوق والزيادة فى نسبة الكربوهيدرات.

قام بتحكيم البحث

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أ.د / ابراهيم ابراهيم مصباح	**كلية الزراعة – جامعة طنطا**