J. Plant Prot. and Path., Mansoura Univ., Vol. 3 (9): 967 - 977, 2012

HOST PLANT – SCALE INSECT, FLORIDA WAX SCALE *ceroplastes floridensis* (COMST) INTERACTION.

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ABSTRACT

The present study was carried out at the experimental farm of Faculty of Agriculture, Mansoura University during the two seasons; 2010 and 2011 to evaluate the of (blood orange, loquat and mango) to Florida wax scale, *Ceroplastes floridensis* (Comst). *C. floridensis* Population fluctuation exhibited three peaks of abundance in blood orange, Loquat and mango orchards. The more favourable host for *C. floridensis* was blood orange followed by loquat then mango. However, *C. floridensis* population showed the highest density on blood orange trees and the lowest on mango trees. The average population density of *C. floridensis* population was (4.53 ± 3.15, 1.36 ± 0.34 and 1.58± 0.36) and (3.28 ± 1.0, 1.44 ± 0.16 and 1.07 ± 0.10) on blood orange, Lquat and mango leaves, respectively. Chemical analysis indicated that loquat and mandarin leaves had the highest percentage of total protein in comparison with blood orange leaves. On the contrary, the pest exhibited the highest population density on Orange leaves. Statistical analysis indicated that there was a significant positive correlation between the changes of total protein contents and *C. floridensis* population density in all tested host plants. While, there was correlation with the carbohydrates percent.

INTRODUCTION

The family Coccidae is the third largest family of scale insects after the armored scale (Diaspididae) and mealy bugs (Pseudoccocidae) (Hamon and Wiliams, 1984). The citrus wax scale *Ceroplastes floridensis* attacks a large number of host plants especially *Citrus* spp. It's main damage is due to the copious production of honey dew, which serves as a substrate for various sooty mould fungi. Severe infestations of citrus may result in culling of the entire crop, reduction of subsequent yields and serious injury to the trees (Podoler *et al*. 1981).

Reproduction is connected with trophic relation (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 (Labeyrie,1976). These lures are natural mimetic structures or chemical compounds. Such chemicals offer considerable potential as a total for managing populations (Thyril and Klein, 1982).

In order to achieve a successful insect pest management control program in any area, it is important to get detailes information concerning the relationship between the pest and host plant species. Therefore, the present investigation aimed to study the following topics :-

- Seasonal activity of *C. floridensis* in response to host plant species.
- Host plant preference by the scale insect, *C. floridensis* population.
- Seasonal abundance of *C. floridensis* population as affected by chemical characters of tested host plants.

MATERIALS AND METHODS

1. Experimental orchard:

The present study was carried out in blood orange, loquat and mango orchards located at the Experimental Research Station of the Faculty of Agriculture, Mansoura University at Mansoura district, Dakahlia Governorate during two seasons ; 2010 and 2011.

2. Sampling of *C. floridensis* population on host plant trees:

Five trees (relatively similar in size and age) of each host plant were selected and market for the present study.To determine the seasonal abundance of the wax scale, *C. floridensis*, samples were biweekly collected from blood orange, loquat and mango orchards from the 4th of January 2010 until 14th of December 2011. Five leaves were collected from each of the four cardinal directions (north, south, east and west) and center core of each tree. The collected leaves were cut, kept inside polyethylene bags and transferred to the laboratory for investigation.

Scale instars were determined by aid of a stereoscopic- microscope of 40 - 100 times magnification force. The number of *C. floridensis* individuals was counted and recorded and the population density (number of insects per 100 cm^{2}of leaf area) was estimated as follows:

$$\text{The population density} = \frac{\text{No. of insects}}{\text{Leaf area (cm}^2\text{)}} \times 100$$

3. Host plant- *C. floridensis* interaction :-

To determine the relation between some chemical leaf components and *C. floridensis* 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 *C. floridensis* in response to host plant species :

To follow up the changes in the population of *C. floridensis,* biweekly samples of leaves were taken and the numbers of nymphal and adult stages were counted on the tested host plant (blood orange, Loquat and mango) leaves.

1.1. In orange orchard:

In the first season, *C. floridensis* population started on blood orange trees with relatively low number (1.88 individuals / 100 cm^2) on 4th of January and then the population increased gradually to reach the first peak of abundance on the 12th of April (4 individuals) (Figure, 1) . After that, the pest population decreased to reach 2.16 individuals on 10th of May, then increased again to reach the second peak of abundance on 6th of July (6.68 individuals). Then, the population fluctuated during summer months and reached the third peak of abundance on 11th of October 2010 (4 individuals).

In the second season (2011), *C. floridensis* population fluctuated during the season in three obvious peaks. These peaks were recorded on 13th of April, 6th July and 5th October with numbers of 3.48, 5.88 and 6.4 individuals/ 100 cm^2, respectively.

1.2. In Loquat orchard:

Data illustrated in Figure 1 (A and B) summarized the changes in the relative abundance of the coccid species, *C. floridensis* on Loquat trees during 2010 and 2011 seasons. The insect pest had three distinct peaks of seasonal abundance in both seasons (2010 and 2011). These peaks were recoded on 12th of April 19th of July and 11th of October 2010 with an average of 2.36, 1.6 and 1.72 individuals / 100 cm^2, respectively (in the first season). In the second season, *C. floridensis* population peak occurred on 30th of March (1.8 individuals), 6th of June (1.8 individuals) and 19th of October 2011 (1.88 individuals).

1.3.In mango orchard:

As shown in Figure (1), the obtained results indicated that *C. floridensis* population on mango trees was relatively higher and fluctuated during the season in three obvious peaks. The first peak of abundance was recorded on 26th of April and 13th of April with numbers of 2.18 and 2.58 individuals during 2010 and 2011seasons respectively. The second peak occurred on 3rd of August (2010) and 3rd of August (2011) with a total number of 1.38 and 1.1 individuals/ 100 cm^2 during the first and second seasons, respectively. The third peak occurred on 22nd of November (2010) and 16th of November (2011) with numbers of 2.06 and 1.5 individuals/ 100 cm^2 during the first and second seasons, respectively.

2.Host plant preference by the scale insect, *C. floridensis* population:

Data presented in Table 1 show the population density of *C. floridensis* as affected by host plant species during the successive seasons (spring, summer, autumn and winter) on blood orange, Loquat and mango. The blood orange leaves received the highest number of *C. floridensis* throughout the whole period of investigation, while the lowest abundance occurred on loquat leaves, while Mango leaves received of intermediate *C. floridensis* population.

Table (1): Average number of *ceroplastes floridensis* population / 25 leaves, during different season in 2010 (A) and 2011(B).

Season	Orange		Loquat		Mango	
	A	B	A	B	A	B
Spring	2.44	2.41	2.02	1.55	2.08	1.14
Summer	4.96	4.24	1.68	1.37	1.26	0.92
Autumn	0.81	4.04	1.60	1.58	1.56	1.12
winter	1.91	2.41	1.2	1.25	1.40	1.08
Total mean	4.53 ± 3.15	3.28±1.0	1.36±0.34	1.44±0.16	1.58±0.36	1.07±0.10

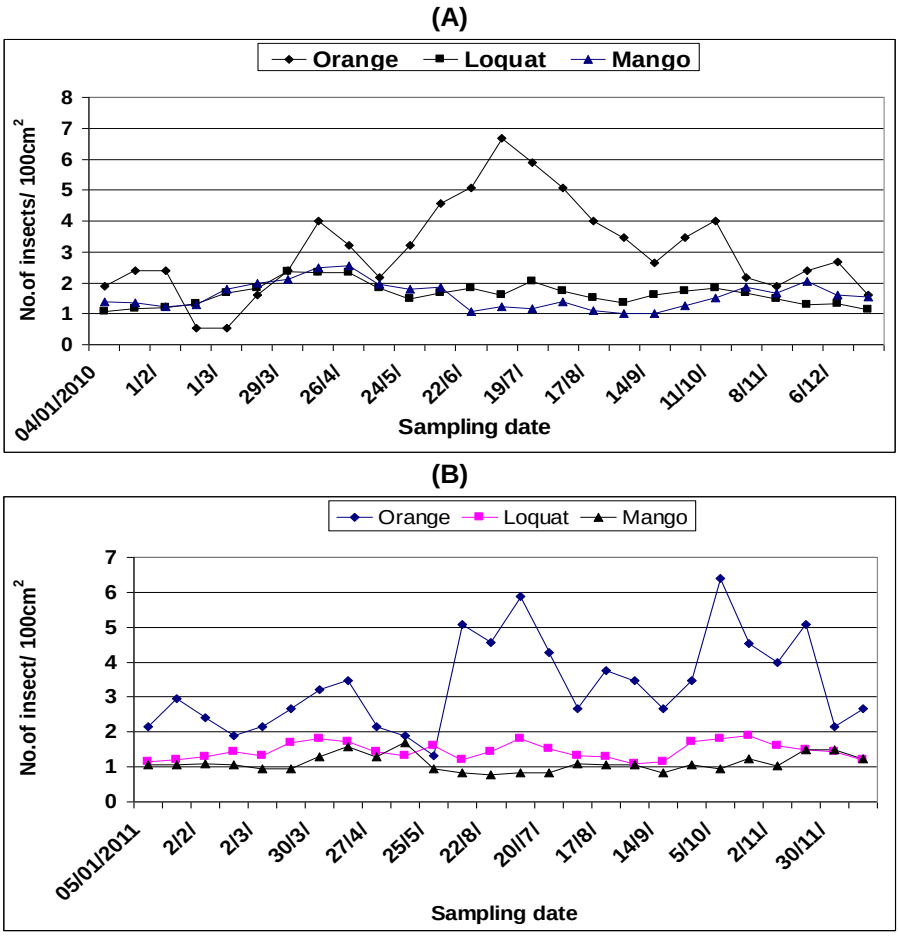


Figure 1: Seasonal abundance of *Ceroplastes floridensis* (Comst) population on different to host plants species (blood orange, Loquat and mango) at Mansoura district during 2010 (A) and 2011(B).

The obtained results indicated that the average number of *C. floridensis* population ranged between 2.41 individuals (in the second season) and 4.96/100cm^2 individuals (in the first season) on blood orange reached the highest density in summer season in both years (4.96 and 4.24 individuals/100cm^2). The average number of insects was 3.07± 1.52 and 3.34 ± 1.31 in the first and second seasons.

The average number of *C. floridensis* population ranged between 1.2 and 2.02 (in the first season) on loquat reaching the highest density in spring (2.02) and autumn (1.58 individuals/100cm^2) during 2010 and 2011 seasons, respectively . The average number of insects/ 100cm^2 was 1.36±0.34 and 1.44±0.16 /100cm^2 in the first and second season, respectively.

On mango trees, the average population density varied between 0.92 and 2.08 individuals/100cm^2 and the highest number occurred in spring

season in both years (2.08 and 1.14 individuals/100cm^2, respectively). The average numbers of insects were 1.58±0.36 and 1.07±0.10in the first and second seasons.

3. population density of *C. floridensis* population as affected by chemical characters of tested host plant:

In the present work, the protein content as well as carbohydrates contents of leaves were tested as possible factors related to Florida wax scale insect population.

C. floridensis showed variable degrees of preference for the different tested host plant species. As shown in Table (2), data indicated that orange harbored the highest population of *C. floridensis*, followed by mango and loquat. On the contrary, the average total protein content was 8.98, 7.9 and 4.46 in loquat, mango and orange. While, the average percentages of total carbohydrates was 18.56 ± 2.71, 18.52 ± 2.08 and 15.09 ± 2.06 respectively.

Table 2: General means of *C. floridensis* population and in response to total Protein and Carbohydrates in blood orange, Loquat and mango orchards during season 2011.

Host plant	Av.no.of *C. floridensis* population	Av. Protein%	Av. Carbohydrates%	R	
				Protein	Carbohydrates
Orange	3.34± 1.31	4.46 ± 0.96	15.08 ± 2.08	0.92	0.42
Loquat	1.44±0.16	8.98 ± 3.20	18.56 ± 2.71	0.78	0.53
Mango	1.07±0.10	7.9 ± 2.27	18.52 ± 3.85	0.81	0.41

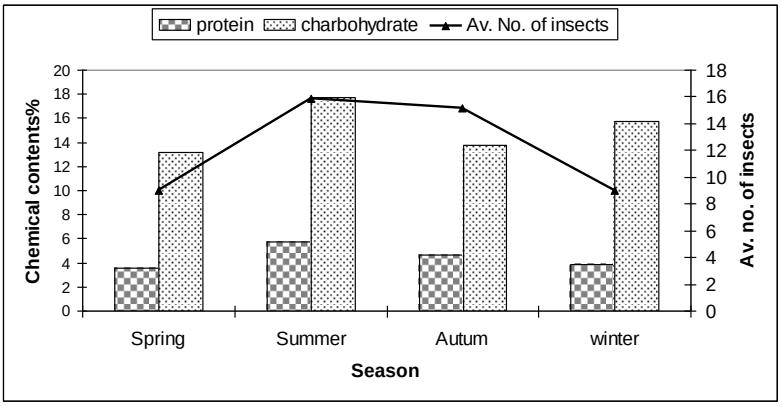
Changes in the percentages of protein and carbohydrate of the tested host plant leaves were estimated on the different seasons (spring, summer, autumn and winter) during 2011 seasons.

Population fluctuation of *C. floridensis* was estimated in response to the changes in the chemical characteristics of host plant leaves (blood orange, loquat and mango) during the growing seasons (spring, summer, autumn and winter) was summarized and illustrated in Fig. 2.

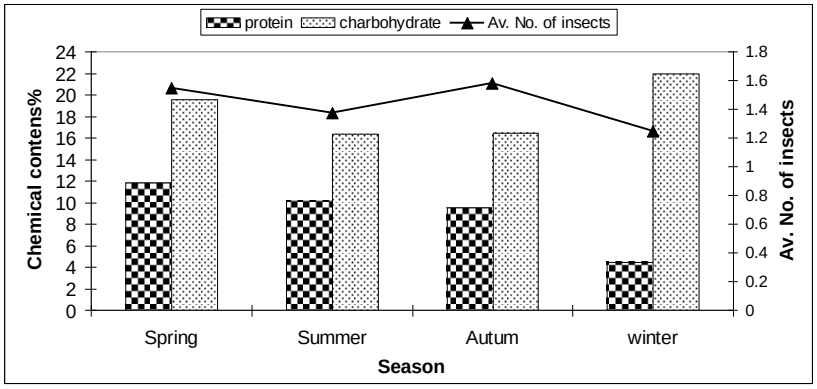
A correlation was observed between the chemical contents (a total protein and carbohydrates) of leaves and the calculated population densities of *C. floridensis*. However, in summer and autumn seasons, leaves of the tested host plants had a higher value of protein than in spring and winter seasons.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

3-1) In response to protein content

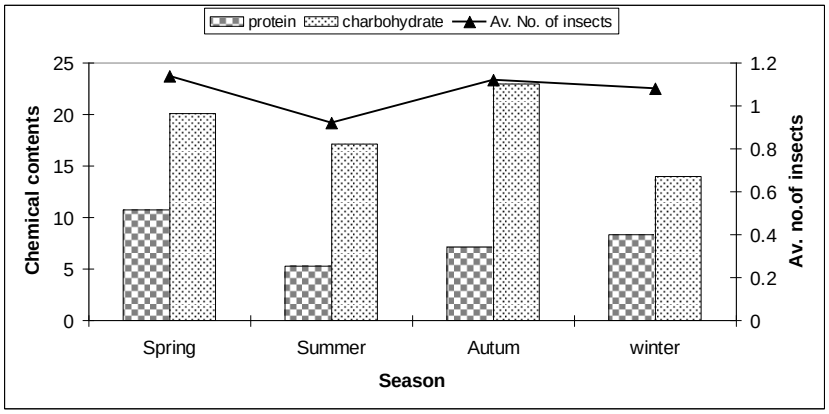
In case of orange leaves (in the second season) the mean numbers of *C. floridensis* population was 2.41, 4.24, 4.04 and 2.41 individual/100cm^2 in spring, summer, autumn and winter corresponding with 3.52, 5.7, 4.7 and 3.9 %.So, the lowest *C. floridensis* population was recorded in winter and spring season (2.41 and 2.41 insect/ 100cm^2) coincide with the lowest percentage of total protein (3.9 and 3.52%).



Orange



Loquat



Mango

Figure (2): Average number of *C. floridensis*/100Cm^2 in spring, summer, autumn and winter in response to total protein and carbohydrate contents on orange, loquat, and mango tress during 2011 seasons.

In case of Loquat leaves. The mean numbers of *C. floridensis* was 1.55, 1.37, 1.58 and 1.25 insects/ 100cm^2 coincide with 11.86, 10.16, 9.49 and 4.41% total protein during spring, summer and autumn seasons, respectively. It concluded that the highest *C. floridensis* population was recorded in spring season (1.55 1insect/ 100cm^2) coincide with the lowest percentage of total protein (10.16 %).

In case of mango leaves, the mean numbers of *C. floridensis* was 1.14, 0.92, 1.12 and 1.08 insects/ 100cm^2 with 10.75, 5.32, 7.17 and 8.36% total protein during spring, summer and autumn season, respectively. So, the lowest *C. floridensis* population was recorded in summer season (0.21 insect/100cm^2) coincide with the lowest percentage of total protein (5.32 %).

3-2) In response to carbohydrates content

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

The mean number of *C. floridensis* was 2.41, 4.24, 4.04 and 2.41 insect/ sample on blood orange leaves coincide with 13.18, 17.73, 13.75 and 15.73 % carbohydrates content.

With respect to the mean number of *C. floridensis* on loquat leaves, it was 1.55, 1.37, 1.58 and 1.25 insect/ 100cm^2 coincide with 19.53, 16.32, 16.45 and 21.97 % carbohydrates content.

While on mango leaves the mean number of *C. floridensis* was 1.14, 0.92, 1.12 and 1.08 insect/ 100cm^2 corresponding with 20.5, 17.13, 22.95 and 13.96 % carbohydrates content.

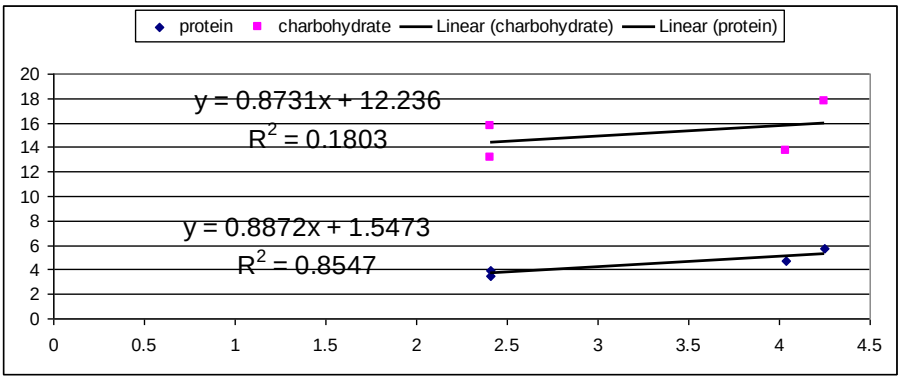
3) Evaluation the changes of population density of *C. floridensis* in response to protein and carbohydrates in host plant leave.

The obtained data as illustrated in Figure (3) obviously indicated that *C. floridensis* population show positive response to the increase of total protein and carbohydrate in the tested host plant leaves, except increase of total carbohydrate was negative response in loquat.

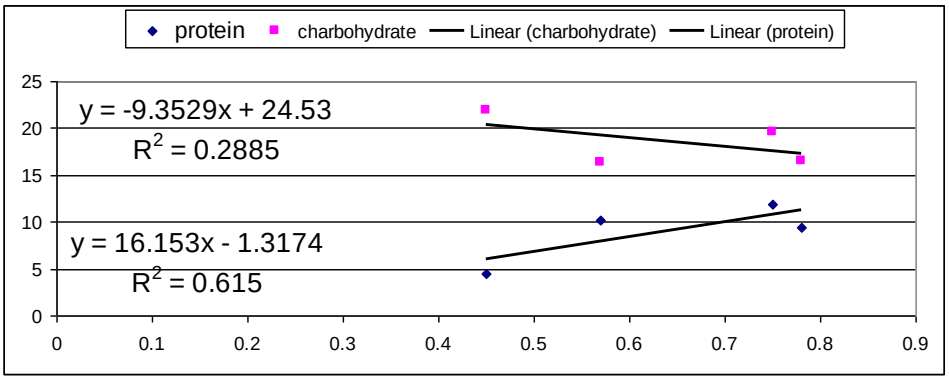
The regression analysis obviously indicated that *C. floridensis* population was significantly increase by increasing the total protein contents. While as *C. floridensis* population show negative and positive response to the increase of total carbohydrate in loquate and (orange & mango).

As shown in Figure (3), *C. floridensis* population on blood orange leaves had positive response to the increase of total protein contents (r = 0.42) and total carbohydrate contents (r = 0.92).

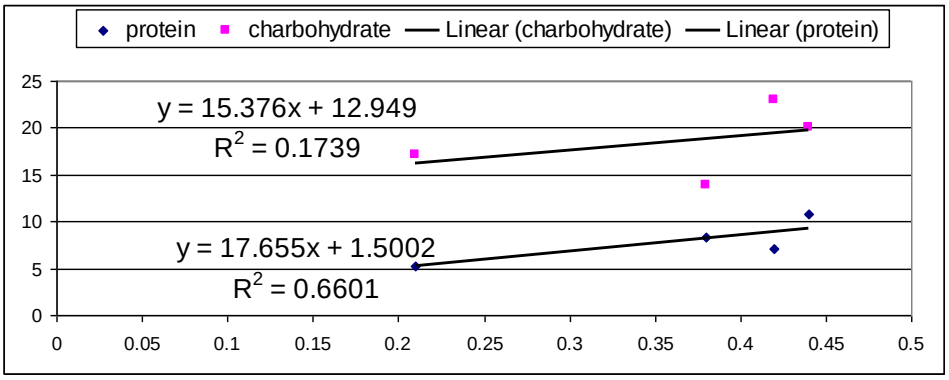
The obtained data indicated that *C. floridensis* population exhibited positive response to the increase of protein and carbohydrate percentages. The correlation coefficients values were 0.53 and 0.77.the relation between *C. floridensis* populations and both protein and carbohydrate could be represented by the following sub models. *C. floridensis* population on mango leaves had positive response to the increase of total protein and total carbohydrate contents (r = 0.42 &r = 0.79).



Orange



Loquat



Mango

Figure (3): Relationship between chemical components (total carbohydrate and portion) of blood orange, loquat and mango leaves and average number of *C. floridensis* l sample during 2011 season.

DISCUSSION

In the present investigation, *C. floridensis* population exhibited three peaks in orange and Loquat and mango orchards. Also, Helmy *et al* (1986), reported three generations of *C. floridensis* population annually occurred in mid-April, late June and early November on mandarin and in late June and mid- November on grapefruit. While, Hodges (2003) mentioned that C*. floridensis* had two annual generations on the different ilex cultivars in Tifton, Gorgea.

C. floridensis showed different degrees of preferability to blood orange, loquat and mango leaves. However, orange leaves proved to be the most preferred host for sheltering *C. floridensis* in comparison with loquat and mango leaves. The highest abundance of *C. floridensis* was recorded in blood orange orchards in compassion with loquat and mango orchards. Similar conclusion was obtained by Hodges (2001 and 2003) that C*. floridensis* exhibited different perretrability to the different host plat (ILEX) cultivars.

Chemical analysis indicated that loquat and mango 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 *C. floridensis* were blood orange followed by loquat and mango 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).So, it resulted in low population of *C. floridensis* on mango and loquat leaves.

The more favourable substrate had comparatively faster maturation, higher percentage of juvenile survivorship and greater reproductive rates for *Aonidiella aurantii* (Caroll and Luck, 1984). So, the obtained results revealed that blood orange leaves acted as the more favorable substrate and could be used as a host for the mass production of 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 no correlation between the concentration of total carbohydrate and the population density of *C. floridensis*.

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العلاقة بين العائل النباتي وحشرة الموالح الشمعية *ceroplastes floridensis* (Comst) .

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أجريت الدراسة الحالية في مزرعة كلية الزراعة جامعة المنصورة لعاميين متتالين (٢٠١٠/ ٢٠١١) بهدف تقييم العوائل النباتية (البرتقال بدمة – البشمله – المانجو) على حشرة الموالح الشمعيه ***ceroplastes floridensis* (Comst)**.

كان لحشرة الموالح الشمعية ***C.floridensis*** ثلاث ذروات على أشجار(البرتقال بدمه و البشمله والمانجو).

كان لحشرة الموالح الشمعية ***C.floridensis*** أعلى نسبة تفضيل للبرتقال بدمه يليه البشملة ثم المانجو و مع ذلك، أظهر تعداد ***C.floridensis*** أعلى كثافة على البرتقال بدمه وأقل على أشجار المانجو، كان متوسط التعداد(٤.٥٣ ± ١.٣٦,٣.٣٦ ± ٠.٣٤ و ١.٥٨ ± ٠.٣٦) و (٣.٢٨ ± ١.٠ ، ١.٤٤ ± ٠.١٦ و ١.٠٧ ± ٠.١٠)

أوضح التحليل الكيميائي أن البشملة و المانجو فى الموسم الأول والثانى على التوالى يحتوى على أعلى نسبة بروتين كلى مقارنة بالبرتقال بدمة.

أوضح التحليل الإحصائي وجود ارتباط معنوي موجب بين التغيرات فى نسبة البروتين الكلى و التغيرات و تعداد حشرة الموالح الشمعية على كل العوائل النباتية المختبرة.في حين كان هناك ارتباط معنوي سالبا بين تعداد حشرة الموالح الشمعيه والزيادة في نسبة الكربوهيدرات.

قام بتحكيم البحث

أ.د / عبد البديع غانم	**كلية الزراعة – جامعة المنصورة**
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