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Article

Field survey of fig wax scale insect *Ceroplastes rustic* L. (Hemiptera: Coccidae) in fig fields of Al-Kifl district/Babylon Governorate and study the effect of some environmental factors on egg hatching

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ABSTRACT

The harmful effects of wax scale insect *C.rusci* L. on fig trees cultivated widely in the Al-Kifl district / southern Babylon governorate in the last two years was the main reason for designing this study. The study involved experiments; the first was a field survey to have scientific evidence about the widespread of *C. rusci* and estimated the infection rate in plants, then tried to find a relationship between environmental factors in this area and studied insects. The second experiment deals with the efficacy of some factors (egg locations, temperature and time) on egg hatching of *C.rusci*. The results provided good information about fig plants' temperature and infection rates with *C. rusci*. The range of temperature degrees, which showed a high level of infection, was 26.5-33.4 ºC. Meanwhile, the highest infection rate was recorded in October, followed by June. The second experiment showed that temperature was a limiting factor for egg hatching; therefore, there was no hatching of *C.rusci* eggs when the temperature was below 15 ºC. When the temperature is above this level (15 ºC), a new limitation factor appears in the egg's location. This experiment proved that the existence of an egg under a fold, which covers the insect, is necessary for egg hatching.

Keywords: *Ceratoplastes rusci*, Temperature, Field survey, Egg hatching**.**

INTRODUCTION

Fig plant *Ficus carica* L. is one of the deciduous fruit trees belonging to the Moraceae family. The genus Ficus includes 400 species and 700 varieties, and it is considered one of the trees of the subtropics because it does not tolerate lower temperatures. Fig cultivated in many North Africa and Mediterranean countries such as Portugal, Spain, France, Greece, and Italy1,2.
Global production of fig fruits is estimated at 1093189 tons per year 3. In the Republic of Iraq, figs are grown in several areas, the most prominent of which is the province of Babylon, where production exceeded 6000 tons for the year 2017, and the bulk of it is concentrated in the district of Al-Kifl, southern of Babylon province, where the area of figs is estimated at more than 2000 dunams 4. Fig plant cultivation has had many problems, such as plant diseases and insects; one of the

most important pests that have affected fig production in the last two years is wax scale insects.

Sap-suckers insects (including wax scale insects) are pests that have a role in determining crop productivity, as they absorb plant juices from leaves, fruits, and the rest of the plant, where the infection leads to the deterioration of the plant, in addition to the fall of the honey-dew symposium that it secretes very densely on trees and plants planted near them, and thus leads to the appearance of infection with soot mold disease on the leaves and the rest of the plant 5. Several studies have indicated that the danger of wax scale insects emphasis by their ability to attack a wide spectrum of plant families, in addition to their high ability to adapt to settle in diverse agricultural ecosystems, their ability to reproduce, their gluttony in absorbing nutrients from the host plant, as well as their secretion of the honey-dew symposium that helps the growth of throwing fungi, and the accumulation of dust on various plant parts [6].

In the last two years, fig plants have been infected widely with wax-scale insects in the Al-Kifl district. This study was designed to establish an idea of the infection range of this insect in the study area and to understand some of the life cycle aspects of *C. rusci*.

MATERIALS AND METHODS

Field Survey

The field survey of scale insects that infect fig trees was carried out in the district of Al-Kifl, which is famous for cultivating figs. Areas included in this study were infested with scale insects. The fig field in the district of Al-Kifl was divided into three areas from the north towards the south (the northern region, the central region, and the southern region) Figure (1). The survey was carried out by visiting three fields from each area, and these fields were randomly selected as the distance between one field. Another was between 1.5 to 2 km (Fig. 2). Five trees were randomly selected from each field, and ten random samples were taken for each part of the tree (twigs, leaves, fruits, branches) from the top, center and bottom of the tree, which were at least 12 years old. The phases were seen and recorded on each branch of the upper and lower surface of the tree using a manual magnifying glass with a magnifying power of 5x and a microscope with a magnification power of up to 1000x. Visits were also made to each field monthly, and during each visit, the average temperature and humidity were recorded (Table 1). The rate of injury rate per part (leaves, twigs, fruits and branches) according to the following equation.

$$\text{Infection percentage} = \frac{\text{No. of infected samples}}{\text{No. of total samples}} \times 100$$

7, the method was applied to determine the rate of incidence rate on the affected tree by using the following equation:

$$\text{Infection percentage of one fig tree} = \frac{\text{Mean of infection of leaves + twigs + fruits}}{4}$$

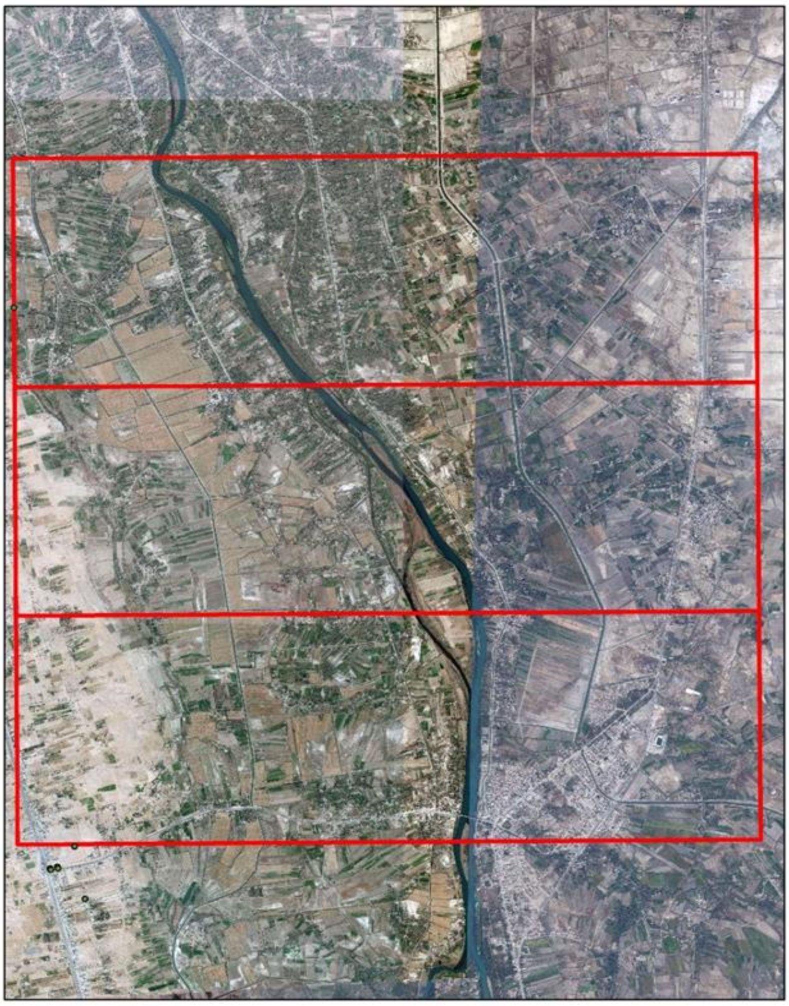

Figure (1) Method of dividing Al-Kifl district to conduct a field survey

Month	Temperature (ºC)	Humidity (%)
March	19.1	45.8
April	23.7	47.3
May	29.5	36.0
June	33.4	31.8
July	37.9	33.2
August	38.9	31.3
September	31.4	39.3
October	26.5	48.0
November	17.9	62.3
December	12.3	53.0

Table 1: Average temperatures and humidity in the fig groves in Al-Kifl district from March to December 2021.

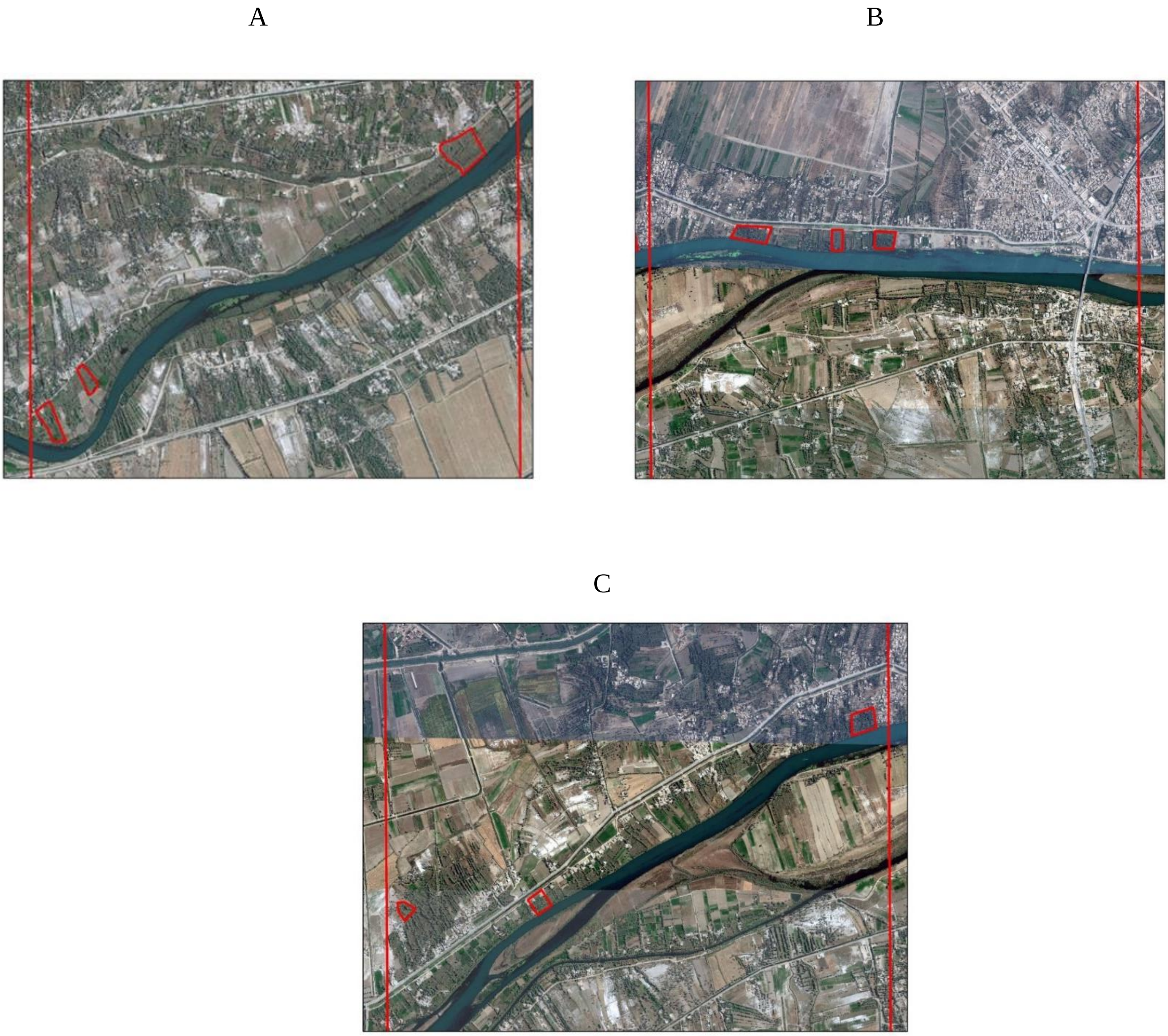

Figure 2: Randomly selected field to scale insect survey (A) northern area (B) central area (C) southern area

Determine the appropriate temperature and place to hatch the eggs of the scale insect on figs

This experiment was conducted by collecting leaves of fig plants containing egg incubator females and brought to the entomological laboratory at the Faculty of Agriculture / University of Kufa, where they were divided into two groups: in the first group, the eggs were isolated from the bottom of the insect by using soft brush where they were placed on uninfected fig leaves in Petri dishes containing filter paper. This filter paper was moistened with some drops of water. Holes were also made in the dish lid for ventilation, and this process was repeated for three dishes (replications). As for the second group, in each dish, a part of a dry fig leaf containing a female was cut to fit the dish size without changing the female location and providing a source of moisture. Holes were also made in the dish lid for ventilation, and this process was repeated for three dishes.

The dishes under study were placed in different incubators at five temperature levels of 15, 18, 21, 23 and 25 ºC to study the appropriate temperature for hatching eggs. The experiment was continuously monitored to determine the appropriate temperature for hatching and the number of hatched eggs per temperature for seven days 8,9.

A **B**

C

Figure 3: the effect of temperature and egg location in the preparation of nymphs resulting from the process of hatching eggs (A) Method of adding plant parts in the dish (B) Making holes in the dish for ventilation (C) Examination of adult insects under a microscope to calculate nymphs resulting from hatched eggs.

Experimental Analysis

All experiments in this study were analyzed by using the statistical program Genstat version 12. Factorial experiments design was applied to estimate the significance between different treatments with a Completely Randomized Design (C.R.D.). The least significant difference test was applied between means on the significant level 0.05. 10.

RESULTS

Field Survey

The results of Table (2) confirm that there are significant differences in the percentages of incidence of the scale insect, where it is clear from the Table that the highest incidence in the leaves of fig plants was in June, September, and October, reaching 100%, while the lowest percentage recorded in December, which was 10%.

The infection rates were recorded on the branches of fig trees from March to October 2021; the highest rate of infection was recorded in November, reached 100%, followed by the rate of infection in September, which amounted to 91.66%, while the lowest percentage was recorded in December which was 15.33%.

The same Table showed that the lowest incidence rates achieved on the fruits of fig trees were in March, April, and December, which amounted to 0%, compared to the highest rates of infection recorded in October and September, which were 100 and 91.66%, respectively.

The study of results in Table (2) indicated that the rates of infection of fig tree branches have varied in the months in which the field survey was carried out, as the highest rate of infection of branches was recorded in November and reached 100% compared to the lowest rate of infection recorded in March and December, which were 3.33%.

Month	**The percentage of incidence (%) on**			
	Leaves	Twigs	Fruits	Branches
March	33.66	37.76	0.00	3.33
April	43.33	55.00	0.00	5.00
May	83.33	61.66	50.00	10.00
June	100	86.66	100	20.00
July	76.60	51.66	71.66	15.00
August	71.66	40.00	55.00	10.00
September	100	91.66	91.66	14.33
October	100	100	100	100
November	20.00	21.60	21.60	8.30
December	10.00	15.33	0.00	3.33
L.S.D. 0.05	12.369	15.214	16.589	11.326

Table 2: Percentage of infection of parts of the fig tree with the scale insect *C. rusci* from March 2021 to December 2021 in the fields of Bani Muslim area - Al-Kifl district - Babylon Governorate

The results of Table (3) indicate a relationship between the temperatures recorded throughout the field survey of fig orchards in the area of Bani Muslim - Al-Kifl District - Babylon Governorate and the percentage of infection with the cortical insect C. rusci, where an increase in the incidence rates is observed starting from March (the percentage of infection is 20%) until its first peak in June (76.66%) and this increase is accompanied by the increase with temperatures from March (temperature 19.1 °C) to June (temperature 33.4 °C).

After June, infection rates declined from 76.66% in June to 44.16% in August, even though the temperature continued to rise from 33.4 °C in June to 38.9 °C in August. Then the incidence of fig trees rises again to reach their maximum peak and the second during the period of field survey in November, reaching 100% and at a temperature of 26.5 °C and then retreating after this month to reach the lowest level on January 1% and at a temperature of 12.3 °C.
The field survey conducted during this study gave a clear idea of the extent of the spread of the scale insect and its interaction with environmental factors, especially the temperature studied here in detail, where it was noted that the atoms of the escalation of the insect population occurred in June and October since temperatures are within the range preferred by this insect for reproduction and spread (25-32 °C). 11, noted that the growth rate of C. rusci was high when the temperature was between 27-28 °C.
11, noted that the growth rate of *C. rusci* was high when the temperature was between 27-28 °C. The study conducted by 12, which was concerned with studying the effect of temperatures on the development of the soft brown scale insect *Coccus hesperidum* L., showed that this percentage of living insects increased when the temperature ranged between 24-30 °C. Furthermore, 13 reported that the average duration of the generation, the average number of eggs per female and the average percentage of egg hatching of the scale insect on fig *C. rusci* increased at the temperature of 25 °C reaching 29 days, 1795.73 eggs and 90% respectively compared to the temperature of 35 °C in which the previous qualities reached the following values of 36 days, 1189 eggs and 40.5% respectively.

Month	Temperature (ºC)	Tree infection (%)
March	19.1	20.00
April	23.7	25.25
May	29.5	51.25
June	33.4	76.66
July	37.9	52.91
August	38.9	44.16
September	31.4	72.75
October	26.5	100
November	17.9	17.66
December	12.3	1.00
L.S.D. 0.05		13.221

Table 3: Comparison between the percentage of infection of one tree with the crustacean insect* C. rusci *and the recorded temperatures in the area of Bani Muslim - Al-Kifl district - Babylon Governorate

Determine the appropriate temperature and place to hatch the eggs of the scale insect on figs

Table (4) shows the number of nymphs resulting from the hatching eggs of the scale insect on the fig C. rusci at different temperatures of 15, 18, 21, 23, 25 °C and for different periods is 1, 2, 3, 4, 5, 6 and 7 days where the preparation of hatched eggs was calculated in two ways that included the first of which included laying eggs directly in the dish (without an insect). At the same time, the second was carried out by laying eggs under the wax shell in The dish (under the insect). The results of this experiment confirmed the existence of significant differences between the interventional coefficients, where the treatment (25 °C × 7 days × under the insect) gave the highest number of 140 nymphs, followed by the interventional treatment (23 °C × 7 days × under the insect) which gave 129 nymphs compared to the interventional coefficients (all studied temperatures × all periods × free) which did not show any hatching of eggs (0 nymphs).

Temp. (⁰C)	**Egg location**	**Number of nymphs after (days)**						
		1	2	3	4	5	6	7
15	With the insect	0	0	0	0	0	0	0
	Free	0	0	0	0	0	0	0
18	With the insect	0	0	0	0	12	33	92
	Free	0	0	0	0	0	0	0
21	With the insect	0	0	0	24	53	89	114
	Free	0	0	0	0	0	0	0
23	With the insect	0	0	0	39	88	106	129
	Free	0	0	0	0	0	0	0
25	With the insect	0	0	28	47	90	105	140
	Free	0	0	0	0	0	0	0
L.S.D. 0.05		5.223						

Table 4: the effect of different temperatures and the place of eggs in the preparation of nymphs resulting from hatching the eggs of the scale insect on the fig C. rusci after 1-7 days in the laboratory

The study of Figure (4) showed that there is a significant direct correlation between the number of nymphs resulting from hatched eggs and the studied temperatures, where the more temperatures increase by 3 degrees Celsius, the number of nymphs responds linearly and directly with this increase down to the temperature of 23 °C which then changes the relationship to bend towards decreasing by the number of nymphs. It is also noted from the exact Figure that the number of nymphs was significant, with the highest average number of nymphs at 25 °C and 29.29 nymphs compared to the non-recording of any resulting nymphs at 15 °C.

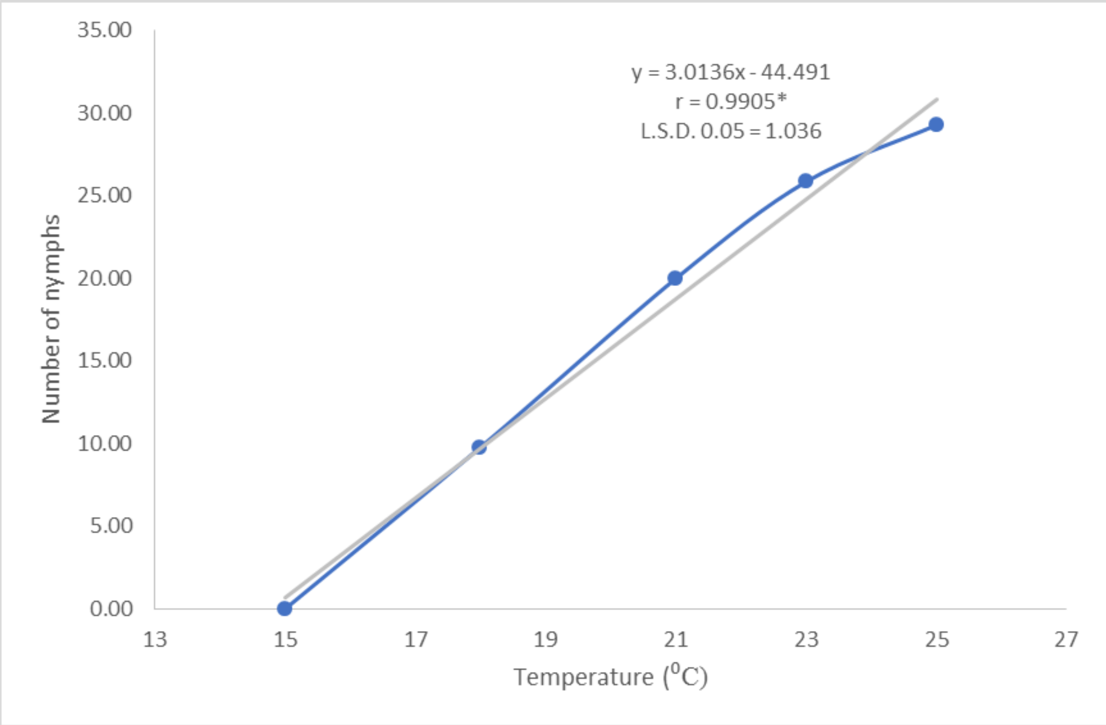

Figure 4: Effect of different temperatures in the preparation of nymphs resulting from hatching eggs of the scale insect on the fig C. rusci in the laboratory, * Significant difference at the probability level of P≤0.05

Figure (5) shows that the eggs under the waxy covering the insect have hatched at a rate of 33.97 nymphs compared to the eggs placed on the dishes without wax folding, which recorded 0 nymphs.

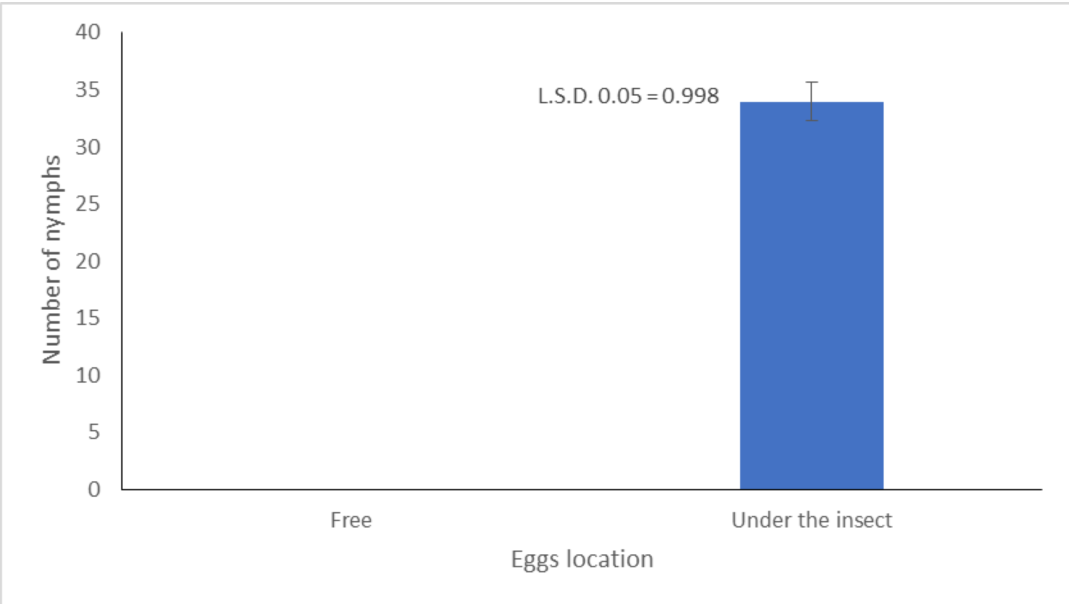

Figure 5: Effect of the place of egg-laying on the preparation of nymphs resulting from hatching the eggs of the scale insect on the fig C. rusci in the laboratory.

Figure (6) also shows that there is a significant direct relationship between the number of nymphs resulting from the hatching of eggs and the time that the number of nymphs begins to appear on the third day and continues to increase until the seventh day, which the number of nymphs on the third day was 2.8 nymphs compared to the highest average number of nymphs of the scale insect C.rusci obtained on the seventh day and amounted to 47.5 nymphs.

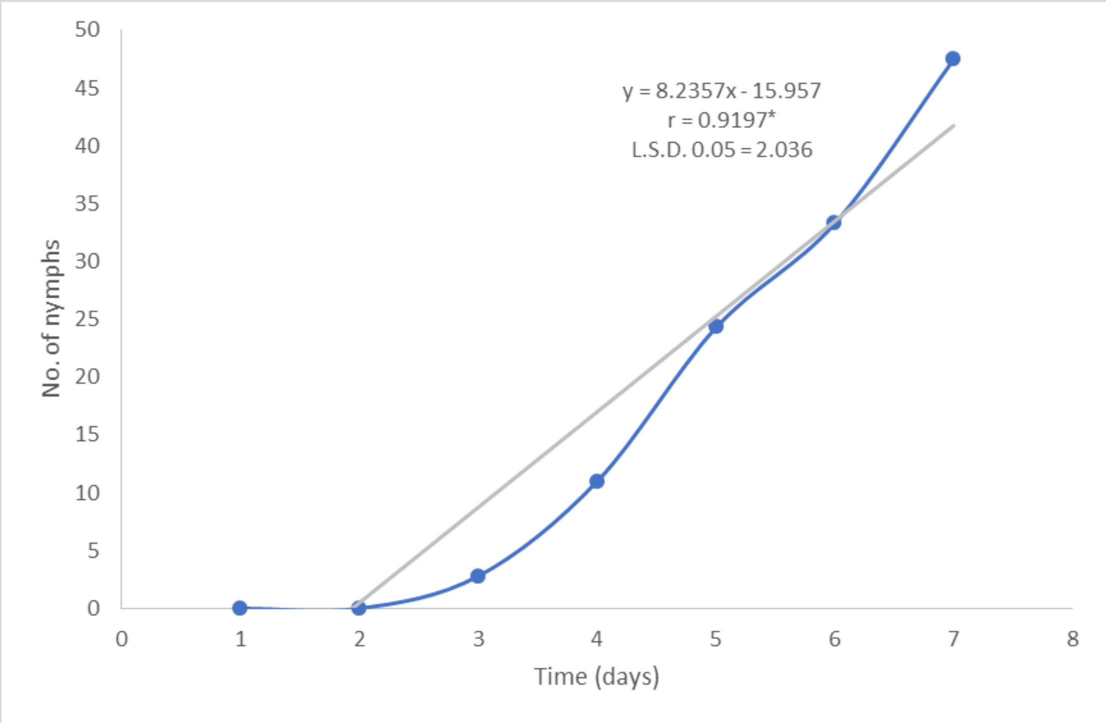

Figure 6: Effect of the duration of time on the preparation of nymphs resulting from the hatching of the eggs of the scale insect on the fig C. rusci in the laboratory, * Significant difference at the level of probability P≤0.05

DISCUSSION

The previous results in Figures 4, 5, and 6 emphasize that when the temperature is below 15 °C, all the eggs will not hatch regardless of the location of the eggs (free or under the insect) or time. When the temperature rises above 15 °C, another factor affects egg hatching to nymphs, which is the egg's location. The egg under the wax fold below the insect started to hatch dramatically and directly with the increasing temperature and time. On the contrary, a free egg would not hatch. The main reason for this phenomenon may return to the egg's dryness as wax folding protects the egg from natural enemies and the required temperature and humidity for egg hatching 14,2.

CONCLUSIONS

The widespread of C. rusci was confirmed by a field survey, which showed that all parts of the fig plant were infected with the insect. There are two peaks of increasing the number of C. rusci in the studied area. The highest was in October, when all studied fields in the Al-Kifl district had been infected; the other peak was June. This study also emphasizes the effect of removing incubating insects from trees, as the eggs under the insect will die because of extreme temperature and dryness.

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