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BIOLOGICAL STUDY OF ORIENTAL SPIDER MITE *EUTETRANYCHUS ORIENTALIS* (KLEIN) IN LABORATORY ON GRAPEFRUIT AND LEMON LEAVES

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Abstract

The study included the effect of two types of citrus in some aspects of the biology of the oriental spider mite *Eutetranychus orientalis* (Klein), lemon *Citrus limon*, Var. Mahali and grapefruit *Citrus paradisi*, var. Duncan at temperature (25 ± 2°C), relative humidity (50-60%) and 12-hour light duration to 12 hours of darkness at the graduate insect laboratory at the college of Agricultural Engineering Sciences / University of Baghdad. Results showed that the food preference of the host species had a direct effect on the growth period of the immature stages of the oriental spider mite survival rate when arise on those species, it recorded the shortest period of egg incubation and larval and nymph development and life cycle and highest survival rate for spider mite stages arise on lemon were recorded 4.03 days, 6.97 days, 11.00 days and 65.97%, respectively. While, the longest duration of egg incubation, larval and nymph development and the lowest survival rate of spider mite stages arise on grapefruit were 4.93 days, 7.96 days, 12.89 days and 57.60%, respectively. The biological and reproductive parameters of the spider mite adults were arise on the lemons and grapefruit. It recorded the longest age of female and male adults, the shortest pre-egg laying period, the longest duration of egg laying and post egg laying and the largest total egg and the number of eggs per day, the largest percentage of egg hatch, the shortest length of the generation and the highest percentage of sexual adult eggs grown on lemons with 13.4, 8.0, 1.67, 8.2, 3.53 days, 39.09, 4.77 eggs, 69.5%, 12.63 days and 1.3:3 respectively. Whereas, It recorded the shortest age of female and male adults, the longest pre-egg laying period, the shorter duration of egg laying and post egg laying and the smallest total egg and the number of eggs per day, the smallest percentage of egg hatch, the longest length of the generation and the lowest percentage of sexual adult eggs grown on lemons with 12.23, 7.33, 1.87, 7.37, 3.0 days, 29.46, 4.0 eggs, 64.3%, 14.76 days and 1: 2 respectively. Thus, sour lemon is the most preferred and appropriate to nourish the oriental spider mite and its growth and development than of grapefruit.

Key words: *Eutetranychus orientalis*, sexual female, lemon, grapefruit.

Introduction

The oriental spider mite *Eutetranychus orientalis* (Klein) is an economically important pest on all citrus species (lemons, oranges, bitter orange, grapefruit, mandrine etc.) in the Mediterranean region, causing different levels of damage to citrus trees varies depending on the age of the plant and the nature of agricultural management and environmental conditions and others and that different plant hosts can affect the life of the oriental spider mite, as their fertility is higher on the lemon than tangerine leaves (Rasmy, 1978; European Food Safety Authority Journal, 2013). This mite lives on the top surface of citrus leaves, extending along the middle axis of leaves, the eggs, the moving stages and the shedding skin are seen in this region of the leaf, its moving stages absorb plant sap from leaves, branches and fruits. The color of the leaves changes to yellowish brown, making them look pale and yellowish. In severe cases, the leaves and fruits fall and the small branches dry up and become naked. As the leaves change to yellowish brown, making them pale and yellowish. In severe cases leaves and fruits fall and the small branches dry and become bare, affecting the quality and quantity of citrus production (Al-Mallah, 2009; Alani, 2010; Sangeetha *et al*., 2013; Al-Azazi, 2015) and that the damage arises as a result of feeding the active moving stages of the mite on the upper surface of the leaves and fruit crust, as adult female lay eggs start when only a few days old and hatch after a week (or less depending on the climate). The entire life cycle is about 10-12 days and the female lives between 1-3 weeks

and in optimal conditions can produce between 10 and 30 generations per year (Burkle, 2014). The importance of this growing pest on the citrus trees and the damage caused by the special importation of different types of citrus and cultivation in different areas of the central regions of Iraq and to add additional information for some of the life characteristics of this oriental spider mite on the leaves of lemon and grapefruit, thus this laboratory studies were conducted.

Materials and Methods

Study of the effect of two types of citrus in some life features of oriental spider mite *Eutetranychus orientalis* (Klein)

For the purpose of studying the effect of the difference of hosts in some aspects of the life of the oriental spider mite, two types of citrus were selected: *Citrus limon* L. (var. Mahli) and *Citrus paradisi* Macfad (var. Duncan), belonging to the Rutaceae family. They were observed as the most sensitive species through the study of population density, annual presence and dietary preference of the oriental spider mite on five types of Citrus (Lemon, Orange, Mandarin, Bitter orange and Grapefruit). The plant leaves samples of the two types from shade house that were planted and prepared for this purpose, as well as field studies included in this study.

Sixty plastic petri dish plates were used (Diameter 9cm, height 1.5 cm). The dishes were divided into two groups: the first group consisted of 30 plates of lemon leaves and the second set 30 of grapefruit leaves, place in the base of each dish a layer of medical cotton moistened with distilled water. Discs of the leaves were placed upside down. The bottom surface was attached to the cotton layer. The cavities were not placed between the edges of the leaf and the cotton surface. Vaseline was placed on the edges of the disc to prevent the spider mites from leaving the leaf. Each group represents three replicates and each replicate represents 10 dishes. In each of the dishes of the two groups, one female virgin (a second nymph stage in the dormancy phase) and two males for each leaf disc (Fig. 1), After removing all the immature, larvae, nymphs and adult of males and females from the surface of the leaf by a soft brush measured (00). After the onset of the second and last nymph stage and ensure mating after one day, males were removed to follow the stages of development by females from the pre-egg laying period and the period of eggs to adult stage. Each petri was closed with perforated thermal nylon the top to ensure ventilation. Petri dishes were placed in incubator at temperature (25 ± 2°C), relative humidity (50-60%), at the graduate insect laboratory, a glass container with a solution of 35 g KOH plus 100 ml of distilled water were placed in the incubator. As well as, thermo hygrometer is installed to ensure that the temperature and humidity are stable. A light source of 500 lux was provided with a timer to give a constant light period of 12 hours per day and this incubator was used in all subsequent laboratory experiments. The dishes were checked continuously every day and leaf discs were replaced whenever needed with new discs of the same type and the following characters were studied:

Fig. 1: Note the presence of males waiting for the emergence of the female from the second nymph stage (magnification 20 X).

1. The number of eggs per day by the fertilized female.
2. Duration of egg incubation.
3. Duration of larval stage.
4. Duration of the first nymph stage.
5. Duration of the second nymph stage.
6. Pre-laying eggs.
7. Egg laying time.
8. Post-egg laying period.
9. Number of total eggs per female during their lifetime: Average number of eggs per day × Egg laying rate.
10. Number of hatched eggs.
11. The percentage of the hatch is determined according to the following equation:

$$\text{Hatch \%} = \frac{\text{number of eggs hatched}}{\text{total number of eggs)}} \times 100$$

12. Sex ratio, the female and male sex ratio is determined as by Shih and Pai, (1995), method which is as follows:

$$\text{Females or Males \%} = \frac{\text{number (males or females)}}{\text{number (males + females)}} \times 100$$

13. Female longevity: the duration from skin shedding adult female until death, including pre-egg laying + egg laying time + post- egg laying period.
14. Life Cycle = Egg incubation time + Evolution of immature adult stage.
15. The longevity of males: is the duration from skin shedding adult male until death.
16. Length of generation = duration of life cycle + pre-egg laying period.

Statistical analysis

The laboratory experiment was designed according to the complete randomized design (CRD). The data were statistically analyzed using the analysis of variance method. The least significant difference LSD was used for at the level of 0.05 probability to compare the means, Genstat v.12.1 software was used in the statistical analysis (Al-Rawi and Khalaf Allah, 2000).

Results and Discussion

Effect of immature stages

The results of this study showed that the difference between the two host citrus plants under study, Lemon and grapefruit, has been reflected on the duration of the growth of the immature adults of oriental spider mite *Eutectanychus orientalis* and its survival rate on these two species (Table 1). It recorded the shortest period of egg incubation and larval and nymph development and life cycle and highest survival rate for spider mite stages arise on lemon were recorded 4.03 days, 6.97 days, 11.00 days and 65.97%, respectively. While, The longest duration of egg incubation, larval and nymph development and the lowest survival rate of spider mite stages arise on grapefruit were 4.93 days, 7.96 days, 12.89 days and 57.60%, respectively (Table 1). Statistical analysis showed significant differences between lemons and grapefruit hosts. This may be due to the difference in the nutritional and chemical content of the leaves. There were significant differences between the two citrus types.

Table 1: The biological features of the immature stages of the mated female of the oriental spider mite *Eutetranychus orientalis* on lemon and grapefruit leaves at laboratory.

T test		Grape-fruit	Lemon	Character
Sig.	T value			
**	12.07	4.93	4.03	Egg
*	4.92	3.43	3.07	Larva
*	4.91	2.43	2.00	First nymph
*	4.00	2.10	1.90	Second nymph
**	9.05	7.96	6.97	Larva and nymph stage
***	27.50	12.89	11.00	Life cycle
*	4.32	57.60	65.97	Survival (%)

*, **, *** Significant at 0.05, 0.01, and 0.001 probability level.

In similar studies, it was found that the difference between plant species and varieties within one species negatively or positively affects the life of the oriental spider mite due to different phenotypic, biochemical, nutritional and secondary metabolites contained in these species or varieties (Mohamed, 1965; Jyotika and Mandeep, 2003; Aldahwi *et al*., 2010). Awad and Rasheed, (1982) indicated that the period of incubation of the eggs and the larval, first and second nymph development of the oriental spider mite on the orange leaves was 8, 2.2, 2 and 2.2 days respectively at 25.4°C. AL-Gboory, (1989) reported that egg incubation time for the oriental spider mite was tested at 28 ± 2°C and relative humidity of 30 ± 2%, on grapefruit 5 days and on lemon for 4.3 days. Al-Ani, (2004) explained that the incubation time for eggs of oriental spider mite on the Bitter orange was 4.46 days at 25°C. Imani and Shishehbor, (2009), reported when studying the life of the brown citrus oriental spider mite *Eutetranychus orientalis* on the lebbeck tree (*albizia lebbeck*), observed under constant temperatures of 20, 25, 30 and 35°C that the average time required for development of oriental spider mite from egg to adult was 11.8 days at 25°C. Ferragut and others, (2013) reported that the average life cycle of oriental spider mite was about 10-12 days for citrus and other plant families in optimal conditions. Al-Azazi, (2015) explained that the time required for the development of the oriental spider mite from egg to adult was 11.2 days on grapefruit in summer.

Effect on adults

The results showed a difference in some aspects of life and reproductive parameters of the adults of oriental spider mite grown on the two types of different citrus fruits, lemons and grapefruit (Table 2). The longest age of adults (males and females) on lemon was recorded at 13.4 and 8.0 days respectively. While the shortest life cycle of adults on grapefruit was 12.23 and 7.33 days, respectively. As for the duration of pre-egg-laying for females, the longest duration of the adults feeding on grapefruit and the lowest on lemon were 1.87 and 1.67 days respectively. The results of the egg laying period and post-egg laying time were opposite to pre-egg laying, with the longest duration of feeding on lemon was 8.2 and 3.53 days respectively. The shortest period of feeding on grapefruit was 7.37 and 3 days respectively.

The results showed a significant difference in the

Table 2: Reproductive measurements of the fertilized female of oriental spider mite *Eutetranychus orientalis* on grapefruit and lemon leaves at laboratory.

Reproductive measurements and adult characteristics of mated spider mites arise on two citrus types				Character	
T- test		Grape-fruit	Lemon		
M laor	T value				
**	7.46	12.23	13.40	Female	Length of adult life cycle
**	6.32	7.33	8.00	Male	
**	4.95	1.87	1.63	Pre-laying eggs period	
***	12.50	7.37	8.20	laying eggs period	
***	8.00	3.00	3.53	Post-laying eggs period	
****	15.63	29.46	39.09	Total laying eggs	
***	11.50	4.00	4.77	Average laying eggs/day	
*	4.46	64.33	69.53	Hatching %	
***	44.55	14.76	12.63	Length of generation	
Z - test		1:2	1.3:3	Sex ratio (Female:male)	
Sig.	Z value				
*	2.05				

*, **, *** Significant at 0.05, 0.01, and 0.001 probability level.

number of eggs / day and the total number of eggs on the two citrus hosts. The largest amount of eggs per day and during lifetime of the adult on the lemon was 4.77 and 39.09 eggs respectively and the lowest on grapefruit amounted to 4.0 and 29.46 eggs respectively. We conclude from these results that the increase in the number of eggs during the lifetime of the adult may be due to the different characteristics of internal and external plant supplements of the hosts fed by female spider mite, especially their contents of food and acceptable concentrations such as proteins, soluble sugars and important minerals. As well as what the host has of secondary compounds and concentrations, which significantly affect its suitability for the growth, development and fertility of the oriental spider mite.

As for the hatching rate, it also varied for the plant hosts. The highest percentage was on citrus lemons and the lowest on grapefruit was 69.5 and 64.3%, respectively. The sex ratio on the two types of citrus was the highest ratio of females: males were on lemon and the lowest was on grapefruit at 1.3:3 and 1:2, respectively. The difference between the two species in the incubation period, the duration of immature stages, the pre-laying egg period and the hatching rate has been reflected on the length of the generation. The shorter duration was on the lemon and the longest duration was on grapefruit, at 12.63 and 14.76 days respectively. These results confirmed the previous studies indicate that the difference in the type of plant that has been arise and fed by the pest has a significant role in different biological aspects; this gives important information that can be used in different pest control programs (Mohamed, 1965; Jyotika and Mandeep, 2003; Aldahwi *et al*., 2010).

In previous studies, Awad and Rasheed, (1982) showed that the average age of females for the oriental spider mite on orange leaves was 12.2 days and the sex ratio (females: males) was 23.3: 77.7 at 25.4°C. AL-Gboory, (1989), reported in a study of the biology of the oriental spider mite on different types of citrus, that the number of eggs laid by the female is 35.2 eggs throughout the life on lemon at 28 ± 2°C and relative humidity (30 ± 2)%. Walter *et al*., (1995) in a study of the biology of the oriental spider mite on citrus at 27°C and relative humidity of 45%, reported that the lifetime of the adult female 8-11 days and males 7-8 days and 25 interacted generations can occur annually under optimum conditions. Al-Ani, (2004) found that the average number of eggs per day was 10.43 eggs / female at the temperature at 25 ± 2°C and relative humidity (60-70%).

We conclude from these results that the increase in the number of eggs during the lifetime of the adult may be due to the different characteristics of internal and external plant supplements of the hosts fed by female spider mite, especially their contents of and acceptable concentrations such as proteins, soluble sugars and important minerals. As well as what the host has of secondary compounds and concentrations, which significantly affect its suitability for the growth, development and fertility of the oriental spider mite.

The results of the current study and previous studies confirm that the different internal and external characteristics of plant hosts fed by adult females especially their contents of nutrients and acceptable concentrations such as proteins, soluble sugars and important minerals. As well as what the host has of secondary compounds and concentrations, which significantly affect its suitability for the growth, development and fertility of the oriental spider mite. It also agreed with studies that showed that the plant resistance against various pests is adversely affected by environmental factors such as plant nutrition. It was observed that there is a close relationship between pest infestation and plant nutrition. Knowing the real reasons why a plant resists a certain pest enables us to choose the best ways and means to deal with chemical fertilizers that will reduce the incidence of such harmful pests (Dahawi *et al*., 2010; Saadi, 2017).

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