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Research Article
Development and Reproduction of the Two-spotted Red Spider Mite, *Tetranychus urticae* Koch as Influenced by Feeding on Leaves of Three Solanaceous Vegetable Crops under Laboratory Conditions

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Abstract

Background and Objective: The two spotted spider mite *Tetranychus urticae* Koch was an important polyphagous pest on majority of economic crops. The objective of current study was to determine host suitability of eggplant, pepper and tomato against this pest by considering development and reproduction under laboratory conditions. **Materials and Methods:** The mite was reared on leaf discs of the tested crops at 27±4°C and 70±4% R.H. Rearing individuals were examined twice daily. Duration of developmental stages, generation time, longevity and fecundity were calculated .Statistical analysis of variance was used and least significant differences at 5% were detected. **Results:** Duration of all developmental stages was significantly shorter on eggplant, followed by tomato while it was relatively longer on pepper. On the other hand, the higher numbers of deposited eggs were recorded on eggplant, while the least numbers were deposited on pepper. **Conclusion:** Pepper was less suitable for development and reproduction of *T. urticae* compared to tomato and eggplant. In future, it is necessary to test host suitability of many pepper cultivars hoping to find resistant cultivars that can be used safety in the integrated pest management against this pest.

Key words: *Tetranychus urticae*, food acceptance, host suitability, developmental periods, longevity, fecundity

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Family Solanaceae are one of the most economically important families. Since it contains many plant species of great economic importance include eggplant (*Solanum melongena*), pepper (*Capsicum annuum*) and tomato (*Solanum lycopersicum*)[1]. These vegetable crops are cultivated widely in Egypt especially in newly reclaimed sandy soils. In 2014, the total areas cultivated with eggplant, pepper and tomato reached 49713, 38132 and 214016 hectares produced 1257913, 601289 and 8288043 t, respectively[2]. Among many obstacles including insects, nematodes, fungi, bacteria and viruses in cultivating of solanaceous crops, phytophagous mites are considered as a major pests of these crops[3-6]. On the other hand, *Tetranychus* spp. (Acari: Tetranychidae) are important polyphagous pests that can cause remarkable damage to the majority of economic plants including eggplant, pepper and tomato in greenhouses and open fields worldwide[7-10].

Eggplant *Solanum melongena* is one of the most important solanaceous crops in different parts of the world. Many authors cleared that one of the factors contributing to low yields is injury caused by many arthropod pests, particularly phytophagous mites that are widely spread during the growing season[5,8,11-13]. Moreover, the two-spotted red spider mite *Tetranychus urticae* Koch was reported as an important pest of cultivated tomato *Solanum lycopersicum* causing losses in most years[6,14,15]. Middle stage of the tomato crop was the most critical period for mite damage and mite infestation, contributing to more than 50% of total yield loss due to severe damage to the leaves and reduction of chlorophyll content as well[16]. Feeding injury caused by tetranychid mite *T. urticae* on pepper *Capsicum annuum* was discussed[17]. In addition, it is one of the most important pest species in annually cultivated plants grown in greenhouse, including pepper[3,17-20].

Acarological studies carried out in Egypt revealed that spider mites particularly *T. urticae* cause remarkable damage to infested solanaceous crops[10,13,21,22]. Several studies indicated that, the two-spotted spider mite does not accept all plants to the same degree, because of differences in nutritive and toxic constituents[23,24]. Other factors such as morphology of leaf surface also play an important role in plant acceptance[25-27]. Understanding the reproductive parameters of a pest is one of the key components in the development of an integrated pest management strategy[28]. Generally, the objective of this study is to through light on certain biological aspects of *T. urticae* on some solanaceous crops under laboratory conditions.

MATERIALS AND METHODS

Rearing of *Tetranychus urticae* under laboratory conditions: Leaves of three solanaceous vegetable crops i.e., eggplant *Solanum melongena*, (Black Baladicultivar), tomato *Solanum lycopersicum* (El-Basha 1077cultivar) and pepper *Capsicum annuum* (Baladicultivar) infested with the two-spotted red spider mite *T. urticae* were collected from Zagazig district, Sharkia govern orate during the growing season 2017. In the laboratory, the leaves were examined under a stereo microscope. After confirming the identity of the mite, the leaves were placed singly with upper surface down on cotton pad soaked with water in Petri dishes of 9 cm diameter. The mite was reared according to the methods described by Gotoh[29], Pontier *et al.*[30]. Each leaf was surrounded by a cotton strip saturated with water to serve as a barrier to prevent escape of mites. Suitable moisture maintained by adding few drops of water as needed. Leaves were changed every alternative day to avoid leaf deterioration and consequent mall nutrition. These cultures were maintained in ambient temperature 27±4°C and 70±4% R.H.

Duration of developmental stages, longevity and fecundity of *T. urticae* females on leaves of three solanaceous crops: Leaf discs of eggplant, tomato and pepper (4 cm in diameter each) were placed singly with the upper surface down on water saturated cotton wool pads in Petri dishes as previously mentioned for the stock cultures. Sexed females from each culture were individually isolated and placed singly on replicated leaves for each host plant. Immediately after the egg deposition, females were transferred to stock culture. Hatched larvae were reared during their life span. Rearing individuals were examined twice a day and the developmental stages: The durations of egg, larval, protonymphal and deutonymphal stages were calculated, in addition to the durations of total immatures, life cycle, generation and life span. Moreover, the preoviposition, oviposition, postoviposition and longevity periods were measured. The number of eggs laid per female was counted. The individuals were transferred to new leaf discs upon the first sign of deterioration[30]. Experiments were carried out under laboratory conditions of 27±4°C and 70±4% R.H.

Statistical analysis: The obtained biological data were subjected to statistical analysis of variance and least significant differences (LSD) were calculated at $p \leq 0.05$ level of probability[31].

Table 1: Developmental periods (in days) of *Tetranychus urticae* female when reared on leaves of three solanaceous crops at 27±4°C and 70±4% R.H

	Host plants			
Mite stages	Egg plant	Tomato	Pepper	$LSD_{0.05}$
Egg	3.93±0.04	3.92±0.05	3.86±0.06	0.151
Larva	2.33±0.06	2.47±0.07	2.56±0.09	0.227
Protonymph	2.26±0.06	2.36±0.06	2.47±0.03	0.156
Deutonymph	2.53±0.06	2.80±0.06	3.06±0.04	0.153
Total immature	7.15±0.14	7.63±0.11	8.13±0.13	0.378
Life cycle	11.03±0.17	11.56±0.12	12.00±0.15	0.432
Generation	12.33±0.16	13.03±0.12	13.93±0.16	0.432
Life span	26.06±0.28	25.26±0.22	24.90±0.22	0.709

±(SE): Standard error. Each value is a mean of 15 replicates

Table 2: Longevity (in days) of *Tetranychus urticae* when reared on leaves of three solanaceous crops at 27±4°C and 70±4% R.H

Crops	Pre-oviposition period	Oviposition period	Post-oviposition period	Longevity
Eggplant	1.30±0.06	11.13±0.21	2.61±0.08	15.03±0.18
Tomato	1.50±0.00	9.93±0.18	2.30±0.09	13.73±0.22
Pepper	1.93±0.04	8.61±0.13	2.36±0.06	12.90±0.12
$L.S.D_{0.05}$	0.131	0.511	0.233	00.518

±(SE): Standard error. Each value is a mean of 15 replicates

RESULTS AND DISCUSSION

Obtained results in Table 1 and 2 demonstrated that, the egg incubation periods of the tetranychid mite *T. urticae* on the investigated solanaceous plant leaves were nearly similar at the same temperature under laboratory condition. These results nearly agree with those of Halloum *et al.*[32], who reported that the egg stage of *T. urticae* lasted 4.00±0.63 days at 25±1°C.

The average durations of larval, protonymphal and deutonymphal stages of *T. urticae* fed on leaf discs of the investigated solanaceous plants at 27±4°C are completed when mite reared on eggplant, tomato and pepper leaf discs (Table 1). The tested plant leaves significantly ($p \leq 0.05$) affected the duration of development for *T. urticae* immature stages. When the mite reared on tested crops at 27±4°C, the shortest period of immature stages was recorded on eggplant leaves. Significantly ($p \leq 0.05$) longer period for development of immature stages was recorded on pepper leaves. On tomato this period values were moderate. It is worth mentioning that the rate of development of *T. urticae* immature stages is influenced by temperature, humidity and quality of food[7].

Regarding total developmental time from egg to adult, data in Table 1 showed that when the mite fed on eggplant, tomato and pepper discs at 27±4°C, the total developmental time from egg to adult, insignificant variations ($p \leq 0.05$) were detected between host plants. Similar results were obtained by Awad[33] who showed that, life cycle of *T. urticae* was completed in 11.92 and 12.98 days when fed on persimmon and pecan leaves, respectively at 27±2°C and 70±4% R.H.

Generation period of *T. urticae* was influenced by host plants. On leaf discs of the tested crops at 27±4°C and 70±4% R.H. the mite completed a full egg to egg cycle when mite female fed on eggplant, tomato and pepper leaves, respectively (Table 1). Abdelaal *et al.*[34], reported that generation time of *T. urticae* averaged 13.64 and 13.93 days when mite feeding was done on soybean and cowpea leaves. Moreover, Hanna *et al.*[25], reported that generation time of *T. urticae* durated 11.38 and 11.43 days 27±4°C when mite fed on the two soybean varieties, Hampton and Gacson, respectively.

The investigated host plants were differed in their effect on life span of the tetranychid mite *T. urticae*. Longer life span was recorded on eggplant leaves. However, comparatively lower values of *T. urticae* life span were recorded on pepper and tomato leaves, respectively. Life span of *T. urticae* averaged 25.69 and 27.06 days on soy bean and common bean leaves, respectively[34].

Data tabulated in Table 2 indicate that, the time from maturation to the first egg (preoviposition period) on eggplant and tomato. Whereas, these values increased on pepper leaves. Female of *T. urticae* continued to deposit eggs for a period when they fed on eggplant and tomato leaf discs, respectively, considerably longer than that reared on pepper leaf discs. Similar results were obtained by Abdelaal *et al.*[34], who showed that, oviposition period of

Table 3: Fecundity of *T. urticae* when reared on three solanaceous crop leave sunder laboratory conditions

	Number of deposited eggs per female	
Crop	Total average	Daily mean
Eggplant	61.13±1.00	5.49±0.04
Tomato	51.86±0.90	5.22±0.07
Pepper	43.33±0.79	5.04±0.09
$L.S.D_{0.05}$	02.658	0.199

±(SE): Standard error. Each value is a mean of 15 replicates

T. urticae female averaged 9.83, 8.88 and 11.63 days on soybean, peanut and common bean leaf discs, respectively at 25±2°C and 60±5% R.H.

Before death of *T. urticae* adult female, it stopped egg laying for a period on tomato, pepper and eggplant leaf discs, respectively (Table 2). Gotoh[29], reported that, most females of *T. viennensis* died within one or two days after the end of oviposition.

Adult female longevity of *T. urticae* significantly ($p \leq 0.05$) affected by type of host plant, when reared on eggplant, tomato and pepper leaves. The longest longevity period was recorded on eggplant leaves. Contrarily, the shortest longevity values were recorded on pepper leaves.

The total average and daily mean of deposited eggs per *T. urticae* female were significantly ($p \leq 0.05$) influenced by host plant species. Feeding on leaves of eggplant resulted in significantly greater number of deposited eggs with the highest daily rate. The least number of deposited eggs was recorded on pepper leaves with the least value of daily rate. Moderate values of the total average and daily mean of deposited eggs per *T. urticae* female were recorded on tomato leaves (Table 3). Similar results were obtained by Wekesa *et al.*[35], when *T. evansi* reared on eggplant, tomato and nightshade resulted in the highest production of eggs while cherry tomato and pepper both resulted in significantly less eggs. Generally, the findings of this study are in agreement with similar studies on tetranychid species. Van de Vrie *et al.*[7] showed that, the rate of development of the immature stages of tetranychids is influenced by temperature, humidity and quality of food. Carey and Bradley[36] indicated that, the developmental times are only slightly affected by the host plant. The diverse host plant species may have the different effects on the spider mite *T. urticae*[23,24,37].

From the previous results, it can be concluded that, the two-spotted red spider mite *T. urticae* is considered a serious pest on some solanaceous crops. In the future, further solanaceous vegetable crops should be tested and their physical and chemical properties related to population development of *T. urticae*, especially leaf structure should be clarified.

CONCLUSION

Pepper is less suitable for development and reproduction of *T. urticae* compared to tomato and eggplant. In future, it is necessary to test host suitability of many pepper cultivars hoping to find resistant cultivars that can be used safety in the integrated pest management against this pest. This study is very important when designing integrated management programs against this pest on the tested crops to choose the most effective host plant in mass production in biological control studies.

SIGNIFICANCE STATEMENT

In this study it was discovered that pepper is less suitable for development and reproduction of *T. urticae* compared to tomato and eggplant. It is necessary to test host suitability of many pepper cultivars hoping to find resistant cultivars that can be used safety in the integrated pest management against this pest.

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