



The Relationship between Temperature, *Tetranychus urticae* and Cucumber Hybrids

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ABSTRACT

Three different temperature degrees (25, 30 and 35°C) were used to study their effect on the biology of two spotted spider mite (*Tetranychus urticae*). The results demonstrated that the longest developmental time was 9 days at 25°C and the shortest developmental time was 6.8 days at 35°C with R.H.65±5%. The maximum period of adult longevity was 17 days at 25°C, and minimum longevity was 13.8 days at 35°C. The pre- oviposition period was 1.5, 1.3, and 0.9 days at 25, 30 and 35°C, respectively. Oviposition period was 8, 7 and 6 days as above mentioned temperature. The highest number of eggs (31.67) was laid at 25 °C after three days and minimum eggs (6.67) were deposited after five days at 35°C. The highest number of larvae which 43 larvae was observed at 35°C after six days and the minimum number 1.17 was recorded at 25°C after three days. As well as, the highest number of nymphs (27.67) was noticed after seven days at 30°C, whereas the lowest number of nymphs (1 nymph) found after four days at 25°C. The Unigene cucumber hybrid showed more resistant to *T. urticae* with lowest mean numbers (267.89, 54.67 and 247.11) of eggs, adults and lesions respectively. While, Saef hybrid was the most susceptible variety with (694.44, 315.89 and 1226.67) for the eggs, adults and lesions respectively.

1. INTRODUCTION

The cucumber (*Cucumis sativus* L.) is one of the most important cultivated crops that belong to the Cucurbitaceae family, have benefits for example contains alkaline forming minerals, an ascorbic acid antioxidants and vitamin B complex. (Maheshwari *et al.*, 2014). *Tetranychus urticae* is one of the most serious agricultural pests in the world. This mite is polyphagous and attacks the broad range of crops. The importance of this mite pest is not only due to direct damage to the plants (i.e. defoliation, leaf burning, and an excessive outbreaks plant death) but also indirect damage

to the plants which decrease both photosynthesis and transpiration. The rapid developmental rate and high reproductive of *T. urticae* allows them to cause damage very quickly when growth conditions are suitable, resulting in a rapid decline of host plant quality (Skorupska, 2004).

The high temperature and non-humid climates are suitable for the development and outbreak of the two-spotted spider mite (Leite *et al.*, 2003). The population growth parameters of *T. urticae* such as developmental rate, survival, reproduction and longevity are

varying according temperature, host phenological stage and relative humidity (Liu and Tsai 1998, and El-Halawany 2001).

Host plant preference and performance are positively correlated, but not always in some cases no correlation or a negative relationship was found between preference and performance (Mayhew, 1997). Wilson and Huffaker, (1976) mentioned that the use of resistant plants could affect pest population density, herbivore damage, and the efficiency of natural enemies and in turns reduce pesticide applications in agricultural ecosystems.

Female spider mites forced to feed on non-preferred host plants generally have low fecundity (Greco *et al.*, 2006). Spider mites disperse mostly in a passive way through wind they are likely to end up near new hosts, hence their selection of host plants should be thought of in terms of acceptance, rather than host finding (Sabelis, 1985). On the other hand, as they are constantly exposed to herbivore damage, plants are known for their ability to defend themselves against pathogens and herbivores (Karban and Baldwin, 1997).

2. MATERIALS AND METHODS

2.1. Preparing stock culture of *T. urticae*

T. urticae specimens were collected from cucumber (*Cucumis sativa* L.) leaves at fields located around Erbil province. They were maintained in the laboratory at $26 \pm 2^\circ\text{C}$. The spider mites were reared on fresh leaves. After several generations, the mites from the stock colony were used for the tests (Riahi *et al.*, 2013). collected mites were maintained on the detached sprouts and leaves of cucumber. Infested plants were kept in wood-framed rearing cages (120x60x60 cm).

2.2. The Effect of Temperature on Biology of *T. urticae*.

The effect of temperature on the biology of *T. urticae* was studied using leaf disk, according the method proposed by El-Halawany (2001), with some modifications, as one leaflet from the first fully expanding leaf at the top per plant of the cucumber, was taken and then it was washed with running water to remove any possible residuals or mites, which may be found on these leaves. Leaf discs of about 3 cm in diameter were made and surrounded by Arabic gum, which acts as a barrier to prevent mite individuals from escaping. These discs were placed on pieces of moisten cotton wool in petri dishes (10-cm diameter) with two couple (male and female) was placed on each disc, on the lower surface of the leaf, for each replicate (six replicates for each temperatures). These petri dishes were kept at three different temperatures (25, 30, and $35 \pm 2^\circ\text{C}$ and $70 \pm 5\%$ R.H.), for 24 hours to allow mating. Thereafter, males were removed, while female served as a source for eggs, which in turn produce known-age larvae. The moisture was kept constant by adding few drops of water to the cotton wool. About 60 hatching larvae were trans and kept singly to a leaf of each plant and left to continue their life span. Observation was made twice daily, early in the morning, and in the evening, under a dissecting microscope (40X). For each temperature, data were recorded for seven days; only data in oviposition period was recorded for five days (El Halawany, 2001 and Romeih *et al.*, 2013).

2.3. Effect of host plant and their variety (hybrid) on the mite population dynamic.

From Erbil Research Center of Ministry of Agriculture, field was prepared for planting cucumber in greenhouse. Three different hybrids, (Saef hybrid, Unigene hybrid and Non- Hamus hybrid) of cucumbers were planted in three rows in order to determine which hybrid is resistant or susceptible to the mites infestation. Ten days after planting cucumbers, Topsin at concentrate 1g/5m and Rival at concentrate 5ml/5m² (Fungicides) were added to the soil according to the

manufacture instructors to control soil fungus; the process was repeated each three weeks. Additionally, in the first stage growth of plants, nutrient deficiency was observed in some leaves like P, Fe, and Mg... etc. NPK was used once a week to prevent the nutrient deficiency. HumiMax it's a fertilizer was added to the soil to increase growth of flowers. To prevent fungal disease Goldazane fungicide was used according to manufacture instructors (5ml/5m²). In the last stage plants growth they infected with 20 mites artificially in order to determine the resistant and susceptibility of plants (Razmjou *et al.*, 2009). Cucumber resistance to mite infestation in greenhouse (plastic house) were tested. Seeds were planted in perlites that were filled with. Patmos after five days; the seedlings were transplanted to the plastic house. Three hybrids of cucumber were planted which were Saef hybrid, Unigene hybrid and Non Hamus 14 hybrid. Each greenhouse of cucumber hybrid was tested with 15 replicates including 5 replicates as negative control (healthy plant) then seedlings were kept in plastic house at 28±2°C. Samples were taken from each hybrid after one week infecting by the mite; three leaves were included for each hybrid. The samples were conveyed to the lab to numerate the number of eggs, immature and mature stages and the number of spots (lesions) per cubic centimeter (Mohammadi *et al.*, 2015). The data was recorded every two days throughout the study period

3. RESULTS AND DISCUSSION

Data in table (1) indicated that, the shortest average developmental time of *T. urticae* 6.8 days at 35°C with R.H.65±5% and the longest developmental time was 9 days at 25°C. Moreover, the mean generation times 7 and 9 days at 35°C and 25°C subsequently were recorded. The average pre-oviposition periods was 1.5, 1.3, and 0.9 days at 25, 30 and 35°C,

respectively. Average, oviposition period was 8, 7 and 6 days respectively as above mentioned temperature degrees. Results in table (1) clearly demonstrated that the maximum average period longevity was 17 days recorded at 25°C. While the minimum time value was 13.8 days at 35°C. Different results were obtained by Riahi *et al.*, (2013) who recorded insignificant impact of temperature on the male longevity in contrast; adult female longevities of *T. urticae* were significantly different among the different temperatures examined the longest at 25 °C (12.91 days) and the shortest at 30 °C (3.56 days). These differences can probably be attributed to the following two reasons: (a) the geographical origin and adaptation of the *T. urticae* population (b) different laboratory conditions such as photoperiod and humidity. Data present in table (2) showed that the average number of eggs, larvae and nymphs was decreased as the temperature increased as it was 17.5, 11.92 and 10.96 eggs at 25, 30 and 35°C respectively, and 14.71, 12.17 and 9.13 larvae at 25, 30 and 35 °C respectively, and 10.96, 6.79 and 8.5 nymphs at 25, 30 and 35°C respectively. While in the adult the average number of adult was increased as the temperature increased as it was 1.46, 2.38 and 4.63 at 25, 30 and 35°C respectively. Results above showed that there are no significant differences between number of eggs, larvae, nymphs and adults at the different temperature (25, 30 and 35°C), but the highest mean were observed at 25°C in all immature stages, while in adult showed reversed result that the highest mean number were observed at 35°C. the results also could be agree with Cossins and Bowler,(1987) that the developmental rate, expressed as the reciprocal of time taken to change from one stage to another, is nothing at the low temperature threshold, increases with temperature and levels off at the optimum, and then decreases rapidly as the high threshold is

approached. El-Halawany, (2001) recorded the longest longevity 26.45 and 20.3 days at 15 and 20°C, of *T. urticae*, and duration of different developmental stages was 7.23 days at 30°C when fed on Cadota fig variety.

Fig. (1) revealed that the maximum eggs were laid after three days among tested temperatures. Meanwhile the highest number of eggs (31.67) at 25 °C were laid by *T. urticae* after three days, and the minimum were 10.67 after one day at same temperature, followed by 30°C which recorded highest and lowest number of eggs (22.67 and 6.67) after (3 and 5) days respectively.

The larvae not observed among determined temperatures in the first two days, whereas the maximum larvae (4.33, 23, 22.67, 43 and 28 respectively) recorded during last five days at 35°C. Meanwhile minimum numbers of larvae (1.17, 16.33, 20, 37 and 20 respectively) were observed by 25°C at same days, as well as the 30°C showed variation in a number of larvae with 3.33, 20.33, 20.67, 38 and 23 respectively (Fig.2).

In the first three days there was no nymph observed among tested temperatures, while the number of nymphs was increased by all tested temperatures. Thus, lowest numbers of nymphs were recorded 1.00, 1.33, and 1.67 at 25, 30 and 35°C respectively during the 4th day whereas maximum number of nymphs were occurred in the last day of the experiment 26, 27.67 and 25.67 at 25, 30 and 35°C respectively (Fig.3). Dicke, (2000) and James and price, (2002) indicated that the population growth parameters of *T. urticae* such as developmental rate, survival, reproduction and longevity may vary in response to changes in temperature, host plant species, host plant nutrition, cultivar kind, phenological stage, exposure to pesticides and relative humidity. Gulati, (2004) revealed that *T. urticae* population showed positive correlation with

high temperature and negative correlation with low temperature. Sunita, (1996) reported positive correlation between mite population and minimum temperature.

Table (3) revealed the relationship between *T. urticae* and three hybrids of cucumber plant. The results showed that the highest population of *T. urticae* eggs, adults and spot lesions caused by sucking mites were observed in Saef hybrid with 694.44 eggs, 315.89 adult and 1226.67 spot lesions on lower leaf surface with average of 306 cm². While the lowest mean number of eggs, adults and lesions were recorded on Unigene hybrid of cucumber with 267.89 eggs, 54.67 adults and 247.11 lesions, respectively on lower leaf surface with average of 253 cm². According the statistical analysis there were no significant differences between Saef hybrid and Unigene hybrid in number of adults, eggs, and lesions.

According to the results Unigene hybrid showed greatest resistant to *T. urticae* according to number of eggs, adults and spot lesions, meanwhile *T. urticae* was well adapted to Saef hybrid and caused high number of spot lesions (1226.67) of cucumber leaves by sucking out the contents of leaf sap. Similar results were also obtained by Ghallab *et al.*, (2011) who revealed that Nemsse cultivar harbored the highest infestation of spider mites, with mean numbers of 77.8 individuals, followed insignificantly by Sweet crunch cultivar (52.5 individuals), while Xena cultivar recorded the lowest infestation (18.9 individuals / 40 leaves). The results also are in accordance with Mondel and Ara, (2006); Kumaran *et al.*, (2007) they demonstrated that *T. urticae* is responsible for causing the loss of foliage of the crop resulting in reduction of the economic yield of fruits ranging from 20-45 % depending upon cropping season and agro-climatic conditions. *T. urticae* is well adapted to various environmental conditions, causing

loss of quality and yield or death of plants by sucking out the contents of leaf cells.

Host plants of spider mites differ in the degree of food quality, which either depend on the level of primary plant metabolites, or on the quantity and nature of secondary metabolites (Rosenthal and Berenbaum, 1991). Many secondary metabolites found in plants have a responsibility in defense against herbivores, pests and pathogens. These compounds can perform as toxicants, deterrents, digestibility reducers or act as precursors to physical defense systems (Bennett and Wallsgrove, 1994; Balkema- Boomstra *et al.*, 2003).

Wilson and Huffaker, (1976) indicated that the nutritional quality, host plant species, cultivar, physiological, ecological and chemical traits of the host plant may influence the life history parameters of spider mites and therefore the degree of plant resistance.

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Table (1): The temperature effects on the life table parameters of *T. urticae*

Parameter	Temperature (°C)		
	25	30	35
Developmental time (days)	9	7.6	6.8
Pre-Oviposition period (days)	1.5	1.3	0.9
Oviposition period (days)	8	7	6
Generation time (days)	9.7	7.8	7

Longevity (days)	17	15.4	13.8
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Table (2): Effect of Temperature on *T. urticae* stages on cucumber hybrid

Mite stage	°C	Mean ± SD	F	Sig
Egg	25	17.5 ± 13.49	2.96	0.06
	30	11.92 ± 7.6		
	35	10.96 ± 8.01		
larva	25	14.71 ± 17.26	1.13	0.33
	30	12.17 ± 12.14		
	35	9.13 ± 7.24		
nymph	25	10.96 ± 17.92	0.67	0.52
	30	6.79 ± 7.5		
	35	8.5 ± 9.69		
Adult	25	1.46 ± 3.97	1.49	0.23
	30	2.38 ± 5.42		
	35	4.63 ± 9.12		

Table (3): The susceptibility of three cucumber hybrids to infested by *T. urticae*

Cucumber variety		Mean ± SD	F	Sig.
Eggs	Saef hybrid	694.44 ± 1010.38	0.93	0.41
	Unigene hybrid	267.89 ± 490.93		
	Non Hamus 14 hybrid	371.67 ± 417.78		
Adults	Saef hybrid	315.89 ± 455.70	1.37	0.27
	Unigene hybrid	54.67 ± 91.16		
	Non Hamus 14 hybrid	252.33 ± 386.50		
Lesions	Saef hybrid	1226.67 ± 1509.77	1.15	0.33

	Unigene hybrid	247.11±348.25		
	Non Hamus 14 hybrid	1138.33 ±2115.67		

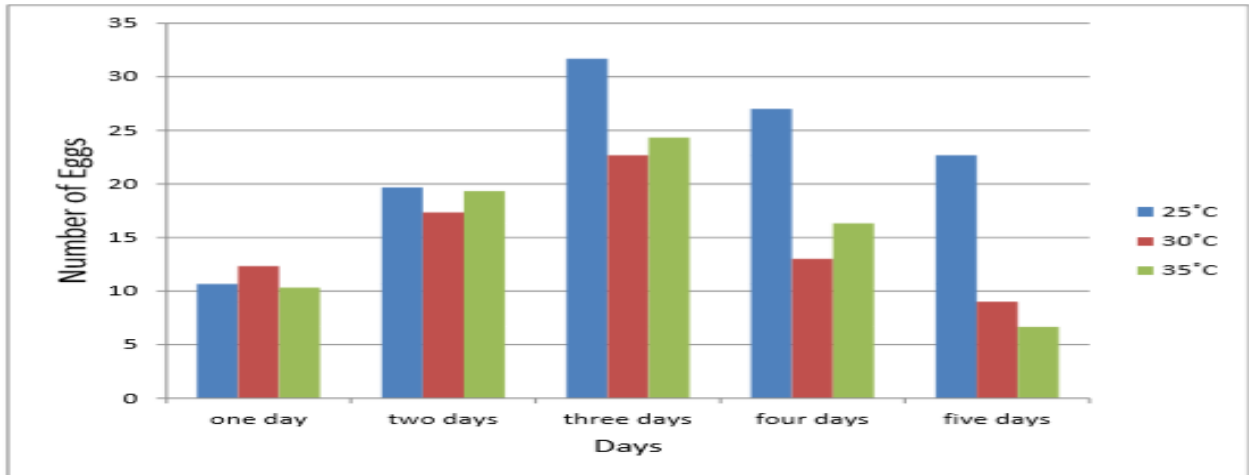


Fig.1: Effect of temperatures on the egg laying by *T. urticae* on cucumber

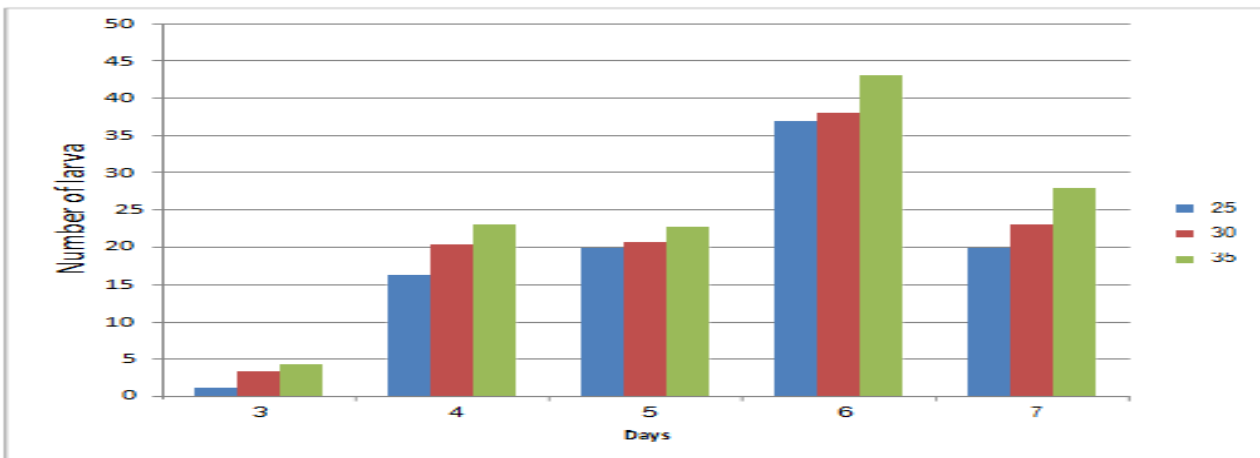


Fig.2: Effect of temperatures on the larvae appearance of *T. urticae* on cucumber

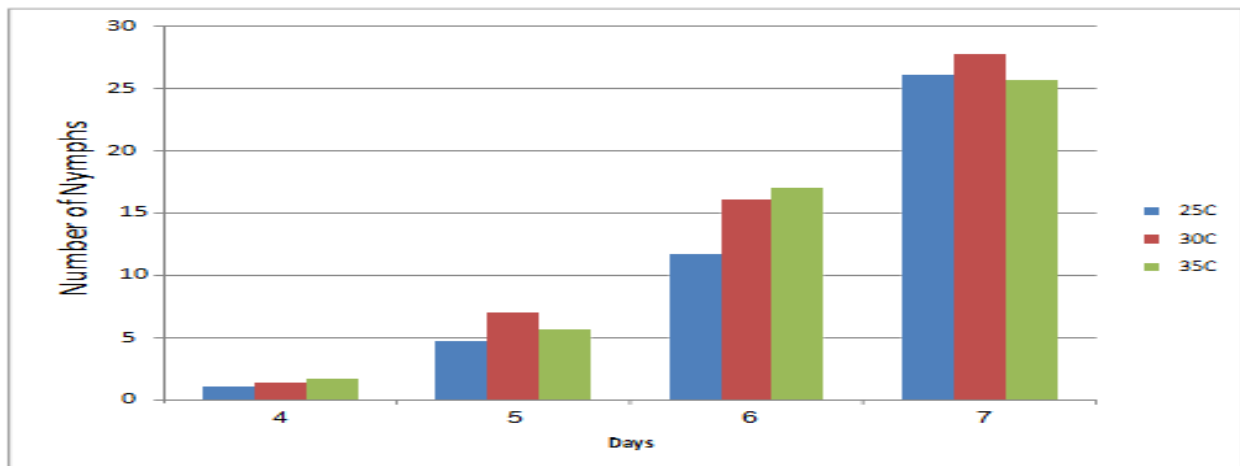


Fig.3: Effect of temperatures on the Nymphs appearance of *T. urticae* on cucumber