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Influence of some Host Plants on Reproduction and Biological Aspects of Two Spotted Spider Mite *Tetranychus urticae* (Koch)

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ABSTRACT

Field reproduction under natural conditions and biological aspects of *Tetranychus urticae* under laboratory conditions at 27±1 ºC & 60-74 RH% on six different host plants namely; squash, *Cucurbita pepo* & cucumber, *Cucumis sativus* (Fam. Cucurbitaceae), eggplant, *Solanum melongena* & tomato, *Lycopersicon esculentum* (Fam. Solanaceae) and bean, *Phasseolus vulgaris* & cowpea, *Vigna sinensis* (Fam. Fabaceae) were occurred and showed that, the number of eggs and moving stages were slowly increased in the beginning of season compared with that at the end. Total number was increased to reach its maximum in the middle of June, then sharply declined thereafter. Cowpea and bean which belonged to family Fabaceae were considered the least preferred host plants due to little reproduction in the field and a few eggs laid were evident under lab. conditions. In general, the ability of *T.urticae* for plant infestation was deferred according to morphological shape of plant leaves which assist to protect different stages of *T.urticae* against environmental factors. So, squash plant considered the suitable plants for *T. urticae* reproduction due to trichomes, spin , gaps and large area of leaves followed by cucumber, eggplant, tomato, bean and cowpea. Cowpea plants was the best host for infestation tolerance because of smoothly and thickness of leaves. Significant positive correlation between population of *T. urticae* and temp. and insignificat negative with RH% were evident.

INTRODUCTION

The two-spotted spider mite, *Tetranychus urticae*, is a ubiquitous polyphagous arthropod herbivore that feeds on a remarkably broad array of species, with more than 150 of economic value. It is a major pest of greenhouse crops, especially in *Solanaceae* and *Cucurbitaceae* (*e.g.*, tomatoes, eggplants, peppers, cucumbers, zucchini) and greenhouse ornamentals (*e.g.*, roses, chrysanthemum, carnations), annual field crops (such as maize, cotton, soybean, and sugar beet), and in perennial cultures (alfalfa, strawberries, grapes, citruses, and plums) (Jeppson, *et al*, 1975). Plants constitutively emit blends of volatiles that can attract herbivores. In many cases the volatiles are specific for herbivory, or even for the herbivore species that inflicts the damage. Herbivores may also use these induced volatiles during host-plant selection, (Visser, 1986 and Dicke & Vet, 1999). The characteristics of host plant acceptance of the *T. urticae* are discussed in light of their potential food resource under natural conditions. Host plant acceptance and fecundity were positively correlated across 11 potential host plants, host plant species on which the fecundity was low were also those on which females settled less readily compared to host plants with high fecundity (Shuichi Yano, 1998)..To test for local adaptation of herbivore populations to a given host plant species, a common practice is to compare their fitness components (e.g., life-history traits) on this plant species with those displayed by other herbivore populations that have evolved on a different plant species (Kawecki and Ebert, 2004). Eggplant, *Solanum melongen* L. is one of the most important solanceous crops it is a good source of nutrients, minerals, antioxidants, vitamins, dietary fiber and body building factors and proteins (Matsubara *et al*. 2005) . Plants and herbivores exert strong selective pressures upon each other, Their ability to get around host plant defenses is particularly important for polyphagous species, which can feed and reproduce on several plant families (Schoonhoven *et al*., 2005).. In Fayoum, *T. urticae* ,was reported as the main mite pest found on marjoram all over the season (Rahil,2006).

Recent studies revealed that adaptation of this herbivore to one host plant could facilitate exploitation of other host plant species and therefore broaden its host range (Magalhães *et al*., 2009; Fellous *et al.,* 2014). The spherical black cultvar was the most susceptible to spider mites, while long black cultivar was lowest level infestation (Azouz, *et al* 2014).

The host plant species can affect critical parameters of population dynamics, and most importantly that maternal and environmental conditions can facilitate colonization and exploitation of a novel host in the polyphagous *T. urticae*, by affecting dispersal behavior (host acceptance) and female fecundity (Cassandra Marinosci, *et al,* 2015).The in-vitro study on the biology of two spotted spider mite *T. urticae*. on some of the preferred host plants viz., okra, egg plant, french bean, pumpkin, tomato, tapioca and mulberry revealed that the egg, larval, protonymphal and duetonymphal stages, adult longevity, pre-oviposition period and post-oviposition period were the shortest on okra followed by egg plant, french bean, tomato, tapioca, pumpkin and mulberry. The oviposition period, sex ratio and the fecundity were more and prolonged on okra followed by egg plant, french bean, tomato, tapioca, pumpkin and mulberry. *T. urticae* showed relatively better performance on okra, which might be attributed to increased level of total chlorophyll, total sugars, protein and lesser wax content, phenol and silica compared to rest of the host plants (Poovizhiraja *et al.,* 2016).The aim of the present work was to study the effect of different host plants on reproduction of *T.urticae* under natural conditions and biological aspects under lab.conditions.

MATERIALS AND METHODS

1- Field reproduction of *T. urticae* under natural conditions:

These investigation including two parts, the first part was carried out in Faculty of Agricultural farm to study the effect of weather factors (ºC & RH%) and host plants on reproduction of *T. urticae*. For this purpose 6 host plants of vegetable crops were cultivated in 1200 m^2, each 200 m^2/ one host cultivated and was divided into four replicates. Seeds were planted in March 15 and the first sample was obtained after 15 days of planting and followed by weekly samples. Six

host plants namely squash, *Cucurbita pepo* & cucumber, *Cucumis sativus* (Fam. Cucurbitaceae), eggplant, *Solanum melongena* & tomato, *Lycopersicon esculentum* (Fam. Solanaceae) and bean, *Phasseolus vulgaris* & cowpea, *Vigna sinensis* (Fam. Fabaceae). Each sample was represented by ten leaves for each replicate.

2- Biological aspects of *T. urticae* under lab.conditions*:*

The second part was conducted under laboratory conditions 27±1 ºC & 60-74 RH% to study the effect of the same previous hosts on biological aspects of *T. urticae*. So females were transferred from leave samples of each crop and reared under laboratory conditions on the same host plants. Biological observations were conducted and recorded such as; incubation periods of eggs, larval, protonymphal, deutonymphal periods , longevity and life span of females and males and fecundity of females were recorded.

RESULTS AND DISCUSSION

A)Field reproduction of *T. urticae*:

1- On Cucurbitaceae host plants :

As shown in Table 1, samples obtained in the beginning of sowing plants were indicated that the number of eggs and moving stages were the lowest compared with that at the end of season. On squash plants, numbers were increased gradually from the first sample to reach the highest number (812 eggs and 1288 individuals) at the third week of June then sharply decreased to reach 312 eggs and 1029 individuals at the end of June. The same trend was occurred with numbers on cucumber plants (715 eggs and 1105 individuals). Numbers of *T. urticae* stages on squash plants were higher compared with that of cucumber plants. So squash plants considered more favorable host for *T. urticae* reproduction than cucumber plants.

Table 1. Total number of *T. urticae* stages from April to June 2017 on cucurbitaceae plants.

Sampling date	Population of *T. urticae* on Cucurbitaceae crops						Weather factors	
	Squash			Cucumber			C	RH%
	E	M	T	E	M	T		
1/4/2017	2	0	2	3	0	3	24.9	40
8/4	3	6	9	2	8	10	21.8	34
15/4	4	12	16	3	12	15	26	47
22/4	15	21	36	7	15	22	24.4	24
30/4	14	40	54	12	20	32	23.9	33
8/5	25	56	81	22	34	56	25.2	34
15/5	30	94	124	31	51	82	28.9	26
22/5	74	222	296	55	167	222	28.6	38
29/5	105	297	402	85	259	344	27.2	28
5/6	205	579	784	180	519	699	28.9	28
12/6	480	1048	1528	404	897	1301	26.2	33
19/6	812	1288	2100	715	1105	1820	30.1	33
26/6	321	1029	1350	192	1048	1240	32.3	29
Total	2090	4692	6782	1711	4135	5846		
Mean	161.5	345.5	507.0	131.2	317.0	448.2		

E= Eggs, M= Moving stages, T= Total

2- On Solanaceae host plants :

The obtained results in Table 2, indicated that, moving stages of *T. urticae* were appeared in the second weekly sample of eggplant and increased gradually to reach the heighest number in June 19, 554 eggs then declined to 425 eggs at finally samples of season but moving stages was increased continuously from second sample (2 individuals) to reach 1437 at the finally samples of season. The same trend of moving stages data was occurred with total number of eggs and moving stages. Total number of *T. urticae* on tomato plants was increased to reach the heighest (826) at the end of season except in sample of June 12 it was declined to (334). Total numbers of eggs and moving stages were started with few numbers then increased gradually to reach the highest number at the end of season. Total numbers on eggplant (1862) was higher than that on tomato plant (826). So it could be concluded that eggplant considered more favorable host for *T. urticae* reproduction than tomato plants.

Table 2. Total number of of *T. urticae* stages from April to June 2017 on Solanaceae plants.

Sampling date	Population of T. urticae on Solanaceae plants						Weather factors	
	Egg plant			Tomato				
	E	M	T	E	M	T	C	RH%
1/4/2017	0	0	0	1	0	1	24.9	40
8/4	1	2	3	1	2	3	21.8	34
15/4	3	6	9	2	6	8	26.0	47
22/4	4	9	13	4	6	10	24.4	24
30/4	10	21	31	7	10	17	23.9	33
8/5	15	19	34	10	13	23	25.2	34
15/5	23	40	63	21	26	47	28.9	26
22/5	34	140	174	26	87	113	28.6	38
29/5	63	198	261	62	162	224	27.2	28
5/6	127	395	522	107	335	442	28.9	28
12/6	308	793	1101	110	224	334	26.2	33
19/6	554	1086	1640	182	472	654	30.1	33
26/6	425	1437	1862	253	573	826	32.3	29
Total	1567	4146	5713	786	1916	2702		
Mean	120.5	318.0	439.5	60.54	147.4	207.8		

E= Eggs, M= Moving stages, T= Total

3- On Fabaceae host plants :

As shown in table 3, eggs of *T. urtica*e on bean plants were appeared with the first sample and moving appeared in the second. On cowpea plants, both eggs and moving stages were appeared in 5th sample at the end of April. Total numbers of *T. urticae* in both 2 crops were started with a few numbers (2 and 4 for bean and cowpea, respectively) then weekly increased to reach the highest number (669 and 276) in June, then decreased gradually at the end of season. Also numbers on bean plants were high compared with that on cowpea crop. So bean plants considered more favorable host for *T.urticae* reproduction than cowpea plants.

Results presented in Table 4, cleared that, among 6 host crops belonged to three families namely, Cucurbitaceae, Solanaceae and Fabaceae. The first family considered more favorable host compared with other families where the mean number of eggs and moving stages on plants of this family were higher than that on other plants. Significantly different were evident except between cucumber and egg plants. Squash plants is the most favorable host plants to *T. urticae*.

Finally, it could be concluded that the ability of *T.urticae* for plant infestation was deferred according to morphological shape of plant leaves which assist to protect different stages of *T.urticae* against environmental factors. So, squash plant considered the suitable plants for *T. urticae* reproduction due to trichomes, spin , gaps and large area of leaves followed by cucumber, eggplant, tomato, bean and cowpea. Cowpea plants was the best host for infestation tolerance because of smoothly and thickness of leaves. Significant positive correlation between population of *T. urticae* and temp. and insignificat negative with RH% were evident. This is also supported by the findings of Zaher *et al*.(1978) who found that *T.urticae* population increased with increasing density to a maximum then decreased thereafter. Also, agreement with studies of Rahil 2006 and Al-Sayed 2014, was occurred.

Table 3. Total number of *T. urticae* stages from April to June 2017 on Fabaceae plants.

Sampling date	Population of *T. urticae* on Fabaceae crops						Weather factors	
	Bean			Cowpea				
	E	M	T	E	M	T	C	RH %
1/4/2017	2	0	2	0	0	0	24.9	40
8/4	1	3	4	0	0	0	21.8	34
15/4	4	8	12	0	0	0	26.0	47
22/4	6	12	18	0	0	0	24.4	24
30/4	10	13	23	1	3	4	23.9	33
8/5	17	24	41	2	6	8	25.2	34
15/5	31	43	74	3	6	9	28.9	26
22/5	51	157	208	20	32	52	28.6	38
29/5	81	238	319	40	78	118	27.2	28
5/6	134	460	594	91	151	242	28.9	28
12/6	154	515	669	117	159	276	26.2	33
19/6	239	214	453	65	119	184	30.1	33
26/6	98	195	293	42	106	148	32.3	29
Total	828	1882	2710	381	660	1041		
Mean	63.7	144.8	208.5	29.3	46.9	76.2		

E= Eggs, M= Moving stages, T= Total

Table 4 Mean total number of *T. urticae* stages from April to June 2017 on different host plants .

T. urticae stages	Population of *T. urticae* on vegetable plant families					
	Cucurbitaceae		Solanaceae		Fabaceae	
	Squash	Cucumber	Egg plant	Tomato	Bean	Cowpea
E	161.5a	131.2ab	120.5b	60.54c	63.7c	29.3d
M	345.5a	317.0a	318.0a	147.4b	144.8b	46.9c
T	507.0a	448.2b	439.5b	207.8c	208.5c	76.2d

E= Eggs M= Moving stages, T= Total

Means within a row followed by the same letter are not significantly different at the 5% level of probability (Duncon test)

Table 5. Correlation between *T.urticae* population on different host plants and (Temp. & %RH).

Family	Crop	Mite stage	Temp.		RH%	
			r	p	r	p
Cucurbtaceae	Squash	Egg	0.554*	0.049	- 0.130	0.671
		Moving	0.677*	0.011	- 0.208	0.494
		Total	0.636*	0.019	- 0.175	0.567
	Cucumber	Egg	0.501*	0.081	-0. 111	0.718
		Moving	0.697*	0.008	- 0. 216	0.478
		Total	0.651*	0.016	- 0.187	0.541
Solanaceae	Eggplant	Egg	0.670*	0.012	- 0.171	0.577
		Moving	0.730**	0.005	-0.212	0.487
		Total	0.720**	0.006	-0.202	0.508
	Tomato	Egg	0.792**	0.001	-0.288	0.340
		Moving	0.803**	0.001	-0.283	0.348
		Total	0.802**	0.001	-0.286	0.344
Fabaceae	Bean	Egg	0.653*	0.016	-0.246	0.418
		Moving	0.668*	0.013	- 0.268	0.375
		Total	0.786**	0.012	- 0.332	0.383
	Cowpea	Egg	0.740**	0.001	- 0.331	0.268
		Moving	0.761**	0.004	- 0.333	0.269
		Total	0.808**	0.003	- 0.327	0.266

****Significant at 5% level of probability *Significant at 1% level of probability**

B) Biological aspects of *T. urticae* on six host plants:

1-**Female duration:**

As shown in Table 6, the shortest incubation period of eggs was occurred with squash host plant (2.4 days) and was significantly prolonged with cowpea host plant (4.2 days) compared with that at other host plants. Insignificant differences was evident with larval, protonymphal and deutonymphal stages. Total immature duration was significantly prolonged to reach 14.1 days at cowpea compared with other host plants which recorded, 11.1, 11.3, 11.6, 11.8 and 11.4 days at squash, cucumber, eggplant, tomato and bean, respectively.

2- Female longevity and fecundity:

The longest oviposition period and longevity were significantly recorded on squash 14.4 and 20.3 days while the shortest were recorded on cowpea 8.1 and

11.9 days. Data obtained, indicated that different host plants significantly affect the fecundity of females as the number of eggs / female was 172.6, 120.5, 87.1, 58.6, 30.4 and 21.4 days on squash, cucumber, eggplant, tomato, bean and cowpea, respectively. From previous data it could be concluded that, squash was the best favorable host plant as a short total immature period, longer longevity, oviposition period and higher fecundity.

Table 6. Biological aspects of *T. urticae* females under laboratory conditions 27±1 ºC & 62-73 RH %.

Female stages *T.urticae*	Different vegetable plants					
	Cucurbitaceae		Solanaceae		Fabaceae	
	Squash	Cucumber	Egg plant	Tomato	Bean	Cowpea
Egg incubation period	2.4±0.5 a 2-3	2.7±0.3 a 2-3	2.6±0.3 a 2-3	3.1±0.4 a 3-4	3.0±0.5 a 2-4	4.2±0.4 a 3-5
Larva	2.2±0.1 a 2-3	2.4±0.2 a 2-3	2.5±0.2 a 2-3	2.5±0.2 a 2-3	2.7±0.2 a 2-3	2.9±0.1 a 2-3
Protonymph	2.7±0.2a 2-3	2.6±0.2 a 2-3	2.9±0.2 a 2-3	3.1±0.2 a 3-4	3.7±0.2 a 3-4	4.0±0.2 a 3-5
Deutonymph	3.8±0.1 b 3-4	3.9±0.2 b 3-5	3.9±0.1 b 3-4	3.8±0.1 b 3-4	2.6±0.2 b 2-3	4.8±0.1 a 4-5
Total immature	11.1±0.3 b 10-12	11.3±0.4 b 9-13	11.6±0.3 b 11-13	11.8±0.3 b 10-13	11.4±0.4 b 9-13	14.1±0.3 a 12-15
Pre-oviposition	1.6±0.2 a 1-2	1.6±0.2 a 1-2	1.5±0.2 a 1-2	1.7±0.2 a 1-2	1.6±0.2 a 1-2	1.8±0.1 a 1-2
Oviposition	14.4±0.5 a 13-17	13.6±0.7 a 11-18	12.4±0.3 b 11-14	13.5±0.3 a 12-15	10.7±0.2 c 10-11	8.1±0.2 d 7-9
Post-oviposition	4.2±0.2 a 3-5	3.7±0.2 b 3-4	3.1±0.2 c 2-4	3.0±0.2 c 2-4	3.1±0.2 c 2-4	2.0±0.1 d 1-3
Longevity	20.3±0.5 a 18-24	18.9±0.8 b 15-24	17.0±0.4 c 15-19	18.2±0.4 bc 16-20	15.5±0.3 d 14-17	11.9±0.2 e 11-13
Iife span	31.4±0.6 ab 29-35	30.2±0.8 abc 27-35	31.6±3.3 a 26-61	30.0±0.7 abc 27-33	26.9±0.4 c 25-29	26.0±0.4 c 24-27
Fecundity	172.6±4.3 a 159-199	120.5±7.1 b 90-150	87.1±2.3 c 72-99	58.6±1.8 d 50-68	30.4±1.7 e 21-40	21.4±0.9 e 17-28

Means within a row followed by the same letter are not significantly different at the 5% level of probability (Duncon test)

3- Male duration and longevity:

The biology of males is slightly faster than the biology of females as showen in Table 7, male duration and longevity were varied according to host plants. Male duration and longevity were varied according to host plants. Total immature period was significantly prolonged compared with other host plants. the shortest total immature period was 10.0 on squash and the longest was 13.9 on cowpea while the feeding on family cucurbitaceae prolonged the longevity to record 18.1, 16.6 days on squash and cucumber followed by family Solanaceae on eggplant and tomato and decreased when fed on family Fabaceae on bean and cowpea. In this respect, (Poovizhiraja *et al.,* 2016) mentioned that the oviposition period, sex ratio and fecundity were more and prolonged on okra followed by eggplant, french bean, tomato, tapioca, pumpkin and mulberry. *T.urticae* showed relatively better performance on okra, which might be attributed to increased level of total chlorophyll, total sugars, protein and lesser wax content, phenol and silica compared to rest of the host plants

Table 7. Biological aspects of *T. urticae* males on different host plants under laboratory conditions 27±1 ºC&62-73 RH %.

Male stages *T.urticae*	Different vegetable plants					
	Cucurbitaceae		Solanaceae		Fabaceae	
	Squash	Cucumber	Egg plant	Tomato	Bean	Cowpea
Egg	2.1±0.4 a 2-3	2.4±0.2 a 2-3	2.3±0.4 a 2-3	2.8±0.4 a 3-4	2.7±0.7 a 2-4	3.9±0.3 a 3-5
Larva	2.0±0.1a 1-3	2.1±0.3 a 1-3	2.2±0.5 a 2-3	2.2±0.2 a 2-3	2.4±0.5 a 2-3	2.2±0.5 a 2-3
Protonymph	2.4±0.3 a 2-3	2.3±0.4 a 2-3	2.6±0.4 a 2-3	2.8±0.4 a 2-4	3.4±0.4 a 3-4	3.7±0.7 a 3-5
Deutonymph	3.5±0.2 ab 3-4	3.6±0.4 ab 2-5	3.6±0.3 ab 3-4	3.5±0.6 ab 2-4	2.3±0.4 b 2-3	4.1±0.1 a 4-5
Total immature	10.0±0.2 b 9-12	10.4±0.8 b 9-12	10.7±0.3 b 9-11	11.3±0.8 b 10-13	10.8±0.4b 9-12	13.9±0.6 a 12-15
Longevity	18.1±0.4 a 16-20	16.6±0.9 ab 15-18	15.0±0.6 b 14-17	15.2±0.6 b 13-17	13.1±0.7 c 11-15	9.9±0.3 d 7-12
Iife	28.1±0.7 a 25-33	27.0±0.5 a 24-30	25.7±0.7 b 23-28	26.5±0.6 ab 23-30	23.9±0.8 c 20-27	23.8±0.4 d 18-27

Means within a row followed by the same letter are not significantly different at the 5% level of probability (Duncon test)

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تأثير بعض العوائل النباتية على التكاثر والمظاهر البيولوجية للعنكبوت الأحمر ذو البقعتين

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تم دراسة تكاثر العنكبوت الاحمر ذو البقعتين في الحقل تحت الظروف الطبيعية و كذلك المظاهر البيولوجية له تحت ظروف المعمل (متوسط درجة حرارة ٢٧ م° و رطوبة نسبية ٦٠-٧٤ %) وذلك على ستة انواع من العوائل النباتية المختلفة وهي الكوسة و الخيار التابعين للعائلة القرعية و الطماطم و الباذنجان التابعين للعائلة الباذنجانية و الفاصوليا و اللوبيا التابعين للعائلة البقولية . وقد أوضحت الدراسة أن تعداد البيض والاطوار غير الكاملة يزداد ببطء في بداية الموسم مقارنة بالتعداد في نهاية الموسم ويزداد التعداد أيضا حتى يصل إلى أعلى معدل له في منتصف شهر يونية ثم ينخفض بعد ذلك. و اثبتت الدراسة ايضا ان نباتات اللوبيا والفاصوليا التابعين للعائلة البقولية هما أقل العوائل تفضيلا للعنكبوت الأحمر وظهر ذلك من خلال تكاثره البطيئ عليهما في الحقل وانخفاض كمية البيض التي تم وضعها في المعمل خلال الدراسات البيولوجية وعموما نجد ان قدرة العنكبوت الاحمر على إصابة العوائل النباتية تختلف باختلاف الشكل المورفولوجي للنبات من حيث وجود الشعيرات أو الأشواك أو الإنخفاضات من عدمه والتي يساعد وجودها على حماية الأفراد من الظروف البيئية ولذلك تعتبر نباتات الكوسة أنسب العوائل النباتية للإصابة بالعنكبوت الأحمر يليها الخيار بينما كانت اللوبيا الأكثر تحملا للإصابة حيث كانت الأقل تعدادا وقد يعزى ذلك إلى خلوها من الشعيرات ونعومة ملمسها وقد أوضحت الدراسات البيئية أن هناك ارتباط موجب ومعنوي بين تعداد العنطكبوت ودرجات الحرارة وسالب غير معنوي مع الرطوبة النسبية.