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Population dynamics and biological aspects of *Tetranychus urticae* on three squash (*Cucurbita pepo*) varieties

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ABSTRACT

Squash (*Cucurbita pepo* L.) is a popular plant in Egypt, field study was carried out to evaluate the susceptibility of three squash varieties, i.e. Eskandarani, Hytech and Miletto infestation with two spotted spider mite *Tetranychus urticae*. Temperature and humidity played a strong role in the *T. urticae* infestation on squash varieties where there is a positive relationship between the population of *T. urticae* and temperature while negative between the population and humidity. Also, temperature plays an important role on biology of *T. urticae* where they completed their development and reproduced at all tested temperatures (20, 25, 30ºC).Also developmental time, oviposition period, adult longevity and life span decreased with increasing temperatures, while daily oviposition rate and fecundity increased with increasing temperatures. Therefore 30ºC is the ideal degree in which all stages of growth are shortened. On the other hand the susceptibility of squash varieties to the *T. urticae* infestation attributable to phytochemical contents which varied from variety to another, and affect mite density levels. A positive relationship was found between mite infestations and squash leaf contents i. e. total carbohydrates, total protein and total lipids in squash leaves, while a negative one found with alkaloids and total phenolic compounds, total flavonoids and total carotenoids and chlorophyll (a&b).Thus temperature and humidity and phytochemical contents of plant leaves has an important effect on infesting squash *by T. urticae.*

Keywords: Biology, Chemical component, Squash, Temperature, *Tetranychus urticae*

Squash (*Cucurbita pepo* L.) plant is very popular in Egypt. It has many nutritional values for humans such as mineral salts, vitamins and a good source of fat and protein (Abdein 2016). Recently, the successful cultivation of squash is affected by several pests and may influence the quality and quantity of production. One of them is *Tetranychus urticae*. Attacking about 1100 species of plant of which more than 150 are economically important such as squash and cucumber, in heavy infestation produce webbing over the entire plants and results in death of the plant (El-Dars *et al.* 2013). Recently, preference and non-preference for pests has acquired great importance in pest control research programs. However, some studies were conducted to evaluate effect of climatic factors and leaf components on pest population dynamics, damages and losses on some vegetable crops by several authors (Kumar *et al.* 2015). Therefore, chemical contents which normally vary from variety to another, may affect the population level of mites (Aiad *et al.* 2014). Thus, the present work is conducted to estimate correlation between weather factors and population *T. urticae* on squash varieties, studying the effect of different temperatures on biology of *T. urticae* and determination of phytochemical leaf components of squash varieties and correlating them with *T. urticae* preference.

MATERIALS AND METHODS

Population dynamics of T. urticae on squash varieties: Three varieties of squash (Eskandarani, Hytech and Milet) were chosen. An experiment was conducted at Farm of Faculty of Agriculture, Fayoum University, Fayoum governorate during 2017 and 2018. Samples were randomly collected weekly. Twenty five leaves of each squash variety were collected from the third week of March till the second week of June in tightly closed paper bags and transferred to laboratory for examination. Movable stages of *T. urticae* were counted and recorded. The daily mean temperatures and relative humidity (RH %) was obtained from the meteorological records (statistical data, Ministry of Agriculture and Land Reclamation, Egypt 2019).

Effect of different temperatures on biology of T. urticae fed on three squash varieties: *T. urticae* was reared on leaves of green acalypha single (*Acalypha wilkesiana*

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marginata Müll.) under laboratory conditions (25±2°C and 70% ±5 RH). The leaves were placed on a piece of cotton pad maintained permanently wet in petridishes (20 cm × 15 cm) as a source of mites. Thirty replicates were used for each variety; six disks of plant leaves were placed upside down on a cotton pad soaked in water in each of five petri dishes. Margins of leaves were surrounded with wet cotton to prevent mites escaping; such leaves were replaced with fresh ones as required at temperatures (20, 25 and 30±2°C) and 70±5% relative humidity. Immatures stages of the mite were observed twice a day to determine the duration of each stage.

Determination of phytochemical leaf components of three squash varieties: Squash leaves of three varieties were collected and transferred to the Faculty of Agriculture Research Park, Cairo University, Egypt for chemical analysis. Total phenol content was determined by Folin-Ciocateu method as modified by Singleton and Rossi (1965). Total carbohydrates were extracted from the plant leaves and prepared for assay according to Crompton and Birt (1967). Total protein was calorically assayed by ninhydrin reagent according to the method described by Lee and Takabashi (1966). Total flavonoids content were determined by Folin-Ciocalteu method according to Hung and Morita (2008). Total carotenoides and chlorophyll (a&b) were determined colorimetrically according to Holden (1965). Alkaloids were determined titermetrically according to Sabri *et al.* (1973).Total lipids were determined according to Bligh and Dyer (1959).

Statistical analysis: Data for various parameters were statistically analyzed according to the technique of analysis using the InfoStat computer software package (version 2012). The differences among treatment means were compared by LSD as a post hoc test at ≤5% level of significance (Gomez and Gomez 1984). Chemical data were subjected to One-way ANOVA (F-test) using a computer programme (SAS Institute 1988) which runs under WIN.

RESULTS AND DISCUSSION

Population dynamics of T. urticae on squash varieties: The simple correlation values (r) in (Table 1) showed that there was highly significant positive correlation between the population dynamics and temperature (r=0.865**, 0.837**and 0.760**). While the correlation was significantly negative with humidity (r=-0.747**,-0.786**and -0.769**) in Eskandarani, Hytech and Milet, respectively in 2017. Also in 2018 it was observed that highly significant positive correlation was found between the population dynamics and temperature (r=0.589**and 0.864**) in Eskandarani, Hytech, respectively. Insignificant positive correlation was found on Milet (r=0.465). While the correlation was significantly negative with humidity in Hytech variety (r=-0.658*) but insignificant negative (r=-0.539,&-0.448) in Eskandarani and Milet, respectively 2018. Finally it was concluded that there was a positive relationship between the populations of *T. urticae* and temperature while negative one between the population and humidity. Similar results were obtained by Abou-Zaid *et al.* (2019) who reported that

Table 1 Simple correlation between mean numbers of on *T. urticae* on squash varieties and climatic factors during 2017 and 2018

Date	Mean numbers of *T. urticae* movable stages					
	2017			2018		
	Eskandarani	Hytech	Milet	Eskandarani	Hytech	Milet
18-Mar	0.8	2.6	1.4	0.2	0	1.6
25-Mar	0.4	1.2	2.4	1	0.8	4
01-Apr	0	0.2	0.2	1.2	2.8	3.8
08-Apr	2	0.6	1	7.2	2.6	7.8
15-Apr	0.4	1.8	3.2	31.4	18	14.4
22-Apr	0.4	10	4	103.4	22.6	35.6
29-Apr	81.8	76	49	52.8	19.6	26.4
06-May	135.4	97.2	52	55.2	26.4	9.8
13-May	149.6	98	89.8	43	12	7.8
20-May	142	138.8	54.6	45.2	20.8	20.2
27-May	83.4	61.8	38.8	63.4	40.2	29.8
03-Jun	148.2	108.2	41.4	42	28.4	20.6
10-Jun	166.8	96	61	35	18.6	9.4
Total	911.2	692.4	398.8	481	212.8	191.2
Average	70.09	53.26	30.68	73	16.37	14.71
r (Tem. °C)	0.865**	0.837**	0.760**	0.589**	0.864**	0.465^{ns}
r (RH)%	-0.747**	-0.786**	-0.769**	-0.539^{ns}	-0.658*	-0.448^{ns}

*P≤ 0.05, **P≤ 0.01 and ns, not significant there was highly significant positive effect of temperature on the population of *T. urticae* infested squash varieties during 2015 and 2016 seasons, on the other hand, average RH % had significantly positive correlation coefficient factor (r) during the first season but insignificant negative relation was observed in the second season. Also, Kumar *et al.* (2015) reported that temperature showed a significant positive correlation with the *T. urticae* whereas a negative correlation was established with relative humidity.

Effect of different temperatures and squash varieties on biology of T. urticae: Total immature stages and life cycle durations decreased with increasing temperature in three varieties where it was slightly shorter for males than females (Table 2). Eskandarani variety had the lowest duration in all stages at three temperature degrees. Also, significant differences were found between durations at 20°C and 30°C. In Eskandarani, females total immature duration in days was 9.67 at 20°C then decreased to 7.33 at 30°C, followed by Hytech (10.61) at 20°C then decreased to 7.67 at 30°C. The longest duration was found in Miletas it varied between 11.61 to 8.63 respectively at 20 and 30°C, while the male followed the same trend. Life cycle durations for females was 11.84 at 20°C then decreased to 8.93 at 30°C followed by Hytech 13.41 at 20°C decreased to 9.50 at 30°C.The longest duration in Milet was (14.64) at 20°C then decreased to (10.66) at 30°C,while the male followed the same trend.

The pre-oviposition and post-oviposition periodsas shown in (Table 2) ranged respectively between (2.77 to 2.37) at 20°C, (2.35&2.27) at 25 °C and (2.33 to 2.07) at 30°C in Eskandarani followed by Hytech (2.87 to 2.53) days at 20°C, 2.60 to 2.47 at 25°C then decreased from 2.47 to 2.10 days at 30°C. The longest one was found in Milet (2.97 and 2.60) days at 20°C, 2.73 to 2.57 at 25 °C then decreased to 2.60 and 2.13 days at 30°C. The oviposition period of *T. urticae* was significantly influenced by temperature, as the longest period observed in Eskandarani, Hytech and Milet 8.40, 8.93 and 9.73 days respectively, at 20°C, whereas it was significantly different from those at 25 and 30°C. Similar to what was observed for the duration

Table 2 Total immatures stages life cycle, longevity, life span and fecundity of *T. urticae*, fed on Eskandarani, Hytech and Milet varieties of squash leaves at three constant temperatures and 60±5% RH

	Sex	Eskandarani			Hytech			Milet		
		20 °C	25 °C	30 °C	20 °C	25 °C	30 °C	20 °C	25 °C	30 °C
Total immature stages	♀	9.67 ± 0.23a	8.40 ± 0.25b	7.33 ± 0.21c	10.61 ± 0.24a	9.13 ± 0.19b	7.67 ± 0.16c	11.61 ± 0.24a	9.86 ± 0.19b	8.63 ± 0.14c
	♂	9.46 ± 0.26a	8.01 ± 0.29b	7.13 ± 0.17c	10.34 ± 0.19a	8.93 ± 0.18b	7.47 ± 0.24c	11.33 ± 0.08a	9.60 ± 0.19b	8.39 ± 0.19c
Life cycle	♀	11.84 ± 0.31a	10.37 ± 0.21b	8.93 ± 0.21c	13.41 ± 0.23a	11.46 ± 0.22b	9.50 ± 0.22c	14.64 ± 0.26a	12.33 ± 0.22b	10.66 ± 0.18c
	♂	11.53 ± 0.26a	9.94 ± 0.32b	8.70 ± 0.25c	13.07 ± 0.27a	11.20 ± 0.24b	9.24 ± 0.27c	14.26 ± 0.11a	12.00 ± 0.21b	10.36 ± 0.21c
Pre-oviposition		2.77 ± 0.10a	2.35 ± 0.11ab	2.33 ± 0.11b	2.87 ± 0.17a	2.60 ± 0.11ab	2.47 ± 0.11b	2.97 ± 0.11a	2.73 ± 0.08ab	2.60 ± 0.09b
Generation		14.61 ± 0.33a	12.72 ± 0.24b	11.26 ± 0.23c	16.28 ± 0.26a	14.06 ± 0.30b	11.97 ± 0.20c	17.61 ± 0.22a	15.06 ± 0.28b	13.26 ± 0.19c
Oviposition		8.40 ± 0.23a	4.73 ± 0.18b	4.27 ± 0.18b	8.93 ± 0.21a	5.53 ± 0.13b	5.13 ± 0.19b	9.73 ± 0.30a	6.07 ± 0.21b	5.80 ± 0.17b
Post-oviposition		2.37 ± 0.10a	2.27 ± 0.10ab	2.07 ± 0.08b	2.53 ± 0.13a	2.47 ± 0.13ab	2.10 ± 0.14b	2.60 ± 0.11a	2.57 ± 0.10a	2.13 ± 0.06b
Longevity	♀	13.54 ± 0.28a	9.35 ± 0.24b	8.67 ± 0.20c	14.33 ± 0.32a	10.60 ± 0.24b	9.70 ± 0.28c	15.30 ± 0.34a	11.37 ± 0.28b	10.53 ± 0.25c
	♂	9.33 ± 0.25a	6.13 ± 0.27b	4.60 ± 0.16c	10.07 ± 0.18a	6.33 ± 0.25b	5.53 ± 0.17c	13.67 ± 0.08a	9.27 ± 0.23b	8.27 ± 0.25c
Life span	♀	25.38 ± 0.43a	19.72 ± 0.50b	17.60 ± 0.24c	27.74 ± 0.36a	22.06 ± 0.38b	19.20 ± 0.33c	29.94 ± 0.31a	23.70 ± 0.54b	21.19 ± 0.31c
	♂	20.86 ± 0.28a	16.07 ± 0.44b	13.30 ± 0.31c	23.14 ± 0.29a	17.53 ± 0.37b	14.77 ± 0.33c	27.93 ± 0.16a	21.27 ± 0.30b	18.63 ± 0.39c
Fecundity		19.60 ± 0.33a	24.13 ± 0.53b	30.40 ± 0.59c	11.07 ± 0.21a	13.20 ± 0.55b	18.07 ± 0.40c	10.33 ± 0.35a	11.73 ± 0.23b	13.13 ± 0.26c
Eggs/female/day		2.33 ± 0.07a	5.10 ± 0.22b	7.12 ± 0.36c	1.24 ± 0.03a	2.39 ± 0.13b	3.52 ± 0.16c	1.06 ± 0.05a	1.93 ± 0.08b	2.26 ± 0.07c

Means with a common letter are not significantly different (P>0.05)

Table 3 Relationship between phytochemical components in leaves of three squash varieties and population of *T. urticae*

Variety	Mean of *T. urticae* movable stages	Phytochemical components							
		Total protein	Total lipids	Total carbohydrates	Chlorophyll		Total phenol	Total flavonoids	Total carotenoids
					a	b			
		(%)		mg/g					
Eskandarani	37.00 ± 8.27a	24.37 ± 0.015a	6.86 ± 0.006a	59.15 ± 0.075a	25.69 ± 0.002 c	26.39 ± 0.001c	20.95 ± 0.002c	1.59 ± 0.002c	52.86 ± 0.001c
Hytech	16.37 ± 3.39b	23.34 ± 0.015b	6.42 ± 0.001b	51.20 ± 0.023b	46.72 ± 0.001b	38.48 ± 0.001b	24.29 ± 0.002b	2.42 ± 0.001b	84.91 ± 0.002b
Milet	14.71 ± 3.02b	19.28 ± 0.062c	5.31 ± 0.01c	51.01 ± 0.001c	62.40 ± 0.002a	62.39 ± 0.001a	24.37 ± 0.001a	4.73 ± 0.001a	96.59 ± 0.001a
LSD (P = 0.05)	10.35	0.17	0.02	0.15	0.007	0.004	0.004	0.006	0.003
Correlation coefficient (*r*)		0.37	0.40	0.53	-0.49	-0.42	-0.53	-0.39	-0.52

Means with a common letter are not significantly different (P>0.05).

of immature stages, the longevity differed significantly with temperature, where it was also progressively shorter with increasing temperatures, *T. urticae* at 20°C had the longest longevity period of female in Eskandarani, Hytech and Milet, viz. 13.54, 14.33 and 15.30 days, respectively. Life span was the longest at 20°C in three varieties 25.38, 27.74 and 29.94 days respectively. Also, life span for males decreased with increasing temperature. Fecundity increased with increasing temperature, as in Eskandarani, fecundity was higher than other varieties at all temperatures 19.60 eggs at 20°C, 24.13 at 25°C and increased to 30.40 eggs at 30°C. Daily oviposition rates were significantly different at the tested temperatures, where it increased progressively with increasing temperature. Eskandarani was the variety with high oviposition rates with 2.33 eggs/female/day at 20°C,(5.10)at 25°C then increased to (7.12 eggs/female/day) at 30°C. It was not surprising that high temperature could enhance the mite species to reproduce higher than the less temperatures.

The effect of the phytochemical components of leaves of the three squash varieties on the infestation with T. urticae: The phytochemical components of squash leaves clarify the susceptibility of plant to infestation with *T. urticae*. Data in Table 3 showed that the mean infestation rates of *T.urticae* in Eskandarani, Hytech and Milet were respectively 37.00, 16.37 and 14.71 individuals. Eskandarani was the most infested variety which had the highest contents of total protein (24.37), total lipids (6.86) and total carbohydrates (59.15). Also have the lowest contents of Chlorophyll a,b 25.69 and 26.39,Total phenol 20.95, total flavonoids 1.59 and total carotenoids 52.86 than other tested varieties. It was concluded that there is a positive relationship between mite infestation levels and total carbohydrates, total protein and total lipids in squash leaves, while a negative relationship found with alkaloids and total phenolic compounds, total flavonoids and total carotenoids and Chlorophyll (a&b). These results are in agreement with Abou-Zaid *et al.* (2019) who reported that total phenol and tannins were repellent compounds and had a negative effect on the *T. urticae* occurrence on four investigated varieties of squash. Kamel *et al.* (2019) found that there is a positive relationship between mite infestation levels and total carbohydrates and nitrogen in sweet pea and pea leaves; however a negative relationship was found with total phenolic compounds. Also, Ali *et al.* (2015) reported that there is a positive relationship between mite infestation levels and total carbohydrates in tomato leaves, while a negative was one found with alkaloids and total phenolic compounds, total flavonoids and total carotenes.

The present results indicate that temperature and humidity are strong factors in the infestation of squash varieties by *T. urticae*. Also, temperature plays an important role on all different aspects of *T. urticae*. The susceptibility of squash varieties to *T. urticae* infestation attributed to phytochemical component of plant leaves. The obtained results should be taken into account in planning of integrated pest management (IPM) programs in squash plants for *T. urticae.* Further studies are needed to obtain practical information for possibility of controlling this pest.

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REFERENCES

Abdein M A E. 2016. Squash plants between classic and modern genetics. *Proteomics & Bioinformatics* **3**(1): 14.

Abo-Shnaf R I A. 2017. Temperature-based life history and life table parameters of the two spotted spider mite (Acari:Tetranychidae) on White Frangipani. *Egyptian Academic Journal of Biological Sciences* **10**(3): 9–16.

Abou-Zaid M M, Azza A, Hosam M K H and Seham A. 2019. Response of squash varieties to *Tetranychus urticae* (Acari: Tetranychidae) and *Bemisia tabaci* (Hemiptera: Aleyrodidae) infestation in relation with its leaf chemical compositions. *Egyptian Journal of Plant Protection Research Institute* **2**(1): 183–93.

Aiad A K, El-Saiedy E M A and Romeih A H M. 2014. Susceptibility of three muskmelon *Cucumis melo* L. varieties to infestation with *Tetranychus urticae* Koch. *Acarines* **8**(1): 59–61.

Ali F S, Afifi A M, El-Saiedy E M A and Ahmed M M. 2015. Effect of phytochemical components, morphological and histological leaf structure of five tomato hybrids on *Tetranychus urticae* Koch infestation. *Acarines* **9**: 23–30.

Bligh E G and Dyer W J. 1959. A rapid method of total lipid extraction and purification. *Canadian Journal of Biochemistry and Physiology* **37**: 911–17.

Crompton M and Birt L M .1967. Changes in the amounts of carbohydrates. Phoshagen, and related compounds during the metamorphosis of the blowfly, *Lucilia cuprina*. *Journal of Insect Physiology* **13**: 1575–95.

El-Dars F M S E, Rizk M A and Takla S S. 2013.Determination of chlorofenapyr residues in squash during crop production cycle. *Egyptian Academic Journal Biological Sciences* **5**(1): 27–32.

Gomez K A and Gomez A A. 1984. *Statistical Procedures for Agricultural Research.* 2nd edn, p 680. John Wiley and Sons, New York, United states of America.

Hamad Amen K H and Hassan O O. 2018. The relationship between temperature, *Tetranychus urticae* and cucumber hybrids. *Zanco Journal of Pure and Applied Sciences* **30**(9): 114–22.

Holden M.1965. *Chlorophylls: In Chemistry and Biochemistry of Plant Pigment,* Goodwin, pp 88-462. T W (Ed). Academic Press, London.

Hung P V and Morita N. 2008. Distribution of phenolic compounds in the graded flours milled from whole buckwheat grains and their antioxidant capacities. *Journal of Food Chemistry* **109**(2): 325–31.

Kamel M S, Aziza M Abou-Zaid and Samia A Yasin. 2019. The effectiveness of phytochemical components and climatic factors on population fluctuation of the spider mite, *Tetranychus urticae* Koch on sweet pea and pea crops. *Journal of Applied Plant Protection* **8**(1): 15–21.

Kumar D, Raghuraman M and Singh J. 2015. Population dynamics of spider mite, *Tetranychus urticae* Koch on okra in relation to abiotic factors of Varanasi region. *Journal of Agrometeorology* **17**: 102–06.

Lee Y P and Takabashi T. 1966. An improved colorimetric determination of amino acids with the use of ninhydrin. *Analytical Biochemistry* **14**: 71–77.

Sabri N N, El-Masry S and Khafaey S M. 1973. Phytochemical investigation of *Hyoscyamus desertorum*. *Planta Medica* **23**(1): 4–9.

SAS Institute .1988. SAS/STAT User's Guide, Ver. 6.03.SAS Institute, Cary, North Carolina, United states of America.

Singleton V L and Rossi J A. 1965. Colorimetry of total phenolics with phosphomolybdic and phosphotungstic acid reagents. *American Journal Enology and Viticulture* **16**: 144–58.