EVALUATION OF SUSCEPTIBILITY OF TEN THREE-WAY CROSSES OF MAIZE HYBRIDS TO SPIDER MITE *TETRANYCHUS URTICAE* KOCH INFESTATION IN GHARBIA GOVERNORATE

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Abstract

Ten Maize hybrids were evaluated in terms of their relative susceptibility to the two- spotted spider mite *Tetranychus urticae* Koch during two years 2004-2005 at Gharbia governorate. Population fluctuation of *T. urticae* on Ten Maize three-way crosses hybrids (i.e. TWC310, TWC311, TWC314, TWC321, TWC322, TWC323, TWC324, TWC327, Nefertity and TWC352), and their relation with weather factors were studies. Susceptibility of different Maize cultivars to spider mites infestation revealed significant differences in movable stages. Influence of leaf chemical components with *T. urticae* infestation was studied. The study showed that the maize hybrid (Nefertity) recorded the highly significant susceptible to *T. urticae* infestation with recording averages of 273.96 and 383.5 moving stages/ 20 leaves during the two successive seasons, respectively. Mite population reached its peak on maize during season 2004 at late of August and early September, for all tested hybrids, while in the second year it has two peaks the first in early of July and the second in early of September, for all tested hybrids. Developmental times and reproduction rate of *T. urticae* were studied on leaves of four maize three way crosses Nefertity, TW327, TW321 and TW310) at laboratory conditions at (28±2°C, 65±5 % RH and 16:8 L: D). Immature developmental time of *T. urticae* was the longest on TW310 (6.5days) followed by TW321 (6.1 days) than TW327 and Nefertity (5.6 & 6.1 days). Fecundity of *T. urticae* was 46.6, 36.8, 29.6 and 28.5 eggs/ female on Nefertity, TW327, TW321 and TW310, respectively. The highest net reproductive rate (Ro) was 18.63 female/ female/generation on Nefertity, and the lowest was 10.29 female/ female/ generation on TW310.

Key words: Maize, *Tetranychus*, Pests, Biology, Population, susceptibility, hybrids.

INTRODUCTION

Maize (*Zea mays* L.) is the most important grain crop in Egypt and produced throughout the country under diverse environments, as it widely distributed all over the world. The two-spotted spider mite, *Tetranychus urticae* Koch (Acari, Tetranychidae) is one of the most serious agricultural pests in the world. This mite attacks a wide range of vegetables, field crops, fruit trees, ornamental plants and weeds (Zaher, 1984). Heavy infestation of maize leaves by spider mites reduces plant

growth and yield, reaching reduction 47% in maize yield (Bacon *et al.*, 1962). The level of infestation depends on the temperature and humidity, and thus varies from year to year. It also depends on the plant cultivars in question (Skorupska, 2004).

Maize cultivars differ in terms of their relative susceptibility to spider mite infestation, highly significant different between single crosses of maize, the single crosses 10, 122 and watania14 were resistance, while Pioneer 3080 were susceptible to spider mites infestation. In addition, significant differences between the two predatory mites *Euseius scutalis* (A.-H.), *Pronematus ubiquitus* McGregor population, and single crosses of maize, (Azouz, 2005).

Giza 125 and Giza 162 varieties proved to be the most susceptible hybrids to spider mite infestation in white and yellow maize varieties, respectively, while Giza 129 and Giza 166 were the most tolerant, respectively. Mite population reached its peak on maize during the fourth and the third weeks of July, respectively, for all tested hybrids. A significant positive correlation was found between mite infestation and both nitrogen and protein contents in maize leaves, (Mead, *et al.* 2010).

Several studies have indicated significant differences in susceptibility, resistance or tolerance level to *T. urticae* on crops, vegetables and fruits (Taha *et al.*, 1991, Labanouska, 2007, Afifi *et al.*, 2010, Rezaie *et al.*, 2013). The population growth parameters of *T. urticae* such as developmental rate, survival, reproduction and longevity vary with temperature, host phonological stage and relative humidity (Liu and Tsai 1998, El-Halawany & Abedl-wahed 2013).

Nutritional quality, physiological, ecological and chemical condition of the host plant may influence on life history parameters of two-spotted spider mite (Taha *et al.*, 1995, Mead, *et al.* 2010, Afifi *et al.*, 2013).

The main objectives of this study to evaluate the population fluctuations of *T. urticae* on Ten maize three way crosses hybrids throughout the two seasons in relation with whether factors and predatory mites. In addition, the relationship between mite infestation and both maize leaves chemical contents. In addition together, susceptibility of four maize three way crosses hybrids to the infestation with *T. urticae* under laboratory conditions.

MATERIALS AND METHODS

Ecological studies:

Field experiments were carried out at the Experimental Farm of Gemmeiza Agriculture Research Station, Agricultural Research Center (ARC), Egypt, during 2004 and 2005 seasons at Gharbia governorate.

Ten maize three way crosses hybrids TWC310, TWC311, TWC314, TWC321, TWC322, TWC323, TWC324, TWC327, Nefertity and TWC352), were cultivated an area of ten feddan (4200m^2), was chosen and prepared for cultivation. This area was divided into 40 plots, each one (1/50 feddan). After 25 days post plantation, every 15 days sample of 20 leaves presented for each variety. Motile stages of phytophagous and predacious mites on lower and upper surface of leaves were counted. Average temperatures (ºC) and average relative humidity (R.H.) prevailing in the area during the study, were recorded.

Phytochemical analysis of maize leaf hybrids:

Leaf samples of the ten maize hybrids cultivated in 2005 season, were picked up every 15 days, cleaned, washed with distilled water, and dried in an oven at70ºC for 48 h., then grinded into fine powder. The total carbohydrate, total protein, nitrogen, phosphorus, calcium and potassium were estimated according to the methods of (Pregl, 1945, Murphy and Riely, 1962 and Dewis and Freites, 1970).

Biological studies:

The stock population of *T. urticae* was collected from Maize (*Zea mays* L.) in Gemmeiza Agriculture Research Station, Gharbia governorate. The stock culture was maintained on maize leaves in a rearing chamber (28ºC, 65 ± 5% RH. and 16:8 light (L): dark (D).

Experiments were conducted on four three way crosses of maize hybrids (Nefertity, TW327, TW321 and TW310). Biological aspects of *T. urticae* at temperatures 28 ± 2 °C and 65 ± 5% RH. and 16:8 L: D photoperiod. One leaflet from the first fully expanding leaf per plant of each hybrid was chosen. It was well washed with running water to remove any possible residuals or mites. Leaf discs of about 2.5-cm in diameter were made surrounded by tangle foot, and placed lower surface up on of moisten cotton wool in Petri dishes of 12-cm diameter, and a *T. urticae* couple (male and female) was placed on each disc, for each hybrid. These Petri dishes were kept for 24 hours to allow mating, thereafter, males were removed, while female served as a source for known-age eggs, and larvae. About 40 hatching larvae were kept singly to a leaf of each hybrid and left to continue their life span. Newly emerged females were copulated and left to deposit their eggs. Monitor was conducted twice daily and essential records were noted. To determine sex ratio, ten newly emerged females to which males were added placed on leaf discs and kept under the same condition of temperatures and RH. From the deposited eggs of each female, 50 eggs (25 eggs after three days and 25 eggs after one week) were left to develop second, and then males and females were counted. Dishes were kept in incubators containing saturated solution of NaCl to maintain at 7 % RH.

Life table parameters of the two-spotted spider mite *T. urticae* Koch

Females of *T. urticae* reached adult stage were transferred singly each to a single female on new leaf discs. Developmental period, mortality of different stages and oviposition by resultant females were recorded daily for each female. Life table parameters were estimated according to (Birch, 1948) using the Life48, BASIC Computer program (Abou-Setta *et. al.*, 1986).

Statistical analysis:

Data were analyzed by one-way analysis of variance (ANOVA) and mean comparison using LSD to test the significant differences between mean values and correlation coefficient between the spider mite population and weather factors, also between mite population and chemical contents of maize leaves using SAS statistical software (SAS Institute, 2010).

RESULTS AND DISCUSSION

Ecological studies:

Population fluctuation of *T. urticae* on maize three-way crosses during 2004-2005 growing seasons

Results in Table (1) indicated that, *T. urticae* occurred during the two seasons from 15th June to 15th September. During the two season, the infestation with mite moving stages occurred in few numbers after 25 days of plantation date on all tested hybrids. A specific trend in population fluctuation was observed, the population increased slowly until July 15st, then it sharply increased until reached its peak during mid of August. This result was observed by all tested maize hybrids with different degrees. After that, the number of mites decreased gradually until the end of the season. The mean numbers of moving stages of *T. urticae* during the first season were 96, 120.79, 137.86, 162.43, 146.04, 125.64, 140.18, 210.93, 273.96 and 150.32 individuals/ 20 leaves for TWC310, TWC311, TWC314, TWC321, TWC322, TWC323, TWC324, TWC327, Nefertity and TWC352, respectively.

In the second season, the two-spotted spider mite *T. urticae* have two peaks, the first in the first week of July and the second in the first week of September on all tested hybrids Table (2). The two-spotted spider mite was recorded with low number in the first week of June 2005, then increased in number to reach its highest population during the first week of July, after that the number decreased from mid July and increased again in early August, then sharply decreased gradually in number until the end of the season. This result was practical by all tested maize hybrids with different degrees. The mean numbers of moving stages of *T. urticae* during the first season were 151.68, 177.82, 253.89, 250.82, 249.71, 237.11, 249.89, 355.5, 383.8

and 1140.75 individuals/ 20 leaves for TWC310, TWC311, TWC314, TWC321, TWC322, TWC323, TWC324, TWC327, Nefertity and TWC352, respectively.

Population fluctuation of *T. urticae* was non-positively correlated with relative humidity during the two successive seasons, while it has non-significant positive correlation between the mean mite population temperatures in the first year and significant positive correlation between the mite population and temperature in the second season Table (1&2).

Similar results were observed by (Margoli & Kennedy, 1984, Azouz, 2005 and Mead, *et al.*, 2010) when studies the population of *T. urticae* on maize hybrids.

Predacious mites:

Results in Table (3&4) showed that, the seasonal fluctuation of predaceous mites associated with *T. urticae* is necessary to explain the variation in its population and their role in minimizing the rate of pest infestation. The present study revealed two species of predaceous mites namely, *Euseius scutalis* (A.-H.) and *Pronematus ubiquitus* McGregor collected together with *T. urticae* during the studying period from June 15, 2004 to September 15, 2005 on three way crosses hybrids.

The two predatory mites population fluctuation started in few numbers in mid July then gradually increased in number reach its peak in early September in all three crosses hybrid during the two successive seasons then sharply decreased gradually in number until the end of the season. This result was suitable by all tested maize hybrids with different degrees. The mean numbers of moving stages of the two predatory mites, *E. scutalis* and *P. ubiquitus* during the first season were 6.25& 5, 11.65& 3.9, 9.25& 4.55, 9& 5.2, 7& 6, 7.65& 4.8, 8.7& 7.15, 13.3& 9.75, 6.85& 5.05, 9.05 and 6.3 individuals/ 20 leaves for TWC310, TWC311, TWC314, TWC321, TWC322, TWC323, TWC324, TWC327, Nefertity and TWC352, respectively. While these values in the second year were, 17& 5.85, 23.85& 4.65, 15.35& 4.5, 18.65& 7.2, 19.4& 6.85, 20.2& 6.4, 20.2& 8.7, 26.7& 10.6, 15.65& 5.2, 15.95 and 7.7 individuals/ 20 leaves for TWC310, TWC311, TWC314, TWC321, TWC322, TWC323, TWC324, TWC327, Nefertity and TWC352, respectively. The population of the predatory *E. scutalis* mite increased in the second year than in the first year on all triple three-way crosses hybrids. Similar to the present study, (Azouz, 2005) reported that fluctuation in mite population of the two predatory mites on single and three-way crosses hybrids of maize associated with *T. urticae* and *Steneotarsonemus saydi* record its peak in early September.

Table 1. Population fluctuation of motile stages of *Tetranychus urticae* Koch, on ten maize three-way crosses hybrids at Gharbia governorate during season 2004.

Hybrids / I.D	Average number of *T. urticae* motile stages/ 20 leaves										Mean Temp.	Mean R.H.
	TWC310	TWC311	TWC314	TWC321	TWC322	TWC323	TWC324	TWC327	Nefertity	TWC352		
15-Jun-04	0.75	1.25	1	0.75	1.25	1.25	1.25	0.75	1.5	1.25	24.33	44.52
01-Jul-04	16	26.25	29	48.25	24	31	22.75	48	52	69	27.10	45.38
15-Jul-04	49	73	82.25	141.75	81	76.75	96.5	140.5	137.25	132	28.54	40.86
1-Aug-04	73.75	85	117.75	155.25	101.75	108	106.75	238.25	269	153.75	27.95	45.14
15-Aug-04	207	278	314	275.75	299	325.25	289	401.75	739.25	303.25	28.17	48.95
01-Sep-04	229.25	269	298.5	380	386.25	240.25	338.25	475.25	512	284	27.62	46.86
15-Sep-04	96.25	113	122.5	135.25	129	97	126.75	172	206.75	109	26.17	53.64
Total	672	845.5	965	1137	1022.25	879.5	981.25	1476.5	1917.75	1052.25		
Mean	96.00	120.79	137.86	162.43	146.04	125.64	140.18	210.93	273.96	150.32		
Correlation coefficient between mean population of *T. urticae* motile stages											0.55	0.34

I.D.= Inspection date * Significant at 5% level.

Table 2. Population fluctuation of motile stages of *Tetranychus urticae* Koch, on ten maize three-way crosses at Gharbia governorate during season 2005.

Hybrids / I.D	Average number of *T. urticae* motile stages / 20 leaves										Mean Temp.	Mean R.H.
	TWC310	TWC311	TWC314	TWC321	TWC322	TWC323	TWC324	TWC327	Nefertity	TWC352		
15-Jun-05	17	15	18.75	8.25	8.75	35	16	21.5	29.25	24.5	25.61	44.31
01-Jul-05	82.25	115.25	132.5	71.5	59	119.5	73	109.25	126.75	71	26.67	42.06
15-Jul-05	66.75	75.75	47.25	31	34.75	35.5	31	68.75	123	38.25	28.84	21.75
1-Aug-05	74	81.75	117.5	127.75	110.25	116.75	131.75	174.25	217.5	103.5	29.43	40.22
15-Aug-05	373	427.5	780	559.5	635	753.75	637.5	915	977.5	655	30.35	43.10
01-Sep-05	322.5	369	502.75	725.75	700.75	451.75	683.75	977.5	1012.5	63.5	28.89	47.03
15-Sep-05	126.25	160.5	178.5	232	199.5	147.5	176.25	222.25	198	29.5	27.66	47.38
Total	1061.75	1244.75	1777.25	1755.75	1748	1659.75	1749.25	2488.5	2684.5	985.25		
Mean	151.68	177.82	253.89	250.82	249.71	237.11	249.89	355.50	383.50	140.75		
Correlation coefficient between mean population of *T. urticae* motile stages											0.65*	0.37

I.D.= Inspection date * Significant at 5% level.

Table 3. Population fluctuation of the two predatory mites *Euseius scutalis* (A.-H.) and *Pronomatus ubiquitous* (McGregor, on ten maize three-way crosses hybrids at Gharbia governorate during season 2004.

Hybrids	Average number of two predatory mites / 20 leaves																				Mean	Mean
	TWC310		TWC311		TWC314		TWC321		TWC322		TWC323		TWC324		TWC327		Nefertity		TWC352		Temp.	R.H.
I.D	*E.*	*P.*	*E.*	*P.*	*E.*	*P.*	*E.*	*P.*	*E.*	*P.*	*E.*	*P.*	*E.*	*P.*	*E.*	*P.*	*E.*	*P.*	*E.*	*P.*		
15/6/04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24.33	44.52
1/7/04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27.10	45.38
15/7/04	2	1	2.25	1	3	1.25	1.5	1.25	3	1	3.5	1.75	4.25	1	2.5	2.25	2.5	1.25	1.75	2.25	28.54	40.86
1/8/04	3.75	2.5	7	2	4.25	3.75	6.25	3	6.5	1.75	4.75	2.25	4.75	5.25	12.2	5.5	9.75	3.25	5.25	5.25	27.95	45.14
15/8/04	8.25	5.25	16	7.75	11.2	10.5	10.2	4.25	5	8.5	6	3.75	10	4.5	16.5	12	6.75	5.5	14.5	4.25	28.17	48.95
1/9/04	12	12	24	6.5	19	4.5	20.5	11.5	12.7	14	16.7	12.2	18.2	15.5	27	18.7	11.5	9.75	17.7	11.5	27.62	46.86
15/9/04	5.25	4.25	9	2.25	8.75	2.75	6.5	6	7.75	4.75	7.25	4	6.25	9.5	8.25	10.2	3.75	5.5	6	8.25	26.17	53.64
Total	31.2	25.0	58.2	19.5	46.2	22.7	45	26.0	35	30	38.2	24	43.5	35.7	66.5	48.7	34.2	25.2	45.2	31.5	24.33	44.52
Mean	6.25	5.00	11.6	3.90	9.25	4.55	9	5.20	7	6.00	7.65	4.80	8.7	7.15	13.3	9.75	6.85	5.05	9.05	6.30	27.10	45.38
Correlation coefficient between mean population of *E. scutalis*																					0.39	0.38
Correlation coefficient between mean population of *P. ubiquitous*																					0.32	0.48

E. = *Euseius scutalis, P.* = *Pronomatus ubiquitous*, I.D.= Inspection date * Significant at 5% level.

Table 4. Population fluctuation of the two predatory mites *Euseius scutalis* (A.-H.) and *Pronomatus ubiquitous* (McGregor, on ten maize three-way crosses hybrids at Gharbia governorate during season 2005.

Hybrids	Average number of two predatory mites / 20 leaves																				Mean	Mean
	TWC310		TWC311		TWC314		TWC321		TWC322		TWC323		TWC324		TWC327		Nefertity		TWC352		Temp.	R.H.
I.D	*E.*	*P.*	*E.*	*P.*	*E.*	*P.*	*E.*	*P.*	*E.*	*P.*	*E.*	*P.*	*E.*	*P.*	*E.*	*P.*	*E.*	*P.*	*E.*	*P.*		
15/6/05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24.33	44.52
1/7/05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27.10	45.38
15/7/05	1.5	1.25	1.75	1.25	2	1.25	1.25	1	1.75	1.5	2.5	1	1.75	1.75	4.75	3.75	3	1.25	1.75	2	28.54	40.86
1/8/05	7.75	1.5	6.75	1.75	6	2.25	4.75	3.5	6.5	2	5.5	1.25	6.75	3	9.5	5.25	4.5	3.75	3.75	2.5	27.95	45.14
15/8/05	26.5	7.75	41.2	9.5	36.5	11.2	32.7	11.7	36.2	12.7	32.2	6.25	37	15.5	43.7	16.2	29.5	9	31.2	13	28.17	48.95
1/9/05	39.5	13.5	55.5	6.75	24	4.75	44.7	14.5	40.2	13.5	46.2	17.2	44	16.5	57.5	19.5	29.7	7.75	34.5	15	27.62	46.86
15/9/05	9.75	5.25	14	4	8.25	4.5	9.75	5.25	12.2	4.5	14.5	6.25	11.5	6.75	18	8.25	11.5	4.25	8.5	6	26.17	53.64
Total	85	29	119	23.2	76.7	24	93.2	36	97	34.2	101	32	101	43.5	133.	53	78.2	26	79.7	38.5	24.33	44.52
Mean	17	5.85	23.8	4.65	15.3	4.8	18.6	7.2	19.4	6.85	20.2	6.4	20.2	8.7	26.7	10.6	15.6	5.2	15.9	7.7	27.10	45.38
Correlation coefficient between mean population of *E. scutalis*																					0.61	0.4
Correlation coefficient between mean population of *P. ubiquitous*																					0.65*	0.38

The statistical analysis correlation between the mean population of the two predatory mites and mean temperatures and relative humidly were non-significant positive in the season 2004, while in the second season it has significant positive correlation between the mean population of the two predatory mites and mean temperatures and non significant positive correlation between the two predatory mite population and relative humidity.

Efficiency of the predacious mites on *T. urticae* population

Statically analysis from Table (5) conducted that, highly positive correlation between the *T. urticae* population and the predatory mites**,** *E. scutalis* in all triple hybrids in the first season 2004, but significant positive on three hybrid TW322, TW323 and Nefertity. Concerning, statistical data obtained in the second season 2005 in Table (6) showed that, highly positive significant between the two-spotted spider mite population and predatory mite *P. ubiquitus* on all single hybrids except the hybrids TW323and TW352.

While, statically analysis from Table (5) reviled that, highly positive correlation between the *T. urticae* population and the predatory mites**,** *P. ubiquitus* in all three hybrids during two seasons 2004-2004, but significant positive on hybrid TW324 and Nefertity, while non-significant on TW323 and TW352, during two season Table (5&6).

These results mentioned that the two predatory mites, *E. scutalis* and *P. ubiquitus* were the main important predator for suppressing population density of *T. urticae* population during the two successive seasons. A similar result was obtained by (Azouz, 2005).

Evaluation of the susceptibility of different maize three-way crosses hybrids to *T. urticae* infestation and its relation with leaf phytochemical components.

Obtained data in Table (7) indicated that, the three cross hybrid Nefertity was the most highly significant susceptible to infestation recording 273.96 and 383.5 individuals/ 20 leaves during the two successive seasons 2004& 2005, respectively, followed by the moderately infested hybrids TWC327, TWC321, TWC324, TWC322 and TWC314 with mean number 210.93& 355.50, 162.43& 250.82, 140.18& 249.89, 146.04& 249.71 and 137.86 &253.89, during the two successive seasons, respectively. No differences between the three-way crosses TWC314, TWC322, TWC324, TWC352 in the first year, while in the second year no differences between the hybrids TWC314, TWC321, TWC322, TWC323 and TWC324. Three-way cross hybrid, TWC310, TWC311 and TWC352 were the most tolerant one that gave the lowest significant difference in the number of mite infestations (96& 151.68, 120.79& 177.82, 150.32 and 140.75, respectively. These results coincided with that obtained by (Azouz, 2005 and Mead, *et al.*, 2010).

Table 5. Correlation coefficient between population fluctuation of predacious mites and its relation to *T. urticae* mites, on ten maize three-way crosses hybrids at Gharbia governorate during season 2004.

Hybrids	TWC310			TWC311			TWC314			TWC321			TWC322		
Pred. / Prey	*E. scutalis*	*P. ubiquitous*	Total Pred.	*E. scutalis*	*P. ubiquitous*	Total Pred.	*E. scutalis*	*P. ubiquitous*	Total Pred.	*E. scutalis*	*P. ubiquitous*	Total Pred.	*E. scutalis*	*P. ubiquitous*	Total Pred.
T. urticae	0.97**	0.91**	0.95**	0.94**	0.98**	0.97**	0.91**	0.88**	0.98**	0.94**	0.87**	0.92**	0.82*	0.97**	0.94**
Hybrids	TWC323			TWC324			TWC327			Nefertity			TWC352		
Pred. / Prey	*E. scutalis*	*P. ubiquitous*	Total Pred.	*E. scutalis*	*P. ubiquitous*	Total Pred.	*E. scutalis*	*P. ubiquitous*	Total Pred.	*E. scutalis*	*P. ubiquitous*	Total Pred.	*E. scutalis*	*P. ubiquitous*	Total Pred.
T. urticae	0.66*	0.65*	0.66*	0.96**	0.77*	0.84*	0.96**	0.92**	0.96**	0.72*	0.76*	0.77*	0.93**	0.64	0.86**

Pred. = Predatory mite, Phyto. = Phytophagous mites

Table 6. Correlation coefficient between population fluctuation of predacious mites and its relation to *T. urticae*, on ten maize three-way crosses hybrids at Gharbia governorate during season 2005.

Hybrids	TWC310			TWC311			TWC314			TWC321			TWC322		
Pred. / Prey	*E. scutalis*	*P. ubiquitous*	Total Pred.	*E. scutalis*	*P. ubiquitous*	Total Pred.	*E. scutalis*	*P. ubiquitous*	Total Pred.	*E. scutalis*	*P. ubiquitous*	Total Pred.	*E. scutalis*	*P. ubiquitous*	Total Pred.
T. urticae	0.92**	0.87**	0.91**	0.93**	0.95**	0.95**	0.98**	0.92**	0.98**	0.99**	0.99**	0.99**	0.99**	0.99**	0.99**
Hybrids	TWC323			TWC324			TWC327			Nefertity			TWC352		
Pred. / Prey	*E. scutalis*	*P. ubiquitous*	Total Pred.	*E. scutalis*	*P. ubiquitous*	Total Pred.	*E. scutalis*	*P. ubiquitous*	Total Pred.	*E. scutalis*	*P. ubiquitous*	Total Pred.	*E. scutalis*	*P. ubiquitous*	Total Pred.
T. urticae	0.82*	0.60	0.77*	0.99**	0.99**	0.99**	0.97**	0.96**	0.97**	0.97**	0.92**	0.97**	0.59	0.53	0.57

Pred. = Predatory mite, Phyto. = Phytophagous mites, M.= Motile stages.

Phytochemical analysis of maize leaf hybrids:

One of the most important factors which may explain the susceptibility or the tolerance of maize hybrids to the infestation of *T. urticae* is the phytochemical components of their leaves. Results in Table (8) show the mean infestation rates of movable stages of *T. urticae* to ten different maize hybrids TWC310, TWC311, TWC314, TWC321, TWC322, TWC323, TWC324, TWC327, Nefertity and TWC352, and the corresponding percentages or amount of their leaves content of some phytochemical components (nitrogen, phosphorus, calcium, potassium, total carbohydrate, total protein) throughout the plant growth stages during 2005 season at experimental farm of Gemmeiza Agriculture research station (ARC), Gharbia governorate and their relation with each other.

Regarding the relation between the population levels and the previously mentioned components, the calculated correlation coefficient values were significantly positive in case of nitrogen and total protein as the corresponding r values were 0.81 and 0.80 respectively, and non significant positive correlation between the population and phosphorus and total carbohydrate. Conversely, the relation was significant negative with calcium as (-0.90), and non significant between population and potassium as (-0.62) in all three-way crosses hybrids.

The highest mean number of *T. urticae* occurred on the leaves of Nefertity and TW327 hybrid (383.5 and 355.5 individuals/20 leaves) was associated with higher levels of nitrogen and total protein (4.06& 4.14, 13.6 and 14.3, respectively), indicating positively significant relationships with the population densities throughout the growing season 2005. The lowest mean number of *T. urticae* on leaves of three-way hybrid TWC310 and TWC311 (151.68 and 177.82 individuals/ 20 leaves) was associated with lower levels of nitrogen, phosphorus, total carbohydrate and total protein (3&2.78, 2.1& 2.4, 50.2&50, 9.4 and 11.6, respectively).

For both calcium and potassium, it seems that by decreasing the amount of those two components in all three-way hybrids, the population density on the leaves increased. Similar results agreement with that obtained by (Margoli& Kennedy, 1984, Labanowska, 2007, Afifi *et al*., 2010, Afifi *et al*., 2013).

Table 7. Evaluation of the relative susceptibility of different maize three-way crosses hybrids to *T. urticae* infestation at Gharbia governorate during season 2004-2005.

Hybrids / Season	Average number of *T. urticae* / 20 leaves										L.S.D.
	TWC310	TWC311	TWC314	TWC321	TWC322	TWC323	TWC324	TWC327	Nefertity	TWC352	
2004	96.00^{e}	120.79^{de}	137.86^{cd}	162.43^{c}	146.04^{cd}	125.64^{de}	140.18^{cd}	210.93^{b}	273.96^{a}	150.32^{cd}	33.75
2005	151.68^{d}	177.82^{cd}	253.89^{b}	250.82^{b}	249.71^{b}	237.11^{bc}	249.89^{b}	355.50^{a}	383.50^{a}	140.75^{d}	65.50

The means with the same letters at the same row are not significantly different at 0.05% level.

Table 8. phytochemical components of ten three-way crosses hybrids leaves and population of *T. urticae* at Gharbia governorate season 2005.

Hybrids	Average no. of motile stages/ 20 leaves	Concentration of Photochemical components					
		N mg/gm	P mg/gm	K %	Ca mg/100gm	Carbohyd. %	Protein %
TWC310	151.68^{d}	3.0^{ef}	2.1^{f}	3.2^{a}	30.4^{a}	50.2^{f}	9.4^{g}
TWC311	177.82^{cd}	2.78^{f}	2.4^{e}	2.8^{b}	29.0^{c}	50.0^{f}	11.6^{f}
TWC314	253.89^{b}	3.0^{ef}	3.5^{b}	2.0^{d}	29.0^{c}	57.6^{d}	12.4^{de}
TWC321	250.82^{b}	3.5^{bc}	3.0^{dc}	2.2^{d}	25.6^{e}	54.0^{e}	12.0^{ef}
TWC322	249.71^{b}	3.7^{b}	3.97^{a}	1.8^{e}	21.6^{g}	64.0^{a}	12.8^{cd}
TWC323	237.11^{bc}	3.3^{cd}	2.78^{d}	2.1^{d}	26.4^{d}	57.85^{cd}	13.0^{c}
TWC324	249.89^{b}	3.0^{ef}	4.0^{a}	2.5^{c}	29.85^{ab}	63.6^{ab}	13.6^{b}
TWC327	355.50^{a}	4.14^{a}	3.1^{c}	1.1^{f}	23.7^{f}	63.0^{ab}	14.3^{a}
Nefertity	383.50^{a}	4.06^{a}	3.5^{b}	1.6^{e}	25.1^{e}	62.2^{b}	13.6^{b}
TWC352	140.75^{d}	3.21^{de}	3.0^{dc}	2.9^{bc}	29.4^{bc}	59.3^{c}	11.6^{f}
L.S.D.	65.5	0.24	0.22	0.21	0.78	1.47	0.57
Correlation coefficients between population and chemicals		0.81*	0.50	-0.90**	-0.62	0.62	0.80*

The means with the same letters at the same Column are not significantly different at 0.05% level.

Biological studies:

Obtained developmental times of various stages of *T. urticae* on four maize three-way crosses hybrids (i.e. Nefertity, TWC327, TWC321 and TWC310) at laboratory conditions of (28±2°C, 75±5 % RH and 16:8 L: D) were presented in Table (9). *T. urticae* females hatched after 2.8, 3, 3.7 and 3.8 days on Nefertity, TW327, TW321 and TW310 variety, respectively, while males hatched after shorter periods.

Shortest developmental durations observed that females and males reached maturity after 7.9 and 7.4 days on three crosses Nefertity, respectively. While the longest duration of females were recorded on TWC310 and TWC321 as 10.4 and 9.8 days.

Female longevity was longer on Nefertity and TWC327 hybrids followed by TWC321 and TWC310 hybrids. Liu and Tsai (1998) studied the development of *Tetranychus tumidus* Banks on Coconut palm at 6 constant temperatures, the developmental periods of immature stages ranged from 39.6 days at 15 °C to 7.4 days at 30°C.

The number of deposited eggs per female of *T. urticae* was highest on Nefertity hybrids as (46.6 eggs/ female), on the other hand, the lowest values was recorded on three-way crosses hybrids TWC310 (28.5 eggs/ female).

Life table parameters of *T. urticae*

Results in Table (9) indicated that mean generation time (T) was longest on N TWC310 was 12.3 days and the lowest was 8.9 days Nefertity hybrids. The same trend was observed for other life table parameters. The required time for population of *T. urticae* to multiply (DT) as 2.85 days on Nefertity variety, while the longest period was 4.3 days on TWC310 hybrid.

The maximum values of intrinsic rate of increase ($\mathbf{r_m}$) and the finite rate of increase (**λ)** was obtained on three-way crosses Nefertity (0.24 and 1.27 individuals/female/day). Minimum values were obtained on three-way crosses TWC310. The peak net reproductive rate (Ro) occurred on Nefertity hybrid as 18.63 individuals per generation, the lowest values on TWC310 hybrids as 10.29 individuals per generation. The r_m value is an important parameter describing the growth potential of a population under different food as it, reflects the overall effects of food on development, reproduction and survival rate of populations.

This result is consistent with findings previous studies Najafabadi, 2012 found that the biology of the two-spotted spider mite on *Phaseolus vulgaris* the analysis of the all life table parameters (r_m , Ro, λ, T and DT) indicated significant differences among five host plants.

Table 9. Biological aspects and life table parameters of two-spotted spider mite *T. urticae* at 28°C and 65% R.H., on different three-way crosses of maize hybrids.

Hybrids / Parameters	Nefertity		TWC327		TWC321		TWC310		L.S.D$_{0.05}$
	♀	♂	♀	♂	♀	♂	♀	♂	
Incubation period	2.8±0.5^{b}	2.8±0.4	3.0±0.5^{b}	2.9±0.4	3.7±0.7^{a}	3.5±0.5	3.8±0.6^{a}	3.5±0.5	0.35
Larva	2.0±0.5^{c}	1.7±0.5	2.0±0.5^{c}	2.1±0.5	2.7±0.7^{b}	2.4±0.4	3.1±0.6^{a}	2.4±0.4	0.36
Protonymph	1.5±0.3^{b}	1.3±0.4	2.0±0.5^{a}	2.2±0.5	1.7±0.3^{b}	1.6±0.3	1.7±0.3^{b}	1.5±0.5	0.27
Deutonymph	1.6±0.4^{a}	1.7±0.4	1.6±0.6^{a}	1.8±0.4	1.8±0.4^{a}	1.7±0.4	1.7±0.3^{a}	1.7±0.7	0.25
Immature stages	5.1±0.9^{c}	4.7±0.0.8	5.6±1.0^{bc}	6.1±0.7	6.1±0.9^{ab}	5.7±0.6	6.5±0.7^{a}	5.6±0.8	0.55
Life cycle	7.9±1.1^{c}	7.4±0.7	8.6±1.2^{b}	9.0±0.9	9.8±1.1^{a}	9.2±0.8	10.4±0.9^{a}	9.1±0.9	0.66
Generation period	8.9±1.3^{d}		10.0±1.4^{c}		11.4±1.3^{b}		12.3±0.8^{a}		0.72
Pre-oviposition period	1.0±0.4^{c}		1.4±0.7^{b}		1.5±0.5^{b}		1.9±0.8^{a}		0.31
Oviposition period	11.7±2.5^{a}		10.3±1.5^{b}		6.9±1.0^{c}		7.2±0.7^{c}		1.07
Post-oviposition period	1.8±0.8^{b}		2.4±0.5^{a}		1.6±0.^{b}		1.6±0.7^{b}		0.37
Longevity	14.5±2.7^{a}	14.8±2.0	14.2±1.4^{a}	14.3±1.8	10.0±0.9^{b}	10.21.6	10.6±1.3^{b}	10.2±1.6	1.10
Mean fecundity (eggs/ ♀)	46.6±4.8^{a}		36.8±3.3^{b}		29.6±4.7^{c}		28.5±4.0^{d}		2.68
Mean daily rate (eggs/ ♀/ day)	4.1±0.9^{ab}		3.6±0.7^{b}		4.4±1.0^{a}		4.1±0.9^{ab}		0.54
Life span	22.4±2.8^{a}	22.3±2.2	22.8±2.1^{a}	23.3±2.3	19.8±1.4^{b}	19.4±2.1	21.0±1.4^{b}	19.3±2.1	1.28
Double generation (DT)^{a}	2.85		3.25		3.51		4.3		
50% mortality^{a}	16.5		14.5		16		15.9		
Sex ratio (female/ total)	0.6		0.65		0.62		0.60		
Intrinsic rate of increases (r_m)^{c}	0.24		0.21		0.19		0.16		
Finite rate of increases (λ)	1.27		1.23		1.21		1.17		
Net reproductive rate (R_o)^{b}	18.63		15.39		14.34		10.29		

The means with the same letters at the same row of females are not significantly different at 0.05% level. ^{a} Days ^{b} Per generation ^{c} Individuals/ female/ day

El-Halawany and Abd El-wahed, 2013 showed that, when reared *T. urticae* on persimmon at different temperatures The maximum values of (r_m) and (λ) was obtained at 30ºC (0.243- 1.34 ♀/♀/day) and Minimum values were obtained at 15 ºC. The peak net reproductive rate (Ro) occurred at 30 ºC as 47.51 to 63.47 individuals/♀/ generation.

Afifi *et al.,* 2013 was studies the biology of *T. urticae* on three cultivars of Eggplants and showed that, the shortest mean generation was 12.08 days on Black baity cultivar, while the longest was 13.2 days on Baity cultivar. The highest (Ro) was 32 females/female/generation on Black baity and lowest was 21.13 females/female/generation on Baity cultivar.

REFERENCES

1. Abou-Setta, M. M., R W. Sorrell, R.W. and C. C. Childers 1986. Life 48: a BASIC computer program to calculate life table parameters for an insect or mite species. Fla. Entomol. 69:690-697.
2. Afifi, A. M, S. M. El-Bishlawy and H. Mohmoud 2013. Resistant of two Eggplant cultivars against the two-spotted spider mite, *Tetranychus urticae* Koch infestation, with note on its biology. Acarines, 7(2) 23-27.
3. Afifi, A. M., A. Y. El-Laithy, S. A. Shehata and M. A. El-Saiedy 2010. Resistance of strawberry plants against the two-spotted spider mite, *Tetranychus urticae* (Acari: Tetranychidae). In: Sabelis, M.V., Bruin, J. Trends in Acarology. Proceedings of the 12th Inter. Cong. Amsterdam. The Netherlands. pp: 505-507.
4. Azouz, H. A. 2005. Ecological and biological studies on some mites associated with cotton and some field crops in Beni-Suef governorate. Ph.D. Thesis, Fac. Agric., Al-Azhar Univ., 181pp.
5. Bacon, O. G., T. Lyons and R. S. Baskett 1962. Effects of spider mite infestations on dent corn in California. J. Econ. Entomol. 55:823-825.
6. Dewis, J. and E. Freites 1970. Physiologicl Methodes of soil and water analysis. Food Agric. Oiranization of thje United Nations. Soils Bull., No. 10.
7. El-Halawany, A.S. and N. Abd El-wahed 2013. Effect of temperature and host plant on developmental times and life table parameters of *Tetranychus urticae* Koch on persimmon Trees. (Acari: Tetranychidae). Egypt. J. Agric. Res., 91(2): 595-606.
8. Labanowska, B. H. 2007. Susceptibility of strawberry cultivars to the two-spotted spider mite. J. Fruit Ornam. Plant Res. 15: 133-146.

9. Liu, Y. H. and J. H. Tsai 1998. Development, survivorship and reproduction temperature. International. J. Acarol., 24 (3):245- 252.
10. Margoli, D. C. and G. G. Kennedy 1984. Population response of the two-spotted spider mite, *Tetranychus urticae* to host phenology in corn and peanut. Ent. Exp. Appl., 36(2): 193-196.
11. Mead, H. M., H El-Kawas. and W. M. Desuky 2010. Susceptibility of certain maize varieties to *Tetranychus urticae* Koch infestation in relation to leaf chemical contents. Acarines, 4, 25-30.
12. Murphy, J. and J. P. Reily 1962. Amodified single solution for the determination of phosophate in natural water, Chem. Acta, 27:31- 36.
13. Najafabadi, S. S. M. 2012. Resistance to *Tetranychus urticae* Koch (Acari: Tetranychidae) in *Phaseolus vulgaris* L. Middle-East J. Sci. Res. 11 (6): 690-701.
14. Pregl, E. 1945. Quantitative Organic Micro Anaysis 4th edit, Vhundril, Ltd. London. J. Appl. Ent. 114:131-137.
15. Rezaie, M., A. Saboori, V. Baniamerie and H. Allahyari 2013. Susceptibility of *Tetranychus urticae* Koch (Acari: Tetranychidae) on seven strawberry cultivars. Inter. Research J. Appl. and Bas. Sci., 4 (9): 2455-2463.
16. SAS Institute, 2010. SAS Statistics and Graphics Guide, Release 9.1. SAS Institute, Cary, North . Carolina 27513, USA.
17. Skorupska, A. 2004. Resistance of apple cultivars to two-spotted spider mite, *Tetranychus urticae* Koch (Acarina: Tetranychidae). Part I. Bionomy of two-spotted spider mite on selected cultivars of apple trees. J. Plant Protection Res. 44 (1): 75-80.
18. Taha, H.A., F.I. El-Attar and M.S. Abdel-Fattah 1991. Susceptability of twelve Sorghum hybrids and varieties to *Tetranychus urticae* Koch mite infestion. Proc. 4th Arab. Cong. Of Plant Protection., Cairo, Egypt 1-5:538-544.
19. Taha, H.A., R.A. Sedrak, A.K. Iskander and A. E. Sharaf 1995. Field and laboratory studies on some pests infesting some Soyabean cultivars and its relation of leaves constituents, with reference to their nature enemies. Egypt, J. Appl. Sci., 10(6): 1-11.
20. Zaher, M. A. 1984. Survey and ecological studies on phytophagous, predaceous and soil mites in Egypt. I: Phytophagous mites in Egypt (Nile valley and Delta). PI 480 Prog. USA Project No. EG. ARS, 30. Grant. No, FG, Eg., 81. 228pp.

تقييم قابلية عشرة هجن ثلاثية للذرة للإصابة بالعنكبوت الأحمر العادى *Tetranychus urticae* Koch (Acari: Tetranychidae) بمحافظة الغربية

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تم تقييم حساسية عشرة هجن من الذرة الهجين للعنكبوت الأحمر العادي خلال عامي 2004، 2005 في محافظة الغربية. اشتملت الدراسة دراسة تذبذب التعداد العنكبوت الأحمر العادى على عشرة هجن من الذرة (هجين ثلاثية 310، 311، 314، 321، 322، 323، 324، 327، نفرتيتي، 352) وعلاقتها بالظروف الجوية المختلفة.

أوضحت النتائج تذبذب تعداد اثنين من المفترسات الأكاروسية المصاحبة للعنكبوت الأحمر العادي. وأشارت نتائج قابلية الهجن الذرة للإصابة أن هناك اختلافات كبيرة للأطوار المتحركة للعنكبوت. وتم دراسة تأثير المحتوى الكيميائي للأوراق على العنكبوت الأحمر العادي. وأشارت النتائج أن هجين الذرة نفرتيتي كان اعلي الأصناف إصابة بالعنكبوت الأحمر العادي بمتوسط موسمي (273.96، 383.5 فرد / 20 ورقة خلال الموسمين على التوالي. سجلت أعلى كثافة عددية للعنكبوت خلال موسم 2004 في أواخر أغسطس و أول سبتمبر على جميع الهجن تحت الدراسة ، بينما في موسم 2005 فقد سجل ذروتين من الكثافة العددية الأولى في أول يوليو والثانية في أول سبتمبر على جميع الهجن تحت الدراسة. تم دراسة معدل التطور والتكاثر على أوراق أربعة أصناف من الهجن الثلاثية (نفرتيتي، هجين ثلاثي 327، 321، 310) تحت الظروف المعملية على درجة حرارة 28 ±2°م، 65 ± 5% رطوبة نسبية وفترة إضاءة 16 ساعة.

سجل أطول فترة لتطور العنكبوت الأحمر العادي على الهجين الثلاثي 310 (6.5 يوم) يليه هجين ثلاثي 321 (6.1يوم) ثم هجين ثلاثي 327 و نفرتيتي (5.6، 6.1 يوم).

كان معدل وضع البيض للعنكبوت الأحمر العادي 46.6، 36.8، 29.6، 28.5 بيضة / أنثى على أصناف نفرتيتي، هجين ثلاثي 327، 321 على التوالي. وسجل اعلي معدل للزيادة الذاتي (Ro) 18.63 أنثى/ أنثى/جيل على الصنف نفرتيتي، وأقل معدل 10.29 أنثى/ أنثى/جيل على هجين ثلاثي 310.