

Seasonal abundance of the two- spotted spider mite *Tetranychus urticae* Koch on common bean *Phaseolus vulgaris* L.

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Abstract: Field experiments were conducted during 2016 and 2017 seasons at Kom-Hamada district, Beheira governorate, Egypt to investigate seasonal abundance of the two- spotted spider mite *Tetranychus urticae* Koch. (Tetranychidae) on common bean *Phaseolus vulgaris* L. Cultivar Giza 9 plants. The initial incidence of the spider mite occurred in relatively few numbers of 1.60 & 0.84 individuals per leaf at the late February of both seasons, respectively. The populations then started to increase and reached the highest density of 18.20 and 20.60 individuals per leaf in the first week of May during 2016 and 2017 seasons, respectively. Temperature appeared to be the most environmental factor affecting population build-up of this pest on the investigated crop. These results may have some practical implications in reducing populations of the two- spotted spider mite attacking common bean plants in Egypt.

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Key words: Seasonal abundance, *Tetranychus urticae*, *Phaseolus vulgaris*, Temperature, Relative humidity, Correlation.

1. Introduction

Common bean *Phaseolus vulgaris* L. is one of the important leguminous crops in many parts of the world including Egypt. The crop in open field conditions has been found to extensively attacked by several arthropod pests, particularly the plant feeder mites of the family Tetranychidae, that are widely spread during the growing season. The most wide spread tetranychid mite species is *Tetranychus urticae* Koch which is considered as one of the most serious acarine pests attacking common bean (Tomczyk *et al.*, 1987; Lee *et al.*, 1988; Latrou *et al.*, 1995 and Razmjou *et al.* 2009). This spider mite remains active almost all the season and it may reaches damaging population levels very rapidly when growing conditions are favourable, resulting significant yield losses (Helle & Sabiles 1985; Gregory & Karban 1998; Rao *et al.*, 1996 and Gotoh *et al.*, 2004). In Egypt, field observations carried out by Farrag *et al.*, 1998; El-Saiedy *et al.*, 2012 a and Abd-Elal, 2015 indicated that, the tetranychid mite, *T.urticae* has been reported currently among the most destructive arthropod pests infesting common bean crop. Little is known about factors influencing population dynamics of the spider mite *T. urticae* on this important crop, that can be important for development of suitable management programme. The present work was carried out to study the population dynamics and stage specific population levels of *T.urticae* in common bean field at Beheira governorate, Egypt throughout

two successive seasons 2016 and 2017 in relation with temperature and relative humidity. Also, mean number of females to males in populations of *T. urticae* and percentage females throughout the crop season was investigated.

2. Materials and Methods

The investigation was carried out in common bean field located at Kom-Hamada district, Beheira governorate, Egypt to estimate periodical incidence of the two- spotted spider mite (TSM) *T.urticae* throughout 2016 and 2017 seasons. Counts of mite stages including egg, immature and adult stages started from February 27 and continuing weekly until first week of June (14 weeks). Twenty five common bean leaves *Phaseolus vulgaris* L. Cultivar Giza 9 were randomly taken from randomly twenty five plants, placed in polyethylene bags, brought to the laboratory of Plant Protection Department, Faculty of Agriculture Zagazig University and immediately examined by stereomicroscope. The data are expressed as numbers of eggs and moving stages (immatures and adults) per leaf. Daily records of average temperature and relative humidity degrees obtained from Agrometeorological Station of Beheira governorate. TSM populations were correlated with average temperature and relative humidity by calculating the simple correlation coefficient (r) according to Costat statistical software (2005).

3. Results and Discussion

Seasonal abundance of *T. urticae* on common bean plants.

Observations on seasonal abundance and stage specific population levels of the two-spotted spider mite *T. urticae* on common bean in the open field during the period from the last week of February to the first week of June throughout 2016 and 2017 seasons are presented in Tables (1 & 2). It was noticed that, the two-spotted spider is considered as important phytophagous pest of common bean, where it remains active during the crop season. Mite populations showed distinct fluctuations during the crop season in their response to changes in average temperature and relative humidity. Population density was very low at the first initial infestation, where it averaged 1.44 & 1.04; 0.72 & 0.36 and 0.88 & 0.48 mite individuals per leaf for egg, immature and adult stages during 2016 and 2017 seasons, respectively. These values started to increase and reached the highest density of eggs (23.92 & 23.32 eggs per leaf) in the 10th and 26th of April for the first and second seasons, respectively. The highest peaks of immature stages (14.88 & 16.72 individuals per leaf) were reached in the 3rd of May for the abovementioned seasons, respectively. (Tables 1 & 2).

Mean number of adults was markedly fewer in comparison with other stages. The highest increase of adult populations (5.48 & 5.00 individuals per leaf) was counted in the 17th and 24th of May in 2016 and 2017 seasons, respectively (Tables 1 & 2), then the populations of the investigated TSM stages decreased to reach 1.4, 1.96 and 0.88 individuals per leaf for egg, immature and adult stages respectively during 2016 season. At the same date in 2017 seasons these values were slightly higher and averaged 3.68; 2.92 and 2.40 individuals per leaf for egg, immature and adult stages, respectively.

The same pattern was similar to that of the mean number of TSM moving stages. The population density of TSM moving stages per leaf varied from 1.60 at the initial infestation (when the average temperature and relative humidity was 16.86 °C and 64.86 % R.H.) to 18.20 individuals per leaf in the 3rd of May 2016 season at the average temperature of 23.43°C and relative humidity of 43.14%. During 2017 season these values varied from 0.84 at the last week of February (19.3°C and 50.14 R.H. %) to 20.60 individuals per leaf in the third of May (average temperature 26.70 °C and relative humidity 38.34%). The maximum mean number of TSM all stages (eggs and moving stages) per leaf was recorded at the first week of May throughout the two seasons, where it averaged 37.2 and 42.4 mite individuals per leaf for 2016 and 2017 seasons, respectively (Tables 1 & 2),

then these populations sharply declined at the last inspection.

In this regard Chauhan & Shukla (2016) found that the infestation of French bean, *P. vulgaris* with TSM starts from the first January and reached its maximum (14.20 individuals per leaf) in the first week of April. El-Saiedy *et al.* (2012 b) reported that the infestation peak of TSM populations on broad bean was occurred during March. The highest number of TSM moving stages on cotton plants was counted at the end of April (Al-Garhy 2016).

Correlation between *T. urticae* populations and each of average temperature and relative humidity.

Data presented in Table (3) indicated that, there were insignificant positive correlation between the changes of the TSM egg mean numbers and average temperature (-0.25 ns) during the first season, while during the second season this correlation was positively insignificant (0.40 ns). With relative humidity, this correlation was negatively insignificant during the two seasons. During 2016 season, significant positive correlation was found between the fluctuations of TSM immature, adult and moving stages and average temperature degrees, with slightly higher values of 0.54*, 0.63* and 0.61* for the aforementioned stages, respectively (Table 3). On the other hand in 2017 season correlation between population of these stages and average temperature was highly positively significant, with slightly higher values of 0.66**, 0.79*** and 0.72** for immature, adult and moving stages, respectively. Considering population of TSM all stages there were non significant positive correlation with average temperature during the first season ($r = 0.13^{ns}$), while it had significant positive correlation with average temperature during the second season ($r = 0.58^*$). Only, there were significant negative correlation between average relative humidity and population of adults ($r = -0.57^*$) and moving stages (-0.56^*) in 2016 season, while this correlation with other stages during the two seasons was negatively insignificant (Table 3). Similarly, Singh (1995) cleared that, temperature, appeared to be regulatory factor for population build up of TSM on cowpea. Maximum, minimum temperature and maximum relative humidity had significant positive effect on population of TSM on kidney bean (El-Saiedy *et al.*, 2012 b). Chauhan & Shukla (2016) mentioned heat average temperature and relative humidity had significantly correlated with TSM population on French bean. There were positive correlation between the changes of *T. urticae* populations on four cotton cultivars and air temperature, while the correlation with relative humidity was positively insignificant (Esmaeel *et al.*, 2018).

Stage specific population levels of *T. urticae* on common bean plants

It was evident when egg, immature and adult stages in TSM population were counted weakly on common bean plants throughout two years (14 weeks for season) eggs were found to be the most dominant stage for all most of the season followed by immature and adult stages. (Table 1 & 2) General mean values of egg, immature and adult stages were 9.51 & 12.23; 6.07 & 6.34 and 2.94 & 2.94 individuals per leaf during 2016 and 2017 seasons, respectively. Mean number of eggs per leaf increased the first seven and nine weeks in 2016 and 2017 seasons respectively.

These numbers decreased as season progressed relative to other stages. For immature stages increasing in their mean number extended to the first ten week during the two seasons, while the mean number of adults increased the first twelve week in 2016 season and the first eleven week in 2017 season. These stages then gradually decreased during the last weeks of the season. In this respect, Krainacker and Carey (1990) found that egg, immature and adult stages of TSM on corn plants slowly increased the first months of the season. Mite populations reached the peak between the 6th and 8th week of experiment, then rapidly decreased.

Table 1. Population dynamics of *T.urticae* different stages on common bean during 2016 season.

Sampling date	Mean number per leaf					Average	
	Eggs	Immatures	Adults	Moving stages	All stages	Temperature	R.H %
27-2-2016	1.44	0.72	0.88	1.60	3.04	16.86	64.86
6-3-2016	4.24	1.56	1.44	3.00	7.24	18.57	59.71
14-3-2016	19.6	2.24	1.36	3.60	23.2	19.86	44.86
21-3-2016	12.68	3.04	2.72	5.76	18.44	18.00	54.57
29-3-2016	7.32	4.56	1.64	6.20	13.52	19.57	53.0
3-4-2016	11.84	5.68	1.44	7.12	18.96	21.29	49.86
10-4-2016	23.92	6.96	2.52	9.48	33.4	21.43	54.43
18-4-2016	11.08	7.84	2.56	10.40	21.48	21.57	54.0
26-4-2016	10.52	8.52	3.2	11.72	2.24	24.57	36.86
3-5-2016	19.00	14.88	3.32	18.20	37.2	23.43	43.14
10-5-2016	2.36	11.16	2.32	13.48	15.84	24.86	51.86
17-5-2016	3.16	10.52	5.48	16.00	19.16	28.57	38.14
24-5-2016	4.6	5.36	4.4	9.76	14.36	26.43	45.86
1-6-2016	1.4	1.96	0.88	2.84	4.24	26.71	44.14
Mean	9.51	6.07	2.44	8.51	18.02	22.26	49.66

* Each value is a mean of 5 replicates.

Table 2. Population dynamics of *T.urticae* different stages on common bean during 2017 season.

Sampling date	Mean number per leaf					Average	
	Eggs	Immatures	Adults	Moving stages	All stages	Temperature	R.H %
27-2-2017	1.04	0.36	0.48	0.84	1.88	19.3	50.14
6-3-2017	3.88	0.84	1.52	2.36	6.24	22.0	50.86
14-3-2017	10.64	2.16	1.88	4.04	14.68	21.7	44.57
21-3-2017	10.36	2.52	2.68	5.20	15.56	20.6	46.86
29-3-2017	15.32	4.20	1.92	6.12	21.44	22.1	39.71
3-4-2017	13.04	5.36	2.48	7.84	20.88	19.6	56.00
10-4-2017	18.36	6.36	3.80	10.16	28.52	26.7	39.43
18-4-2017	19.52	7.96	3.96	11.92	31.44	24.0	46.57
26-4-2017	23.32	14.92	3.84	18.76	42.08	26.9	44.57
3-5-2017	21.8	16.72	3.88	20.6	42.40	26.7	38.43
10-5-2017	9.16	9.00	4.04	13.04	22.2	26.7	44.71
17-5-2017	9.20	7.00	3.32	10.32	19.52	25.7	39.14
24-5-2017	11.88	8.40	5.00	13.4	25.28	28.1	42.43
1-6-2017	3.68	2.92	2.40	5.32	9.00	25.6	41.43
Mean	12.23	6.34	2.94	9.28	21.51	24.07	44.63

* Each value is a mean of 5 replicates.

Mean numbers of females to males and percentage females in population of *T. urticae* on common bean plants during 2016 and 2017 seasons.

Date in Table (4) indicated that, mean numbers of adult females and adult males of the two-spotted spider mite, *T. urticae* increased as the crop season progressed during the two years of study. The greatest

mean number of females and males was recorded in the 17th and 24th of May in 2016 and 2017 seasons, respectively, where it averaged 3.92 & 1.56 and 3.92 & 1.08 individuals per leaf for females and males throughout the first and second seasons, respectively. Each stage then gradually decreased over the last weeks of the season. (Table 4).

Table 3. Correlation coefficient values (r) between changes in population of *T. urticae* different stages infesting common bean plants and each of average temperature and relative humidity during 2016 and 2017 seasons.

Season	Factor	<i>T. urticae</i> stage						
		Eggs	Immatures	Females	Males	Adults	Moving stages	All stages
2016	Temp.	-0.25 ns	0.54 *	0.60 *	0.65 *	0.63 *	0.61 *	0.13 ns
	R.H.	-0.12 ns	-0.51 ns	-0.57 *	-0.53 *	-0.57 *	-0.56 *	-0.39 ns
2017	Temp.	0.40 ns	0.66 **	0.78 ***	0.75 **	0.79 ***	0.72 **	0.58 *
	R.H.	-0.34 ns	-0.41 ns	-0.41 ns	-0.46 ns	-0.44 ns	-0.43 ns	-0.40 ns

ns = non significant.

Table 4: Mean numbers of females to males and percentage females of *T. urticae* on common bean plants during 2016 and 2017 seasons.

Sampling date	2016			2017			Mean % female
	Mean number per leaf			Mean number per leaf			
	Females	Males	% Females	Females	Males	% Females	
February 27	0.80	0.08	90.91	0.44	0.04	91.67	91.29
March 6	1.24	0.20	86.11	1.28	0.24	84.21	85.16
March 14	1.20	0.16	88.24	1.60	0.28	85.11	86.68
March 21	2.04	0.68	75.00	2.24	0.44	83.58	79.25
March 29	1.28	0.36	78.05	1.40	0.52	72.92	75.48
April 3	1.08	0.36	75.00	1.84	0.64	74.19	74.60
April 10	2.12	0.40	84.13	3.24	0.56	85.26	84.69
April 18	1.96	0.60	76.26	3.28	0.68	82.83	79.54
April 26	2.44	0.76	76.25	3.24	0.60	84.37	80.31
May 3	2.80	0.52	84.34	2.96	0.92	76.29	80.28
May 10	1.72	0.60	74.14	3.24	0.80	80.20	77.17
May 17	3.92	1.56	71.53	2.56	0.76	77.11	74.32
May 24	3.12	0.28	70.91	3.92	1.08	78.40	74.66
June 1	0.76	0.12	86.36	1.76	0.64	73.33	79.84
Mean	1.89	0.55	79.80	2.36	0.58	80.68	80.24

* Each value is a mean of 5 replicates.

Considering the percentage females in the mite population on common bean plants, it was noticed that the percentage females was higher during the first weeks of the infestation. This value was 90.91 and 91.29% at the initial infestation of the first and second

seasons, respectively. However, as the crop season progressed this value slightly decreased especially the period of the maximum population of the mite on plants. At the highest population density of TSM moving stages per leaf (in the 3rd of May) the

percentage females was 84.14 & 76.29% during 2016 & 2017 seasons, respectively (Tables 1, 2 and 4). Generally, the percentage females ranged from 70.90 to 90.91% in 2016 season and from 72.92 to 91.67% in 2017 season. General mean of proportion of females was 79.80 and 80.68 % in 2016 and 2017 seasons, respectively. These results are nearly in agreement with those of Carey & Bradley (1982). They reported that percentage of female offsprings of *T.urticae* was 74%. Gotoh (1985) cleared that the proportion of *T. viennensis* females was 82.4%. Correlation between sex ratio of *T.urticae* and nitrogen contents in apple leaves was significant (Wermelinger & Delucchi, 1990). Potter (1978) showed that the functional sex ratio of *T. cinnabarinus* becomes distinctly skewed towards males especially the period of the maximum dispersal from the host plant. Sex ratios of *T.urticae* (% female) were 78, 85 and 82% when the mite reared on three bean cultivars (Uddin *et al.*, 2015). Under laboratory conditions Karami-Jamour & Shishehbor (2012) cleared that, the sex ratio (% females) of tetranychid mite *T. turkestanii* ranged from 69.00 to 81.01 %.

From the previous results, it could be concluded that, the infestation of the two- spotted spider mite *T.urticae* on common bean plants under field conditions was observed at different growth stages of the crop. Population build- up of this pest was significantly affected by temperature degrees. These results may have some practical implications in reducing numbers of this pest. On the other hand counting of mite different stages weekly during the crop season may be useful in monitoring populations of this agricultural pest.

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