Middle East Journal of Agriculture Research
ISSN 2077-4605
Volume : 07 | Issue : 02 | April-June | 2018
Pages:481-491

Seasonal Fluctuation of main Pests Inhabiting Strawberry Plants In Relation To Certain Weather Factors at Sharkia Governorate, Egypt

Gamila Sh. Selem[1], Ghada M.A. Morsi[2] and Saneya R. M. Farag[2]

[1]*Plant Protection Dept., Fac. of Agric., Zagazig Univ., Egypt.*
[2]*Plant Protection Res. Inst. Agric. Res. Center, Dokki, Giza, Egypt.*

Received: 26 Feb. 2018 / Accepted: 05 May 2018 / Publication date: 24 May 2018

ABSTRACT

Seasonal fluctuation was conducted during the two successive seasons, 2014/2015 and 2015/2016 of the main pests infested strawberry plants. The obtained results revealed that the dominant species were *Tetranychus urticae* Koch (Prostigmata: Tetranychidae), *Aphis gossypii* Glover (Homoptera: Aphididae), *Bemisia tabaci* (Genn.) (Homoptera: Aelyrodidae), *Thrips tabaci* Lind. (Thysanoptera: Thripidae) and *Scheloribates zaheri* Yousef and Nasr (Sarcoptiformes: Oribatulidae). The seasonal abundance of these species were higher during the second season than the first one which recorded with total numbers of 11180 and 10024 individuals /sample during seasons 2015/2016 and 2014/2015, respectively. The obtained results appeared that the seasonal abundance of *T. urticae* showed four peaks of population density and the highest one was in the 1st week of April during the two seasons of study. On the other hand, the population density of *A. gossypii*, *B. tabaci, T. tabaci* and *S. zaheri* on strawberry plants recorded three peaks during the two seasons of the study.

The relationship between the daily mean temperature with total number of these species showed insignificant positive correlation with *T. urticae* activity but showed insignificant and significant positive correlation with *A. gossypii* activity during the seasons 2014/2015 and 2015/2016 respectively. The relative humidity had insignificant positive and negative correlation with *T. urticae* activity and negative correlation with *A. gossypii* activity but insignificant correlation with activity at the first season of the study (2014/2015), while significant correlation at the second one (2015/2016). The dew point had insignificant correlation with *T. urticae* and *A. gossypii* activity but negative correlation with activity at the first season of the study, while positive correlation at the second one.

Key words: Strawberry plants, pests, seasonal fluctuation, temperature, relative humidity, dew point.

Introduction

Strawberry (*Fragaria x ananassa* Duch.) is one of the most important members of the family Rosaceae. It has become one of the most economic vegetable crops in Egypt and considered the main cash crop for strawberry growers in Qalyubia, Ismailia, Sharkia and Beheira governorate according to the Annual Report of Agric. Statistics Dept. 2005/2006 season, Min. of Agric., A.R.E. It is one of the most favorite and delicious fruits of which the demand has been increased in Egypt for local consumption and for exportation and the fruits are rich in vitamin C and are commonly eaten fresh as a dessert fruit, it also used as a pastry or pie filling. Cultivation of strawberries is an important economic activity for small- and medium sized farms in different producing regions (Ferla *et al.* 2007).

Under Egyptian conditions, strawberry is liable to be attacked by several pests which are responsible for considerable quantitative and qualitative losses in the fruit yield. It is appropriate that attention be given to the more important insect and other pests which attack strawberry plants. These pests can cause serious economic loss by markedly reducing crop yields and quality (Rings and Neiswander, 1966).

This study aimed to evaluate the seasonal fluctuations and population density of the main pests infesting strawberry plants and also study the combined effects of certain principle weather factors on the tested pests. The obtained data can help producers to implement an integrated pest

Corresponding Author: Gamila Sh. Selem, Plant Protection Dept., Fac. of Agric., Zagazig Univ., Egypt.
E-mail:gamilashehata@yahoo.com

management (IPM) program for pests, it is crucial to know the species and their seasonal fluctuation to identify population peaks and, therefore, define the best time to employ control measures (Miller and Foottit (2009); Henz (2010).

Materials and Methods

1- Experimental design:

The seasonal fluctuation of pests (insects and mites) infesting strawberry plants was carried out at Abo Hammad district, Sharkia governorate, Egypt from the 3rd week of October, 2014 to the 2nd week of June, 2016. An experimental area of about 1/6 feddan was divided into four replicates (each replicate about 175m^2). This experimental area sown by frigo strawberry seedlings variety festival (*F. x ananassa*). Sowing dates were in Sept. 21, 2014 and 2015. The weekly sampling started after four weeks of cultivation date at 3rd week of October and continued until the end of the crop (the second week of June) in both seasons of the study. These samples were taken regular weekly. The plant sample was 25 leaflets from each replicate were randomly taken, which used for counting the main pests infesting strawberry plants. Weekly samples were picked at early morning randomly from each replicate representing the different plant levels.

2- Laboratory study:

The collected leaflet samples were transferred to the laboratory in paper bags for inspections in the same day. The upper and lower surfaces of each leaflet were examined carefully by using stereoscopic microscope and the number of each insects and mites was counted, recorded and identified.

3- Impact of Certain Weather Factors on Population Density of the Main Pests Infested strawberry plants:

3.1. Meteorological data:

Meteorological data regarding mean daily temperature, relative humidity and dew point were obtained from the Central Laboratory of Agricultural Meteorological during the inspection period (2014/2015 and 2015/2016 seasons). Population means of each pest on each observation date as well as weather factors were recorded. The daily records of these factors were recalculated to get the daily averages within a week corresponding with sampling dates. Population means and overall means of pests for whole growing seasons were calculated.

3.2. Data analysis:

The data were subjected to statistical analysis and the simple correlation coefficient (r), partial regression values (b) and coefficient of determination (CD%) were used to describe the relationship between population fluctuation of pests and each of temperature, relative humidity and dew point in natural conditions on strawberry plants according to Costat Software Microcomputer Program (Anonymous, 1990)

Results and Discussion

1. The main pests attacking strawberry plants:

The obtained data compiled in Table 1 shows the total number of the main pests infesting strawberry plants at Abo Hammad district, Sharkia Governorate, Egypt during two successive seasons from the 3rdweek of October, 2014 to the 2nd week of June, 2016. The main pests attacking strawberry plants revealed 5 species in 5 genera belong to 5 families and 4 orders. They were: the red spider mite, *Tetranychus urticae* Koch, the cotton aphid, *Aphis gossypii* Glover, the cotton whitefly, *Bemisia*

Table 1: Total number of the main pests recorded on strawberry plants during 2014/2015 and 2015/2016 seasons at Abo Hammad district, Sharkia governorate, Egypt.

Order	Family	Species	English name	stage	Feeding behaviour	Total no. of individuals				General	
						2014/ 2015	Dom. %	2015/ 2016	Dom. %	Total no.	Dom. %
Prostigmata	**Tetranychidae**	*T. urticae*	The red spider mite	Moving stage (adult, larva& nymph)	Phytophagous	5441	54.28	5817	52.03	11258	53.09
Homoptera	**Aphididae**	*A. gossypii*	The cotton aphid	Adult & nymph	Phytophagous	2756	27.49	3070	27.46	5826	27.48
	Aelyrodidae	*B. tabaci*	The cotton whitefly	nymph	Phytophagous	946	9.44	1077	9.63	2023	9.54
Thysanoptera	**Thripidae**	*T. tabaci*	The cotton thrips	Adult & nymph	Phytophagous	564	5.63	721	6.45	1285	6.06
Sarcoptiformes	**Oribatulidae**	*S. zaheri*	The oribatid mite	Moving stage (adult, larva& nymph)	Unknown nutrition	317	3.16	495	4.43	812	3.83
Grand total						10024	100.00	11180	**100.00**	**21204**	100.00

tabaci (Genn.), the cotton thrips, *Thrips tabaci* Lind. and The oribatid mite, *Scheloribates zaheri* Yousef and Nasr.

The seasonal total numbers were (21204 individuals/ sample) of the main pests for the two seasons. The total numbers of these pests were higher in the second season (11180 individuals/sample) than in the first one which recorded (10024 individuals /samples). The identification of the main pests proved that *T. urticae*, was the main occurred one recording 5441and 5817 individuals/sample in the two season respectively. *A. gossypii* occupied the second position recording 2756 and 3070 insects/sample for the first and second season, respectively. The populations of *B. tabaci* were higher in the second season than in the first recording 1077 individuals/sample for the second season and 946 individuals/sample for the first one. As for *T. tabaci* the population was also higher in the second season (721 insects/sample) than in the first one (564 insects/sample). The least category was represented by *S. zaheri* which recorded 495 individuals/ sample in the second season and 317 individuals/ sample in the first one. These results are in agreement with that obtained by Petrova *et al.* (2000) mentioned that the two-spotted spider mite *T. urticae* is the most polyphagous of the spider mite species and the most economically important arthropod pest in commercial strawberry plantations.

2. Seasonal fluctuation of the main pests attacking strawberry plants:

Data in Tables (2 & 3) showed that the highest percentage monthly total number of all pests occurred in April, 2015 & 2016 by 40.48% and 39.05, respectively. The obtained results could be discussed as follows:

a) The red spider mite, *T. urticae* Koch*:*

Data presented in Tables (2&3) indicated that total numbers of 5441 & 5817 individuals were recorded during seasons 2014/2015 and 2015/2016, respectively. The activity period of *T. urticae* was extended from 3rd week of October until 2nd week of June and recorded four peaks, the first one was the lowest occurred in the 4th week of October with the weekly total number of 93 and 89 individuals / 100 leaflets for the two seasons of study, respectively. The second peak occurred in the 2nd week of November with 132 and 136 individuals /100 leaflets during the two seasons of the study, respectively. The third peak was the highest one, it occurred in the 1st week of April with 1027 and 1083 individuals/ 100 leaflets for the two seasons, 2014/2015 and 2015/2016, respectively. The fourth peak took place in the 1st week of May with weekly total number of 151 & 160 individuals /100 leaflets during the two investigated seasons, respectively. These results are in agreement with those obtained by Huffaker *et al.* (1969); Dabrowski *et al.* (1971); Sances *et al*. (1979); Wyman *et al*. (1979); Oatman *et al.* (1985); Shanks & Doss, (1989); Stonneveld *et al*. (1996) and Walsh *et al*. (2002). Sato *et al*. 2004 reported that the two-spotted spider mite, *T. uticae* is a major pest of strawberry plants throughout the world. Strawberry plants are susceptible to attack in the preflowering and flowering period. Heavy infestation of strawberry leaves by this pest reduce plant growth and yield (Klamkowski*et al*., 2006). Petrova *et al.* (2000) mentioned that the two-spotted spider mite *T. urticae* is the most polyphagous of the spider mite species and the most economically important arthropod pest in commercial strawberry plantations.

b) The cotton aphid, *A. gossypii* Glover*:*

As shown in Tables (2& 3) the population density of the cotton aphid recorded three peaks occurred in the 4th, 2nd and 3rd of October, March and April with a weekly total number of 32, 241 and 416 insects/100 leaflets in the first season, respectively while in the second one were 43, 212 and 430 insects/ 100 leaflets in the same period of activity at the first season, respectively.

These results partial agree with that of Rondon *et al.* (2005) who observed that the seasonal dynamics of the cotton aphid, *A. gossypii* had two peaks of populations on strawberry leaves on 25 February and on 15 March. El-Gindy (2002) and Hashem (1997) mentioned that the population density of the cotton aphid had two generations on bean plants.

Table 2: Weekly total number of the main pests infesting strawberry plants at Abo Hammad district, Sharkia Governorate during 2014/2015 season.

Date (week)		*T. urticae*	*A. gossypiis*	*B. tabaci*	*T. tabaci*	*S. zaheri*	Weekly total no.	%	Monthly total no.	%
Oct.	3rd	33	23	24	13	11	104	1.04	300	2.99
	4th	93	32	36	22	13	196	1.96		
Nov.	1st	81	27	43	29	16	196	1.96	817	8.15
	2nd	132	22	38	26	15	233	2.32		
	3rd	119	18	33	24	9	203	2.03		
	4th	112	14	30	20	9	185	1.85		
Dec.	1st	82	13	17	13	6	131	1.31	363	3.62
	2nd	71	9	8	9	3	100	1.00		
	3rd	47	8	6	7	2	70	0.70		
	4th	41	11	5	4	1	62	0.62		
Jan.	1st	24	13	7	2	0	46	0.46	255	2.54
	2nd	27	15	9	6	0	57	0.57		
	3rd	32	18	11	9	0	70	0.70		
	4th	37	20	13	11	1	82	0.82		
Feb.	1st	39	24	14	13	4	94	0.94	605	6.04
	2nd	52	28	16	15	7	118	1.18		
	3rd	87	35	18	20	11	171	1.71		
	4th	109	54	20	26	13	222	2.21		
Mar.	1st	301	169	29	30	17	546	5.45	2602	25.96
	2nd	323	241	30	33	25	652	6.50		
	3rd	425	101	45	53	22	644	6.42		
	4th	493	178	31	44	14	760	7.58		
Apr.	1st	1027	237	37	26	17	1346	13.43	4058	40.48
	2nd	657	341	46	19	22	1085	10.82		
	3rd	498	416	75	14	38	1041	10.39		
	4th	140	334	90	10	12	586	5.85		
May	1st	151	189	58	8	11	417	4.16	898	8.96
	2nd	78	81	46	25	9	225	2.24		
	3rd	44	50	33	17	7	159	1.59		
	4th	24	23	31	11	2	97	0.97		
June	1st	14	8	29	4	0	55	0.55	126	1.26
	2nd	48	4	18	1	0	71	0.71		
Total		5441	2756	946	564	317	10024	100.00	10024	100.00
Dominance %		54.28	27.49	9.44	5.63	3.16				

c) The cotton whitefly, *B. tabaci (*Genn.):

Data in Tables (2 & 3) revealed that the population of *B. tabaci* was higher during the second season than the first one (1077 & 946 individuals/ sample, respectively). The number of individuals fluctuated with increasing until reached its peak three times in the two seasons of investigation. The first peak in the 1st week of November recorded the lowest population (43 & 37 individuals/100 leaflets) in the two seasons of the study, respectively. The second one occurred in the 3rd week of March by 45 & 76 individuals/100 leaflets in 2014/2015 &2015/2016, respectively. While the third peak was the highest one, it occurred in the 4th week of April by 90 & 106 individuals/100 leaflets in the two seasons of the study, respectively. These results are in agreement with that obtained by Khanzada *et al.* (2016) showed that cotton whitefly's population, *B. tabaci* on sunflower was found to be low in the 1stweek of January and maximum in the 3rd week of April. Also, El-Khayat *et al.* (1994) who studied the relative population density of the cotton whitefly, *B. tabaci* at two locations in Qalubiya Governorate (Moshtohor and El-Kanater El Khaireia) on some summer vegetable crop leaves.

d) The cotton thrips*, T. tabaci* Lind.:

The population density of the cotton thrips, *T. tabaci* recorded three peaks, the first one occurred in the 1st week of November with the weekly total number of 29 and 32 insects / 100 leaflets for the two experimented seasons, respectively. The second peak and the highest took place in the 3rdweek of March by 53 & 67 insects/100 leaflets in the two seasons of the study. The third peak and the lowest was recorded in the 2nd week of May with of 25 & 30 individuals/100 leaflets for the two seasons, 2014/2015 and 2015/2016, respectively (Tables 2&3). These results are in agreement with that obtained by Khanzada *et al.* (2016) reported that cotton thrip's population, *T. tabaci* on sunflower was minimum in 1st week of January and the highest recorded in the 3rd week of April.

Table 3: Weekly total number of the main pests infesting strawberry plants at Abo Hammad district, Sharkia Governorate during 2015/2016 season.

Date (week)		*T. urticae*	*A. gossypii*	*B. tabaci*	*T. tabaci*	*S. zaheri*	Weekly total	%	Monthly total	%
Oct.	3rd	55	35	19	18	23	150	1.34	354	3.17
	4th	89	43	30	20	22	204	1.82		
Nov.	1st	77	30	37	32	29	205	1.83	840	7.51
	2nd	136	25	21	30	25	237	2.12		
	3rd	125	20	19	28	21	213	1.91		
	4th	113	17	16	21	18	185	1.65		
Dec.	1st	100	16	14	19	13	162	1.45	462	4.13
	2nd	75	13	10	17	11	126	1.13		
	3rd	59	11	10	14	9	103	0.92		
	4th	35	10	8	11	7	71	0.64		
Jan.	1st	33	9	6	8	5	61	0.55	227	2.03
	2nd	35	6	5	6	4	56	0.50		
	3rd	39	5	3	2	0	49	0.44		
	4th	40	19	2	0	0	61	0.55		
Feb.	1st	43	25	12	20	4	104	0.93	691	6.18
	2nd	59	31	17	23	8	138	1.23		
	3rd	94	35	19	27	10	185	1.65		
	4th	130	44	39	32	19	264	2.36		
Mar.	1st	293	108	62	47	25	539	4.82	2953	26.41
	2nd	341	212	66	56	37	708	6.33		
	3rd	460	178	76	67	33	814	7.28		
	4th	555	189	70	49	29	892	7.98		
Apr.	1st	1083	355	67	31	26	1562	13.97	4366	39.05
	2nd	674	363	62	20	17	1136	10.16		
	3rd	519	430	58	18	35	1060	9.48		
	4th	150	373	106	12	19	608	5.44		
May	1st	160	213	58	19	16	514	4.60	1115	9..97
	2nd	68	109	50	30	12	273	2.44		
	3rd	51	60	44	25	10	190	1.70		
	4th	32	51	37	11	7	138	1.23		
June	1st	24	25	19	6	1	75	0.67	172	1.54
	2nd	70	10	15	2	0	97	0.87		
Total		5817	3070	1077	721	495	11180	100.00	11180	100.00
Dominance %		52.03	27.46	9.63	6.45	4.43	100.00			

e) The oribatid mite, *S. zaheri* Yousef and Nasr*:*

The weekly total numbers of *S. zaheri* on strawberry plants represented in Tables 2 & 3. These results clear that three peaks were recorded for *S. zaheri* population density in the two seasons of the study. The first one and the lowest was occurred in the 1st week of November with weekly total

number of 16 &29 individuals/100 leaflets. The second peak occurred in the 2nd week of March by25 & 37 individuals/100 leaflets. The third peak took place in the 3rd week of April with weekly total numbers of 38 & 35 individuals/100 leaflets for the two experimented seasons, respectively.

3) Impact of daily mean temperature, relative humidity and dew point on the activity of the main pests infested strawberry plants:

Data presented in Table (4) showed the simple correlation (r), simple partial regression coefficients (b) and coefficient of determination (CD%) for relationship between the activity of main pests attacking strawberry plants and the daily mean of each temperature ,relative humidity and dew point during the two successive seasons 2014/2015 and 2015/2016. Aheer *et al*. 1994 showed that the incidence and development of all the insect pests are much dependent upon the prevailing weather conditions, such as temperature and relative humidity.

a) T. urticae:

Data in Table (4) revealed the effect of daily mean temperature on the activity of *T. urticae* had insignificant positive (r_1 = 0.0154 and 0.2078) during 2014/2015 & 2015/2016, respectively. On the other hand, the relationship between the daily mean relative humidity and the population of this pest had insignificant positive and negative effect in both seasons (r_2 = 0.0534 and -0.1918) during 2014/2015 & 2015/2016, respectively. While dew point showed insignificant negative and positive correlation where r_3= -0.0643& 0.0012 during the two seasons of the study, respectively.

As for regarding partial regression, there were positive relationship between the population densities of *T. urticae* and daily mean of temperature in the two seasons of the study, whereas b_1= 0.8071&9.277, successively. While relative humidity had positive and negative relationship whereas b_2 = 1.5863 &-4.9746 during 2014/2015 &2015/2016, respectively. Partial regression between population density of *T. urticae* and daily mean of dew point was negative and positive effect, whereas b_3 = -3.7969 & 0.0888 during 2014/2015 and 2015/2016, consecutively. It can be seen from results that the regression coefficient (b_1= 0.8071 & 9.277) revealed that, for each unit, the increase in the temperature would also increase the mite population by 0.80& 9.27 per leaflet in the two seasons of the study, respectively. The regression coefficient (b_2 = 1.5863 &-4.9746) shows that, for 1% increase, the relative humidity would increase and decrease the population of mite by1.58 and 4.97 per leaflet during 2014/2015 and 2015/2016, respectively. On contrary, the regression coefficient (b_3 = -3.7969 &0.0888) indicates that, every increase unit in the dew point would decrease and increase the population of mite by 3.79 & 0.08 per leaflet during the two studied seasons, respectively.

Daily means of temperature, relative humidity and dew point effected on *T. urticae* population by 17.66% and 16.37% during 2014/2015 and2015/2016, respectively. This mean that the total effect of the three tested weather factors on the variance occurring during the first season was slightly higher as compared to recorded in the second one. These results are in disagreement with that obtained by Amaar *et al.* (2014) who showed that minimum, maximum temperature had insignificant negative effects on *T. urticae* population fluctuation during the first season, but in the second one recorded significant negative effects for the tested weather factors. While the mean relative humidity had insignificant positive effect in both seasons of the study.

b) A. gossypii:

Statistical analysis of the obtained data in Table 4 showed that the correlation between the activity of *A. gossypii* population and daily mean of temperature was insignificant and significant positive (r_1= 0.0894 and 0.4264*) during the two investigated seasons, respectively. Concerning the correlation between *A. gossypii* population and relative humidity, there were insignificant and significant negative correlation where (r_2 = -0.0955 &-0.4033*) throughout both seasons of the study, respectively. While dew point had insignificant negative and positive correlation whereas (r_3 =-0.1427 &0.0610) during the two investigated seasons, respectively.

The partial regression between *A. gossypii* population and temperature was positive (b_1 =2.3563 & 10.0579) in the two seasons of the study, respectively, but with relative humidity, there was

Table 4: Effect of daily mean temperature, relative humidity and dew point on the main pests population on strawberry plants during seasons, 2014/2015 and 2015/2016 at Abo Hammad district, Sharkia governorate.

Character correlated		Pest species									
		T. urticae		*A. gossypii*		*B. Tabac*i		*T. tabaci*		*S. zaheri*	
		2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016	2014/ 2015	2015/ 2016
Simple correlation coefficient	r_1	0.0154	0.2078	0.0894	0.4264*	0.4654**	0.5046**	0.0006	0.0824	0.1166	0.3231
	r_2	0.0534	-0.1918	-0.0955	-0.4033*	-0.2074	-0.4137*	0.2581	-0.0436	0.1141	-0.0096
	r_3	-0.0643	0.0012	-0.1427	0.0610	0.2257	0.1882	0.1007	0.0326	0.0765	0.3784*
Partial regression coefficient	b_1	0.8071	9.2771	2.3563	10.0579	2.0960	2.5135	2.3965	0.2398	0.0590	0.6453
	b_2	1.5863	-4.9746	-1.4329	-5.5256	-0.5318	-1.1970	0.1612	-0.0737	0.1015	-0.0112
	b_3	-3.7969	0.0888	-4.2527	2.4266	1.1502	1.5790	0.0316	0.1598	0.0342	1.2731
Coefficient of determination	**CD %**	17.66	16.37	39.81	37.98	31.21	33.69	12.23	2.45	18.40	19.88

(r_1) Simple correlationcoefficient between pest population and mean temperature.
(r_2) Simple correlation coefficient between pest population and mean relative humidity.
(r_3) Simple correlationcoefficient between pest population and mean Dew point.
(b_1) Partial regression coefficient between pest population and mean temperature.
(b_2) Partial regression coefficient between pest population and relative humidity.
(CD) Coefficient of determination.

negative effects (b_2= -1.4329 and -5.5256) in the two investigated seasons, successively. With regard dew point there was negative and positive effects where (b_3 = -4.2527 & 2.4266) during 2014/2015 and 2015/2016, respectively.

The total effect of the three abovementioned weather factors on population activity of this species was higher than that in the first season as compared to the second one, recording CD% values of 39.81 and 37.98% in the first and the second season, successively. Similar trends were found by Srasvan *et al.* (2017) revealed that the cotton aphid, *A. gossypii* population exhibited positive but non-significant interaction with temperature.

c) B. tabaci:

There were highly significant positive correlations between the population of *B. tabaci* and mean of temperature whereas r_1= 0.4654**& 0.5046** in both investigated seasons, consecutively. Relative humidity showed negative correlation with insignificant and significant on the population, whereas r_2 values were -0.2074& -0.4137* in the two seasons of the study, respectively. While dew point cleared insignificant positive correlated where r_3 = 0.2257 &0.1882 in 2014/2015 and 2015/2016, respectively.

There were positive partial regression between the population densities of *B. tabaci* and mean of temperature, whereas b_1= 2.0960& 2.5135 in the two investigated seasons, successively. Concerning relative humidity, there were negative partial regression between means of relative humidity and the population densities of this insect where (b_2= -0.5318 & -1.1970) in the two investigated seasons, respectively. While dew point had positive effect where b_3= 1.1502 & 1.5790 in 2014/2015 and 2015/2016, respectively.

Each of temperature, relative humidity and dew point effected on *B. tabaci* population by 31.21 & 33.69% in the first season and the second one, successively. This means that the total effect of temperature, relative humidity and dew point on the variance occurring in the *B. tabaci* population during the first season was lower than that recorded in the second one (Table 4). These results are in partial agreement with that obtained by Kumawat *et al*. (2000) had reported that the temperature was significantly correlated with whitefly densities. These results are in disagreement with that obtained by Jesus *et al.* (2009) revealed that there were insignificant negative correlation between whitefly population, *B. tabaci* and temperature mean.

d) T. tabaci :

Statistical analysis (Table 4) revealed that the fluctuation of *T. tabaci* populations were insignificant positive correlated with the daily mean temperature where (r_1 =0.0006 and 0.0824) during 2014/2015& 2015/2016 respectively. While the daily mean relative humidity showed insignificant positive and negative correlation where (r_2 = 0.2581 and -0.0436) in both seasons of the study, consecutively. Data also cleared that the daily mean dew point showed insignificant positive correlation where r_3= 0.1007& 0.0326 during the two seasons of the study, respectively.

The partial regression between total numbers of *T. tabaci* and mean of temperature was positive effects (b_1 = 2.3965 and 0.2398) in the two seasons of the study, respectively. Whereas the effect of relative humidity was positive and negative (b_2 = 0.1612 and -0.0737) during the two investigated seasons, consecutively. The daily mean dew point showed had positive effect where b_3= 0.0316 and 0.1598 in 2014/2015 and 2015/2016, respectively. This means that the regression coefficient (b_1 = 2.3965 & 0.2398 and b_3= 0.0316 and 0.1598) depicted that, for every unit, the increase in the mean temperature and dew point would also cause an increase in the population of thrips by 2.39& 0.23 and 0.03& 0.15 per leaflet in the two studied seasons, respectively. The regression coefficient (b_2= 0.1612 and -0.0737) suggested that, for each unit, the increase in the mean relative humidity would increase the thrips population by 0.16 per leaflet in the first season, while in the second one, the increase in the mean relative humidity would decrease the thrips population by 0.07 per leaflet.

The total effect of the three abovementioned weather factors on population activity of this species in 2014 / 2015 season was greatly higher than that in 2015/2016 season, which the corresponding values were 12.23 and 2.45 % , respectively. From the obtained results it can be decided that the insect population was weakly affected by changes in the tested weather factors.These results are in agreement with that obtained by Waiganjo *et al.* (2008) who showed that the temperature had a positive correlation with

thrips population while relative humidity established significant negative correlation. Also, Kirk (1997) had reported that with increase in temperature there was increase in thrips activity, development and population growth wherein plant hosts started to offer attraction to thrips pest. Khan *et al*. (2011) showed a significant positive correlation between mean temperature and population of thrips.

e) S. zaheri:

Regarding the influence of three tested ecological weather factors on *S. zaheri* numbers, the results in Table 4 revealed that the mite population was insignificant positive correlated with daily mean temperature (r_1= 0.1166 & 0.3231) and was insignificant positive and negative for relative humidity (r_2 = 0.1141 & -0.0096) in the first and second seasons, consecutively. While the daily mean dew point showed insignificant and significant positive correlation where (r_3 = 0.0765 and 0.3784*) in both seasons of the study, consecutively.

The partial regression between population density of *S. zaheri* and means of temperature and dew point were positive (b_1 = 0.0590 & 0.6453 and b_3 = 0.0342 & 1.2731) in the two seasons, respectively. But, the relative humidity was positive and negative (b_2= 0.1015 and -0.0112) during 2014/2015 and 2015/2016 seasons, consecutively.

The CD % of these ecological factors was responsible as both of 18.40 and 19.88 % throughout both seasons, respectively.

In conclusion, the highest infestation levels of the main pests infested strawberry plants coincided with the three studied weather factors, temperature, relative humidity and dew point.

References

Aheer G. M., K. J. Ahmed and A. Ali, 1994. Role of weather in fluctuating aphid density in wheat crop. J Agric. Res., 32(1): 295–301

Amaar, M. I., S. A. EL-Refai, S.A. Rashwan, Rania and M.F.A.H. Hegab, 2014. Population dynamics and control of certain pests infesting green bean (*Phaseolus vulgaris*) at Qalubiya governorate, Egypt. Egypt. J. Agric. Res., 92 (3): 921-933.

Annual Report of Agric. Statistics Dept. (2005/2006) season, Min. of Agric., A.R.E.

Anonymous, 1990. Costat Software Microcomputer programe; version 4-20, cohort Software, Berkley CA, USA.

Dabrowski, Z.T., J.G. Rodrigez, and C.E. Chapin, 1971. Studies in the resistance of strawberries to mite. IV. Effect of season on preference or nonperference of strawberries to *Tetranychus urticae*. J. Eco. Entomol., 64: 806- 809.

El - Gindy, M. A., 2002. Studies on certain homopterous insect vectors of plant pathogenic diseases (Ph.D of Thesis Fac. Agric. Zagazig Univ. 263 pp.

El-Khayat, E. F., A.M. El-Sayed, F.F. Shalaby and S.A. Hady, 1994. Infestation rates with *Bemisia tabaci* (Genn.) to different summer and winter vegetable crop plants. Ann. Agric. Sci., Moshtohor, 32(1): 577-594.

Ferla N.J., M.M. Marchetti and D. Gonçalves, 2007. Ácarospredadores (Acari) associados à cultura do morango (Fragaria sp., Rosaceae) e plantaspróximas no Estado do Rio Grande do Sul. Biota Neotrop, 7:1–8

Hashem, M.S., 1997. Studies on certain insect's infesting some vegetable plants in Sharkia Governorate. M. Sc. Thesis, Fac. Agric. Zagazig Univ., 167 pp.

Henz, G.P., 2010. Desa fiosen frenta dospor agricultores familiaresna produção de morango no Distrito Federal. Hortic Bras 28:260–265.

Huffaker, C.B., M. Van de Vrie and J.A. McMurtry, 1969. The ecology of tetranychid mites and their natural control. Annu. Rev. Entomol. 14:125-174.

Jesus, F. G., A. L. Boica Junior, S.A.M. Carbonel, C.P. Stein, and R.M. Pitta, 2009. Infestation of *Bemisia tabaci* (Genn.) biotype B (Hemiptera: Aleyrodidae) and *Calio thrips phaseoli* (Hood.) (Thysanoptera: Thripidae) in beans genotypes. Arquivos do Instituto Biologico (Sao Paulo). 76 (3): 393-399.

Khan, Y. A., W. Nazeer, A. Hameed, J. Farooq and M.R. Shahid, 2011. Impacts of abiotic factors on population fluctuation of insect fauna of *Vignaradiata*and *Tetranychus urticae* Koch in Sindh, Pakistan. Front. Agric. China, 5(2): 231–236.

Khanzada, M.S., T.S. Syed, S.R. Khanzada, G.H. Abro, M. Salman, S. Anwar, M. Sarwar, A.A. Perzada, S. Wang and A.H. Abro, 2016. Survey on population fluctuations of thrips, whiteflyand their natural enemies on sunflower in different localities of Sindh, Pakistan. Journal of Entomology and Zoology Studies, 4(1): 521-527.

Kirk, W.D.J., 1997. Distribution, abundance and population dynamics. In: T. Lewis (ed.) Thrips as crop pests. CAB, Oxon, United Kingdom , 217-257.

Klamkowski, K., M. Sekrecka, H. Fonyodi and W. Treder, 2006. Changes in the rate of gas exchange, water consumption and growth in strawberry plants infested with the two-spotted spider mite. J. Fruit Ornam. Plant Res. 14: 155-162.

Kumawat, R.L., B.L. Pareek and B.L. Meena, 2000. Seasonal incidence of jassid and whitefly on okra and their correlation with abiotic factors. Annals of Biology,; 16(2):167-169.

Miller G.L. and R.G. Foottit, 2009. The taxonomy of crop pests: the aphids. Insect biodiversity Science and Society, p 463–473

Oatman, E.R., M.E. Badgley and G.R. Platner, 1985. Predators of the two-spotted spider mite on strawberry. Calif. Agri. 39: 9–12.

Petrova, V., Z. Èudare and I. Ðteinîte, 2000. Invertebrates fauna on strawberry in Latvia. Proc. Latvian Acad. Sci., Section B, 54, 79–84.

Rings, R. W. and R. B.Neiswander, 1966. Insect and Mite Pests of Strawberries in Ohio. Research Bulletin, 987.

Rondon, S.I., D. J. Cantliffe and J.F. Price, 2005. Population dynamics of the cotton aphid, *Aphis gossypii* (Homoptera: Aphididae), on strawberries grown under protected structure. Florida Entomologist, 88(2):152-158.

Sances, F.V., J.A. Wyman and I.P. Ting, 1979. Morphological responses of strawberry leaves to infestations of twospotted spider mite. J. Econ. Entomol. 72:710–713.

Sato, M.E., T. Miyata, M. Da Silva, A. Raga and M.F. De Souza Filho, 2004. Selections for Fenpyroximate resistance and susceptibility, and inheritance, cross-resistance and stability of Fenpyroximate resistance in *Tetranychus urticae* Koch (Acari: Tetranychidae). Appl. Entomol. Zoo., 39:293–302

Shanks, C.H. and R.P. Doss, 1989. Population fluctuation of two spotted spider mite (Acari: Tetranychidae) on strawberry. Environ. Entomol.18: 641- 645.

Srasvan, K. G., S.V.S. Raju and S. Y. Kattula, 2017. Impact of abiotic factors on the population fluctuations of sucking insect pests on okra (*Abelmoschus esculentus* L.). Journal of Entomology and Zoology Studies, 5(3): 1258-1263.

Stonneveld, T., H. Wainwright and L. Labuschagne, 1996. Development of two spotted spider mite (Acari: Tetranychidae) populations on strawberry and raspberry cultivars. Ann. Appl. Biol., 129:405–413.

Waiganjo, M.M., L.M. Gitonga, and J.M. Mueke, 2008. Effects of weather on thrips population dynamics and its implications on the thrips pest management. Afr. J. Hort. Sci., (1): 82-90.

Walsh, D.B., F.G. Zalom, D.V. Shaw, and K.D. Larson, 2002. Yield reduction caused by two spotted spider mite feeding in an advanced-cycle strawberry breeding population. J. Am. Soc. Hort Science, 127:230–237

Wyman, J.A., E.R. Oatman and V. Voth, 1979. Effects of varying twospotted spider mite infestation levels on strawberry yield. J. Econ. Entomol., 72:747–753