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Interaction between certain weather factors and plant age of cantaloupe on *Bemisia tabaci* (Hemiptera: Aleyrodidae) infestation over different sowing dates

Abd Allah, Y. N. M. [1]; Refaei, B.M. [2]; Metwally, S. A. G. [1]; Ibrahim, S.A. [1] and El Sawaf, B.M. [2]

[1]*Plant Protection Research Institute, Agriculture Research Center, Dokki, Giza, Egypt.*
[2]*Entomology Department, Faculty of Science, Ain Shams University, Egypt.*

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Abstract:

To study the effect of certain weather factors and plant age over three sowing dates on the whitefly; *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) infesting cantaloupe plants, field experiments were carried out over summer plantation three successive growing seasons; 2015, 2016, and 2017 in Qaha, Qalyubiya Governorate. The results revealed that *B. tabaci* eggs and nymphs have differed significantly among the three tested sowing dates (Mar.16, Apr. 2, and Apr. 16) over the tested growing seasons. Statistical analysis revealed that *B. tabaci* oviposition was significantly affected by plant age. The polynomial regression model explained 90.13, 84.97, and 61.5% of the variability of *B. tabaci* oviposition over Mar.16, Apr. 2, and, Apr. 16, respectively in 2015. In 2016, the polynomial regression model explained 95.6% of *B. tabaci* laying eggs on Mar. 16, however, the insignificant role was clear on Apr. 2 and Apr. 16. In 2017, the plant age was significant on Apr.2 only (81.74%). The nymph activity was significantly affected by plant age in the three tested sowing dates as 87.8, 92.7, and 95.1 %, respectively over 2015; 90.66, 82.2, and 91.6%, respectively, over 2016 and 90.5,3, 82.4 and 80.72%, respectively, over 2017. Concerning the changes that occurred in *B. tabaci* oviposition the changes in the environmental variables altogether were insignificant over 2015 and 2016. However, in 2017, the role of the three weather factors altogether had a significant response only in on Mar.16 (70.9%). Effect on nymphal activity in 2015, the combined role of the climatic factors had a significant influence on Mar.16 (77.8 %), however, it had an insignificant effect on Apr. 2 and Apr. 16. In 2016 and 2017, the combined role of the three weather factors was insignificant in the nymphal infestation. The combined effect of meteorological parameters and plant age altogether confirmed that the plant age on different sowing dates plays a significant role in the *B. tabaci* build up on cantaloupe more than weather variables and thus represented by their contribution with higher percentages than the studied weather factors with *B. tabaci* oviposition and nymphal infestation. In other words, plant age reflected different morphological and leaf compositions in different growth stages which may affect egg laying (Morphological traits) and the insect life as a source of its feeding (Biochemical elements).

Introduction

To escape, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) infestation on cantaloupe plants in the field, there was a great demand to study certain ecological parameters affecting *B. tabaci* in the field. The first step of this approach is to study the effect of climatic factors (Including prevailing weather conditions i.e., the maximum temperature, the minimum temperature, and the mean relative humidity) and plant age as well as infestation levels of the insect. This pattern enables us to predict *B. tabaci* infestation by temperature and humidity. Besides, studying the interaction between plant age and physical factor/pest dynamics in the sowing dates is necessary. This information may enable good planning to prevent the pest from reaching a heavy infestation or economic threshold and consequently save the loss in yield.

Devi and Ram (2018) found that the delay of the planting date has significantly increased the infestation of *B. tabaci*. The activity and incidence of pest infestation are influenced to a large extent by climatic conditions. Consequently, parasitoids and predators were affected (Chaudhuri *et al*., 1999 and Arif *et al*., 2006). Information with respect to pest population dynamics in relation to meteorological parameters such as temperatures, humidity, rainfall, and sunshine hours is used in planning a weather based pest forewarning model (Selvaraj and Ramesh, 2012).

The aim of the present work is to study the effect of certain weather factors and plant age over three sowing dates on the whitefly *B. tabaci* infesting cantaloupe plants.

Materials and methods

An area of about 1,400 m^2 represented the experimental area in 2015, 2016, and 2017. This field study was carried out in the Experimental Farm of Plant Protection Research Institute in Qaha region, southwest of Qalyubiya Governorate (30°17'00 "N, 31° 12'00 "E of 133 meters (436 ft) below sea level) in Egypt over the summer plantation. Cantaloupe seeds were sown directly in successive single rows on the southern edges. Each plot (Replicate) measured 11.9 m^2. Rows are designed as 7 plants per row spaced 0.30 m apart. The four tested cultivars; Arava, Majus, Darvina, and Royal 481 were planted on the three tested fortnight dates (Mar. 16, Apr. 2, and 16.) under a complete randomized block design (CRBD) over the three years of study.

The tested meteorological parameters were maximum temperature (Mix. T.), minimum temperature (Min. T.), and daily mean relative humidity (RH.). The relationship between the tested ecological factors and *B. tabaci* activity is well studied. Means of *B. tabaci* eggs and nymphs were tabulated against the corresponding weather data. The simple correlation coefficient values, linear regression, and multiple regression between the mean counts of *B. tabaci* eggs and nymphs in weeks plotted to weekly tested weather factors. The percentages of explained variance (E.V. %) as the combined effect of the weather factors were considered. Plant age in weeks (Representing the continuous nutritional values over the growing season) and the percentages of explained variance (E.V. %) as the combined effect of plant age and the percentages of explained variance (E.V.%) of three weather factors and the three plant ages altogether were successfully calculated.

1. Whitefly sampling procedures:

During the three vegetative growing seasons (2015, 2016, and 2017) assessments were conducted 30 days following cultivation and continued weekly. Cantaloupe leaves

(360) were randomly picked up as possible representing all plant levels from the three tested sowing dates (10 leaves * 3 plots * 4 cultivars * 3 sowing dates). Leaves samples were kept separately in polyethylene bags to be transferred to the laboratory. The presence of whitefly *B. tabaci* eggs and nymphs was examined with the aid of a binocular stereomicroscope. The number of eggs and nymphs was assessed on the abaxial leaf surface. Then, the number of eggs and nymphs per the three replicates in each experiment was estimated.

2. Meteorological data:

The data of different meteorological data, such as maximum and minimum temperatures and relative humidity over 2015, 2016, and 2017 were acquired from www.wunderground.com.

3. Data analysis:

All the obtained data during the trials over the three growing seasons were subjected to analysis by using SAS (SAS Institute, 1988) program. Simple correlation and linear regression were calculated according to the relation:

$$Y= a+ b X$$

The effect of a single weather factor was considered linear regression. The partial regression was used to obtain the amount of variability in the pest activity which could be attributed to the percentages of explained variance (E.V.%) as the combined effect of the climatic factors. In the multiple regression of interaction between weather factors and plant age on three sowing dates, the combined effect of weather factors was considered as multiple linear regression as $Y= a \pm b_1$ Max. T. $\pm b_2$ Min.T. $\pm b_3$ RH. Plant age in weeks (Presenting the continuous nutritional values over the growing season) was considered as the third degree of polynomial ($Y= a \pm b_1 \text{ Age} \pm b_2 \text{ Age}^2 \pm b_3 \text{ Age}^3$).

The combined effect of weather factors and plant age was considered as multiple regression, presented as $Y= a \pm b_1$ Max. T. $\pm b_2$ Min.T.$\pm b_3$ RH. $\pm b_4 \text{ Age} \pm b_5 \text{ Age}^2 \pm b_6 \text{ Age}^3$.

Results and discussion

The obtained results presented in Tables (1-9) showed the interaction between Max.T., Min.T., mean RH. %, and cantaloupe plant age (As the third degree of polynomial) on means of deposit *B. tabaci* eggs and nymphal activity over three summer plantation sowing dates of three consecutive growing seasons.

1. Effect of weather factors and plant age on deposited *Bemisia tabaci* eggs on different sowing dates:

In 2015, data are shown in Table (2) indicated Max.T., Min. T. and RH. % had an insignificant negative correlation with eggs on the first sowing date (r values were -0.43, -0.7, and -0.2, respectively). Partial regression indicated that the effect of minimum temperature (In the presence of the other two weather factors was negative and significant while the two other factors were insignificant.

On the second sowing date (Apr. 2) maximum and minimum temperatures had an insignificant positive relation to the numbers of laid eggs (r= 0.4 and 0.3, respectively). The insignificant negative relation of RH. was detected (r= -0.3). The observations on Apr.16 indicated an insignificant and negative association of Max. T., Min. T. and RH. with deposited eggs on cantaloupe. Where this relation was weak in the case of Max. T. (Table 2).

Concerning the changes that occurred in *B. tabaci* eggs due to the changes in the environmental variables altogether in the first sowing date, the multiple regression model explained

68.6%. Besides, this effect decreased by delaying the sowing date by 15 days (Apr. 2) as E.V. = 20.15 % and increased again by delaying the date of sowing month (Apr. 16) E.V. = 49.58%.

The effect of plant age on the three sowing dates revealed that egg oviposition was significantly affected by plant age during the three sowing dates. The polynomial regression model explained 90.13, 84.97, and 61.5% in the variability of *B. tabaci* egg oviposition over first, second, and third sowing dates, respectively.

In other words, the combined effect of three tested climatic factors and plant age altogether in the first sowing date indicated that the activity of *B. tabaci* adults in laying eggs was affected by plant age than by meteorological parameters where the multiple regression model explained 91.7% as the plant age contributed with 90.13%. Likewise, the combined effect in the second and third dates were 96. 6 and 64.4 %, respectively, and the contribution of plant age with high percentages in these values. As a result, the plant age was an effective factor in *B. tabaci* laying eggs and influenced oviposition preference by a big magnitude over this season.

The obtained results in Table (4) over 2016 clearly indicated that, the relation of Max. T. with *B. tabaci* eggs number in the three sowing dates was explained by a linear regression model which indicated by insignificant negative r values = -0.2, -0.056, and -0.3, respectively. Besides, a negative relation was detected between Min. T. and egg numbers in the three tested sowing dates (r= -0.5, -0.1, and -0.5, respectively). However, RH. had insignificant positive relation on the first date and an insignificant negative on the second and third dates (r= 0.3, -0.5, and – 0.3, respectively).

At the same in the previous year, the role of the three climatic factors in laying eggs on cantaloupe plants was insignificant. Moreover, it decreased by delaying the sowing date and the multiple regression model explained 53.04 and 47.1, 29.5 % the in the variability of *B. tabaci* laying eggs on first, second and third sowing dates, respectively. With respect to the effect of plant age, the combined role indicated that the role of plant age was highly significant on egg laying on cantaloupe plants. In particular, the third degree polynomial regression model explained 95.6 % of the variability of *B. tabaci* laying eggs on Mar. 16. However, the insignificant role of plant age was clear on Apr. 2 and Apr. 16 as polynomial regression model explained 57.9 and 68.8%, respectively. On Mar. 16, the combined effect of weather factors and plant age altogether, cleared that the egg laying in this season also, was highly influenced by plant age than the tested weather factors as the multiple regression model explained 99.9 % as the plant age contributed with 95.6 % from this percentage. By delaying the sowing date 15 days (Apr. 2) or a month (Apr. 16) it was found that, the combined role of tested factors expressed an insignificant effect on laying eggs and the multiple regression model explained 82.72 % and significant effect as 94.4 %, respectively. The same trend was observed at the plant age had a great influence on laying *B. tabaci* eggs than the other tested meteorological factors.

The obtained data in Table (6) indicated that the results in 2017 came to confirm the test in previous years. The correlation coefficient values of the meteorological factors with *B. tabaci* eggs indicated that insignificant negative relation was found between Mix. T. on Mar. 16 and Apr. 16 (r= -0.3 and -0.1, respectively). Likewise, Min. T. had an insignificant negative relation with eggs number on the same dates as -0.3 and -0.1, respectively. Whereas, on Apr. 2 the correlation of Mix. T. and Min. T. were best explained by the linear regression model as indicated by significant r values = -0.7 and -0.8, respectively (*P*= <0.05).

In the case of RH., there was an insignificant and negative response on *B. tabaci* eggs on Mar. 16 and Apr. 2 as correlation coefficient values r = -0.5 and -0.3. However, this relation was significant on Apr. 16 as r= -0.8, however, regression value b = 0.6 i.e. as the RH. (45.8%) increase the laying of *B. tabaci* eggs decreased by 0.6 eggs/leaf in Qaha. The role of the three weather factors altogether had a significant response in the first sowing date as the multiple regression model explained 70.9% of the variability in *B. tabaci* laying eggs. This response was insignificant and decreased by delaying the date 15 days (67.33%) or a month (60.81%).

Concerning the changes that occurred in deposited eggs by *B. tabaci* in cantaloupe plants due to growing up in cantaloupe plants. The plant age played an important and significant role in laying eggs over the second date, Apr. 2 as a multiple regression model explained 81.74% variability in *B. tabaci* laying eggs. However, this relation was insignificant in the first and third sowing dates 60.97 and 61.4%, respectively. The multiple regression model of the tested climatic factors and plant age altogether in the first, second, and third dates explained 77.3, 98.02, and 99.2 %, respectively. In other words, the role of all climatic factors in the variability in whitefly laying eggs was higher on the first date than the role of the plant age and significantly affected whitefly laying eggs this year. Whereas in the delayed (Apr. 16) sowing dates, plant age contributed with a high percentage in the combined effect of weather factors and plant age altogether (Table 6).

2. Effect of weather factors and plant age on nymphal activity in different sowing dates:

In 2015 the population varied in the three sowing dates in relation to weather factors and cantaloupe plant age (Tables 1 and 7). In this sense, on the first sowing date (Mar. 16), Mix.T. and Min. T. had a strong positive response on population (r= 0.7 and 0.9, respectively) In other words, as the Mix.T. increased one unit pest population may increase by 1.5 nymphs/ leaf. Moreover, increasing Min.T. one unit also resulted in a significant increase in population by 2.6 nymphs/leaf in Qaha region during 2015. This means the average mean of Mix. T. and Min. T. (30.93 and 22.43 ◦C, respectively) was favorable for nymphal activity. However, the very weak association between RH. and the nymph population was detected as r= 0.002. On the subsequent dates; Apr. 2 and Apr. 16 the Mix. T. had an insignificant positive effect on nymphs (r=0.6 and 0.1, respectively). The strong positive correlation and significant effect of Min. T. was detected on the second sowing date (Apr. 2) (r= 0.83) and insignificant negative on the third sowing date as r values= -0.2. On the contrary, a very weak association was detected between RH. and nymphal infestation on the first date, however, an insignificant positive relation was detected in the second sowing date as r= 0.2. While, the significant role of RH. was cleared in the third sowing date as it was negatively correlated with *B. tabaci* nymph population, and whitefly increased by decreasing RH. by 1.2 nymph /leaf. The combined role of the climatic factors had a significant influence on the first sowing date as multiple regression model explained 77.8 %, however, it had insignificant effect in the second and third ones as E.V.%.= 71.96 and 55.1, respectively.

The nymph survival and activity was significantly affected by plant age in the three tested sowing dates and this was clear from the combined effect of plant age as it influenced nymph survival by 87.8, 92.7 and 95.1 % (*P*<0.01) in the first, second and third sowing dates, respectively. Regarding the interaction between climatic factors and plant age the explained variance had great influence on nymphs activity with great percent as E.V.%= 93.6, 96.97, and 96.6 %, respectively. In other word, plant age as source of food influence the activity of *B. tabaci* nymphs than the climatic factors.

In 2016, the influence of certain of weather factors, plant age and the combined role of them altogether on *B. tabaci* nymph build up in the three tested sowing dates shown in Table (8). In the first sowing date (Mar. 16), the Mix. T. had insignificant positive influence on *B. tabaci* nymph activity as r value = 0.5. Moreover, Mix. T. had weak association with nymphs population in the second and third sowing dates. On the other hand, the positive correlation of Min. T. was best explained by linear regression as indicated by significant values of r= 0.8 and (*P* <0.05) in the first sowing date. Min. T. had insignificant positive and negative response on nymphal activity in the second and third dates as r values= 0.4 and - 0.2, respectively. The mean of relative humidity had insignificant negative influence on the insect activity the first and third sowing dates (r= -0.6 and -0.6, respectively). Besides, RH had weak negative association with nymphs in the second sowing date.

Regarding change occurred in *B. tabaci* nymph development due to the changes in the weather factors in three tested sowing dates, the multiple regression model explained 75.9% in variability of *B. tabaci* activity *P* <0.05. However, the combined role of the three weather factors was insignificant and decreased by delaying sowing which was 51.03 % in second sowing date and 34.97 % in the third sowing date.

On the other hand, the third degree of polynomial regression model of cantaloupe age explained 90.66, 82.2 and 91.6% in the variability of *B. tabaci* build up on Mar.16, Apr.2 and Apr.16 dates, respectively and it had a highly significant response on the occurrence of nymph population on cantaloupe leaves especially in the first and third sowing dates (*P* <0.01). The multiple regression model of weather factors and cantaloupe age altogether on *B. tabaci* buildup explained 99.4, 96.2 and 98.4% in variability of pests in the first, second and third dates, respectively. These values reflected the role of the combined effect of the three weather factors on *B. tabaci* development was lower than the role of the plant age in the three tested sowing dates. As a result, the population buildup was significantly affected by biotic (Represented plant age) to large extent, especially in the first and third sowing dates followed by abiotic factors (represented the environmental variables) in this season .

In 2017**,** with regard to the weather factors on the three sowing dates the correlation of Mix. T. and Min. T. were best explained by the linear regression model as indicated r values = 0.3 and 0.3 on Mar. 16, r = 0.4 and 0.5 on Apr. 2 and 0.1 and 0.2 on Apr. 16. On the other hand, RH had insignificant negative association with nymph population in the first sowing date (r= -0.3). Whereas, weak associations with nymphs were detected in the second and third dates. The effect of three weather factors altogether on the occurrence of *B. tabaci* was insignificant and didn't affected by the three tested sowing dates (14. 37, 49.1

and 37.8 %, respectively). The polynomial regression model of plant age explained 90.53, 82.4 and 80.35% in the activity and occurrence of nymphs and these values were significant and affected by delaying sowing date. The multiple regression model explained 94.83, 82.4 and 80.72% in first, second and third sowing dates, respectively. Subsequently, the combined effect of meteorological parameters and plant age altogether confirmed that, the plant age was more effective and play principal role in *B. tabaci* infestation and thus represented by their contribution with higher percentages than the studied weather factors in the three tested sowing dates. Besides, the overall combined effect decreased by delaying sowing date (Table 9).

The effect of Mix. T., Min. T. and RH. on *B. tabaci* egg deposition and nymphal activity in the three tested sowing dates under investigation over summer plantation seasons of 2015, 2016 and 2017. Revealed that, the tested weather factors had a non significant negative effect on *B. tabaci* egg laying in three tested sowing dates except on the first sowing date of 2017. The plant age had a significant effect on egg laying on cantaloupe leaves over the three tested sowing. Moreover, the combined effect of weather factors and plant age had a non significant effect on laying egg in most cases. On the other hand, the temperature (Mix. T. and Min. T.) had a positive effect on nymphal activity. The relative humidity had a negative impact in most instances. The combined role of the three tested weather factors was significant in the first sowing date over 2015 and 2017. The plant age played a primary and significant role on *B. tabaci* nymphal infestation. The combined role of weather factors and plant age altogether had significant effect in most instances on *B. tabaci* nymphal activity. The current investigation revealed that, the plant age in different sowing dates played a significant role in the *B. tabaci* build up on cantaloupe more than weather variables in most instances. In other words, plant age reflected different morphological and leaf compositions in different growth stages which may affect egg laying (Morphological traits) and the insect life as a source of its feeding (biochemical elements). The weather factors also affect the insect survival but it came next to plant age in most instances in this work.

Our results were compatible to the results of Hanafy (2007) who demonstrated in a field study on sweet pea plants that the plant age and climatic factors affect thrips during the four planting dates. The plant age affects thrips populations more than weather factors in most dates. Smith (2005) reported that factors intrinsic to insects, plants, and the environment can substantially alter the expression of resistance-related genes in plants. Khan *et al*. (1999) revealed that aphids population increased with increasing the plant age. Leite *et al.* (2006) suggested that *B. tabaci* was affected by plant aging. Maximum temperature expressed positive correlation with *B. tabaci* population (Soni and Dhakad, 2017). Selvaraj and Ramesh (2012) indicated that maximum and minimum temperatures had positive and significant responses and the evening relative humidity had negative and significant responses on the development of *B. tabaci*. Abdel-Rahman *et al.* (2018) indicated in a study in Egypt that, the maximum and minimum temperatures had non-significant positive responses on *B. tabaci* infesting cotton, however, relative humidity had a highly negative and significant correlation.

Our findings revealed that maximum and minimum temperatures had a positive response to *B. tabaci* nymphal activity in most instances over the three sowing dates. However, relative humidity had a negative impact on *B. tabaci* population. Plant age affects *B. tabaci* laying eggs and nymphs activity more than the weather factors in the three sowing dates. The information on this topic can lead to better predictive capabilities in *B. tabaci* management. The prediction of the highest colonization according to obtained results from population corresponding to weather factors and plant age may provide IPM system about the appropriate time to take control option before the highest population builds up.

Table (1): Mean values of temperatures and relative humidity registered in the weeks of sampling of *Bemisia tabaci* eggs or nymphs on cantaloupe in the three sowing dates over the 2015 summer plantation season in Qaha, Qalyubiya Governorate.

Sampling date	Temp. (^{0}C)		RH. (%) Mean	Mean of *Bemisia tabaci* eggs/ leaf			Mean of *Bemisia tabaci* nymphs/ leaf		
	Max.	Min.		Mar. 16	Apr. 2	Apr. 16	Mar. 16	Apr. 2	Apr. 16
Apr. 16	20.57	12.14	51.86	10.03	-	-	1.03	-	-
23	26.86	15.14	40.57	21.13	5.77	-	2.53	0.15	-
30	29.86	15.57	40.14	15.4	12.4	-	12.14	2.4	-
May 7	28.57	16.14	53.86	16.82	11.22	1.02	11.4	4.21	2.49
13	30.16	18.83	45.83	12.02	14.74	16.94	12.41	10.52	9.85
20	32.3	18.3	47.57	8.91	14.4	25.67	15.03	35.03	17.22
27	36.14	21.43	35.43	6.2	16.2	9.99	20.7	28.74	26.80
Jun. 3	29.43	19.57	47.43	4.03	16.22	5.98	30.11	38.46	21.63
10	32.14	20.71	45.87	2.85	14.34	3.14	21.93	37.57	18.31
17	32.28	21.14	53.57	1.66	4.4	1.44	23.75	32.73	15.77
24	32.6	22.43	48.3			0.53	-	-	9.195
Jul. 1	32.28	22.14	48	-		0.08	-	-	3.45
8	32.43	22.14	55	-		0.08	-	-	2.35
15	33.3	22.86	56	-		0.09	-	-	1.175
22	35	23	49.3	-		0.07	-	-	0.20
Mean	30.93	19.44	47.9	9.89	12.2	5.42	15.10	21.1	10.70

Table (2): Multiple regression of abiotic factors and plant age on *Bemisia tabaci* egg numbers in different sowing dates over 2015.

Sowing date	Factor	Level	Simple corr. and reg.			Multiple reg.				
			R	B	P	b	P	E.V.%	F	P
Mar. 16	Weather factors	Max. T.	-0.43	-0.7	0.2	1.2	0.2	68.6	4.37	0.059
		Min. T.	-0.7	-1.5	0.02	-3.02	0.04			
		RH.	-0.2	-0.21	0.6	-0.1	0.7			
	Plant age^1- age^3		-	-	-	-	-	90.13	18.3	0.002
	Combined effect		-	-	-	-	-	91.7	5.53	0.1
Apr. 2	Weather factors	Max. T.	0.4	0.6	0.3	0.3	0.8	20.15	0.42	0.7
		Min. T.	0.3	0.5	0.5	0.2	0.9			
		RH.	-0.3	-0.2	0.4	-0.2	0.6			
	Plant age^1- age^3		-	-	-	-	-	84.97	9.42	0.02
	Combined effect		-	-	-	-	-	96. 6	9.36	0.1
Apr. 16	Weather factors	Max. T.	-0.1	-0.3	0.8	1.6	0.4	49.58	2.62	0.1
		Min. T.	-0.5	-1.9	0.1	-3.1	0.1			
		RH.	-0.4	-0.65	0.1	-0.4	0.4			
	Plant age^1- age^3		-	-	-	-	-	61.5	4.26	0.04
	Combined effect		-	-	-	-	-	64.4	1.5	0.3

Plant age in weeks (Presenting the continuous nutritional values over the growing season) was considered as third degree of polynomial ($Y = a \pm b_1 Age \pm b_2 Age^2 \pm b_3 Age^3$).

Table (3): Mean values of temperatures and relative humidity registered in the weeks of sampling of *Bemisia tabaci* eggs and nymphs on cantaloupe in the three sowing dates over the 2016 summer plantation season in Qaha, Qalyubiya Governorate.

Sampling date	Temp. (^{0}C)		RH. (%)	Mean of *Bemisia tabaci* eggs/ leaf			Mean of *Bemisia tabaci* nymphs/ leaf		
	Max.	Min.	Mean	Mar.16	Apr.2	Apr.16	Mar. 16	Apr. 2	Apr. 16
Apr. 17	29.71	18.86	45	7.29	-	-	1.03	-	-
24	35.14	19.71	43.14	10.3	3.14	-	3.82	0.52	-
May 1	33.3	19.43	42.14	13.99	19.25	-	10.11	1.29	-
8	31	19.71	44.57	13.10	11.125	0.84	14.29	3.35	0.42
15	36.71	23	35.43	8.35	17.125	6.05	18.45	16.52	3.67
22	33	20.86	44.71	2.8	10.84	14.2	17.2	38.58	12.29
29	30.14	19.71	44.3	1.20	10.18	5.79	18	37.9	16.5
Jun. 5	38.43	25	29.57	0.73	13.16	3.03	25.1	32.96	16.61
12	35.14	21.71	40.3	0.31	6.25	1.61	16.35	21.43	16.4
19	36	24.3	48.14	-	2.21	0.74	-	24.8	10.2
26	37.71	24.86	51.6	-	-	0.51	-	-	5.07
Jul. 3	34.6	24.14	59	-	-	0.0875	-	-	2.04
10	35	24.71	57	-	-	0.29			0.85
Mean	34.3	22	44.99	6.45	10.36	3.31	13.82	19.70	8.41

Table (4): Multiple regression of abiotic factors and plant age on *Bemisia tabaci* egg numbers on different sowing dates over 2016.

Sowing date	Factor	Level	Simple corr. and reg.			Multiple reg.				
			r	B	P	b	P	E.V.%	F	P
Mar. 16	Weather factors	Max. T.	-0.2	-0.4	0.6	1.02	0.4	53.04	1.88	0.25
		Min. T.	-0.5	-1.33	0.2	-5.3	0.1			
		RH.	0.3	0.3	0.4	-1.1	0.3			
	Plant age^1- age^3		-	-	-	-	-	95.6	35.95	0.0008
	Combined effect		-	-	-	-	-	99.9	326.6	0.003
Apr. 2	Weather factors	Max. T.	-0.056	-0.12	0.9	-1.1	0.45	47.1	1.5	0.3
		Min. T.	-0.1	-0.3	0.9	-0.4	0.8			
		RH.	-0.5	-0.5	0.2	-0.9	0.1			
	Plant age^1- age^3		-	-	-	-	-	57.9	2.3	0.2
	Combined effect		-	-	-	-	-	82.72	1.6	0.4
Apr. 16	Weather factors	Max. T.	-0.3	-0.4	0.4	0.6	0.8	29.5	0.84	0.5
		Min. T.	-0.5	-0.95	0.2	-1.5	0.55			
		RH.	-0.3	-0.2	0.3	-0.1	0.8			
	Plant age^1- age^3		-	-	-	-	-	68.8	4.4	0.06
	Combined effect		-	-	-	-	-	94.4	8.42	0.05

Plant age in weeks (Presenting the continuous nutritional values over the growing season) was considered as third degree of polynomial ($Y= a \pm b_1 Age \pm b_2 Age^2 \pm b_3 Age^3$).

Table (5): Mean values of temperatures and relative humidity registered in the weeks of sampling of *Bemisia tabaci* eggs and nymphs on cantaloupe cultivars in the three sowing dates over 2017 summer plantation season in Qaha, Qalyubiya Governorate.

Sampling date	Temp. (^{0}C)		RH. (%) Mean	Mean of *Bemisia tabaci* eggs/ leaf			Mean of *Bemisia tabaci* nymphs/ leaf		
	Max.	Min.		Mar. 16	Apr. 2	Apr. 16	Mar. 16	Apr. 2	Apr. 16
Apr. 16	26.3	16.6	55.86	5.78	-	-	0.73	-	-
23	31.43	18.43	36.7	39.72	6.06	-	2.83	0.23	-
30	28.43	17	44.1	11.77	15.88	-	9.68	1.2	-
May 7	28.71	17.33	45.57	28.74	15.81	1.31	13.51	2.56	1.32
15	36.1	21.4	37.4	16.14	11.08	9.03	17.83	13.3	2.96
22	32	20.86	45.86	6.16	9.22	2.73	21.69	33.49	6.07
28	32.5	21	42.2	2.75	8.18	9.39	20.06	26.43	9.06
Jun. 4	33.3	21.86	47.86	1.42	9.14	3.80	15.28	26.59	18.89
12	36	24.125	41.5	2.11	4.01	1.80	7.7	21.78	14.29
18	35.2	23.5	49.83	0.64	2.25	0.75	7.4	14.33	10.05
26	34.9	23.4	52.9	-	1.08	0.17	-	7.25	5.57
Jul. 3	38	25.6	50	-	-	0.11	-	-	2.09
Mean	32.74	20.9	45.8	11.52	8.27	3.23	11.67	14.71	7.81

Table (6): Multiple regression of abiotic factors and plant age on *Bemisia tabaci* egg numbers in different sowing dates over 2017.

Sowing date	Factor	Level	Simple corr. and reg.			Multiple reg.				
			R	B	P	B	P	E.V.%	F	P
Mar. 16	Weather factors	Max. T.	-0.3	-1.1	0.4	2.6	0.6	70.9	4.87	0.05
		Min. T.	-0.5	-2.6	0.1	-5.98	0.2			
		RH.	-0.5	-1.2	0.1	-1	0.3			
	Plant age^1- age^3		-	-	-	-	-	60.97	3.12	0.1
	Combined effect		-	-	-	-	-	77.3	1.7	0.355
Apr. 2	Weather factors	Max. T.	-0.7	-1.36	0.01	0.3	0.8	67.33	4.12	0.07
		Min. T.	-0.8	-1.6	0.004	-2.56	0.1			
		RH.	-0.3	-0.2	0.4	-0.053	0.8			
	Plant age^1- age^3		-	-	-	-	-	81.74	8.95	0.01
	Combined effect		-	-	-	-	-	98.02	6.48	0.1
Apr.16	Weather factors	Max. T.	-0.1	-0.1	0.8	0.4	0.8	60.81	2.59	
		Min. T.	-0.3	-0.5	0.4	-0.5	0.7			0.2
		RH.	-0.8	-0.6	0.01	-0.5	0.56			
	Plant age^1- age^3		-	-	-	-	-	61.4	2.65	0.2
	Combined effect		-	-	-	-	-	99.2	39.31	0.025

Plant age in weeks (Presenting the continuous nutritional values over the growing season) was considered as third degree of polynomial ($Y= a \pm b_1 Age \pm b_2 Age^2 \pm b_3 Age^3$).

Table (7): Multiple regression of abiotic factors and plant age on *Bemisia tabaci* nymphal infestation in different sowing dates over 2015.

Sowing date	Factor	Level	Simple corr. & reg.			Multiple reg.				
			r	b	P	b	P	E.V.%	F	P
Mar. 16	Weather factors	Max. T.	0.7	1.5	0.03	-0.5	0.65	77.8	7.03	0.02
		Min. T.	0.9	2.6	0.001	3.3	0.06			
		RH.	0.002	0.003	0.99	0.1	0.7			
	Plant age^1 - age^3		-	-	-	-	-	87.8	14.43	0.004
	Combined effect		-	-	-	-	-	93.6	7.3	0.1
Apr. 2	Weather factors	Max. T.	0.6	3.8	0.07	0.01	0.99	71.96	4.28	0.1
		Min. T.	0.83	5.65	0.005	5.6	0.1			
		RH.	0.2	0.5	0.6	0.36	0.65			
	Plant age^1 – age^3		-	-	-	-	-	92.7	21.04	0.003
	Combined effect		-	-	-	-	-	96.97	10.65	0.1
Apr. 16	Weather factors	Max. T.	0.1	0.45	0.7	-0.35	0.85	55.1	3.27	0.1
		Min. T.	-0.2	-0.9	0.5	-0.6	0.7			
		RH.	-0.7	-1.2	0.01	-1.2	0.04			
	Plant age ^{1}- age^3		-	-	-	-	-	95.1	51.8	0.0001
	Combined effect		-	-	-	-	-	96.6	23.4	0.002

Plant age in weeks (Presenting the continuous nutritional values over the growing season) was considered as the third degree of polynomial ($Y = a \pm b_1 Age \pm b_2 Age^2 \pm b_3 Age^3$).

Table (8): Multiple regression of certain abiotic factors and plant age on *Bemisia tabaci* nymphal infestation over 2016 summer plantation season.

Sowing date	Factor	Level	Simple corr. & reg.			Multiple reg.				
			r	B	P	b	P	E.V.%	F	P
Mar. 16	Weather factors	Max. T.	0.5	1.26	0.2	-1.3	0.3	75.9	5.25	0.05
		Min. T.	0.8	2.95	0.01	6.7	0.046			
		RH.	-0.6	-0.9	0.1	0.82	0.4			
	Plant age $^{1-}$ age^3		-	-	-	-	-	90.66	16.18	0.005
	Combined effect		-	-	-	-	-	99.4	59.31	0.02
Apr. 2	Weather factors	Max. T.	0.04	0.2	0.9	-6.2	0.1	51.03	1.74	0.3
		Min. T.	0.4	3.1	0.2	8.7	0.1			
		RH.	-0.1	-0.35	0.7	-0.6	0.6			
	Plant age $^{1-}$ age^3		-	-	-	-	-	82.2	7.7	0.026
	Combined effect		-	-	-	-	-	96.2	8.44	0.1
Apr.16	Weather factors	Max. T.	0.01	0.02	0.9	-0.7	0.8	34.97	1.1	0.4
		Min. T.	-0.2	-0.6	0.6	0.6	0.9			
		RH.	-0.6	-0.4	0.1	-0.5	0.3			
	Plant age $^{1-}$ age^3		-	-	-	-	-	91.6	21.83	0.001
	Combined effect		-	-	-	-	-	98.4	30.38	0.01

Plant age in weeks (Presenting the continues nutritional values over the growing season) was considered as third degree of polynomial ($Y = a \pm b_1 Age \pm b_2 Age^2 \pm b_3 Age^3$).

Table (9): Multiple regression of abiotic factors and plant age on *Bemisia tabaci* nymphal infestation over 2017 summer plantation season.

Sowing date	Factor	Level	Simple corr. and reg.			Multiple reg.				
			r	b	P	b	P	E.V.%	F	P
Mar. 16	Weather factors	Max. T.	0.3	0.7	0.3	-0.5	0.9	14.37	0.34	0.8
		Min. T.	0.3	0.8	0.4	1.3	0.8			
		RH.	-0.3	-0.3	0.4	-0.4	0.7			
	Plant age^1- age^3		-	-	-	-	-	90.53	19.11	0.002
	Combined effect		-	-	-	-	-	94.83	9.17	0.05
Apr .2	Weather factors	Max. T.	0.4	1.7	0.3	-7.2	0.2	49.1	1.93	0.2
		Min. T.	0.5	2.5	0.1	10. 7	0.1			
		RH.	0.1	0.3	0.7	-1.4	0.2			
	Plant age^1- age^3		-	-	-	-	-	82.4	9.37	0.01
	Combined effect		-	-	-	-	-	93.1	6.7	0.1
Apr. 16	Weather factors	Max. T.	0.1	0.1	0.9	-4.1	0.2	37.8	1.01	
		Min. T.	0.2	0.6	0.5	5.4	0.1			0.46
		RH.	0.01	0.01	0.98	-0.7	0.3			
	Plant age^1- age^3		-	-	-	-	-	80.35	6.82	0.03
	Combined effect		-	-	-	-	-	80.72	1.4	0.5

Plant age in weeks (Presenting the continuous nutritional values over the growing season) was considered as the third degree of the polynomial ($Y= a \pm b_1 Age \pm b_2 Age^2 \pm b_3 Age^3$).

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