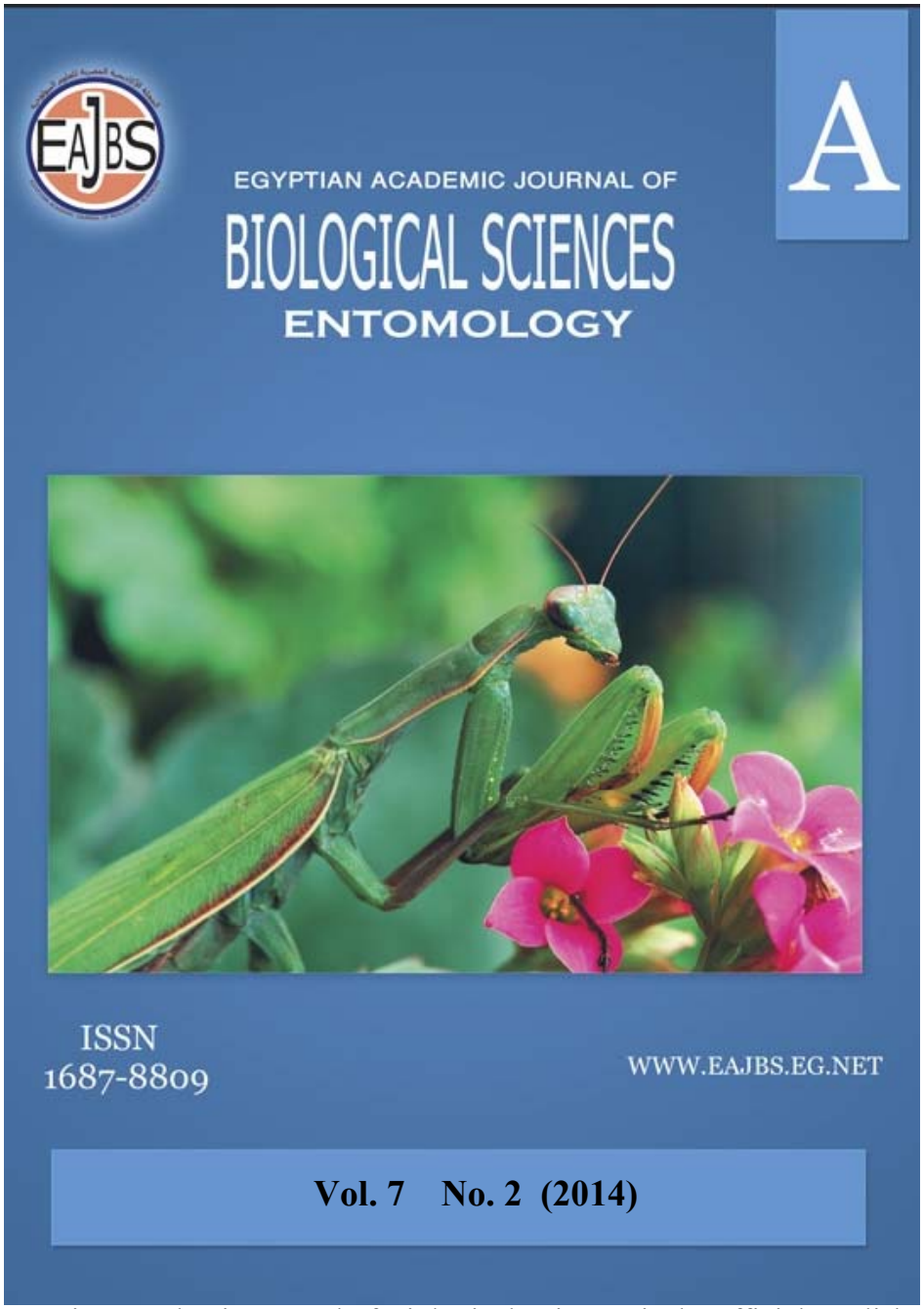

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Comparison between the infestation rate of certain pests on cucumber and kidney bean and its relation with abiotic factors and anatomical characters.

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ABSTRACT

Two host planst**,** Cucumber, *Cucumis sativus* L. and kidney bean *Phaseolus vulgaris* L. were sown at Horticultural Research Station at Kaha region, Qalubiya Governorate, Egypt to determine the host preference to certain pests including, thrips *Thrips tabaci* (Lind.), aphids, whitefly, *Bemisia. tabaci* (Genn.) and the two spotted spider mite, *Tetranychus urticae* (Koch) and its relationship with climatic factors and anatomical characters during two successive seasons 2011 and 2012.

The results indicated that the infestation rate of *B. tabaci* and *T. tabaci* increased on cucumber leaves more than kidney bean. On the contrary, kidney bean was suitable host to development of aphid and *T. urticae*. The incidences of the four studied pests were significant and positive correlated with maximum temperature and maximum relative humidity. While, the population density of these pests positively correlated and non-significant with minimum temperature. On the contrary, the minimum relative humidity had negative and non-significant effect on the two host plants.

In the two host plants, anatomical characters of play an important role in the infestation rates of the previously mentioned pests. Kidney bean had the thickest layers of upper& lower epidermis and spongy tissues and the thinnest layer of palisade tissue. On the other hand, cucumber leaves had the thickest layer of palisade tissue. The population density of all pests had positive relationship and significant with palisade and spongy layers. While, this relation was significantly negative with upper and lower epidermis. *i.e*., infestation rates of all studied pests increased by increasing the thickest layers of palisade and spongy tissues and decreased by increasing the thickest of upper and lower epidermis. The amount of variability that could be attributed to the combined effect of the tested weather factors and anatomical characters on the four studied pests was more than 60%.

Key words: Cucumber, *Cucumis sativus,* kidney bean *Phaseolus vulgaris,* population density, host preference, climatic factors, anatomical characters, *Thrips tabaci, Bemisia. tabaci*, aphids, *Tetranychus urticae*.

INTRODUCTION

Cucumber, *Cucumis sativus* L. and kidney bean *Phaseolus vulgaris* L are the most important economic vegetables crops cultivated in Egypt and many countries of the world. The cultivated area with theses two crops increased during the last two decades especially in new reclaimated regions in both open and protected plantation,

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to cover needs for local consumption and for exporting to the foreign markets. Cucumber and kidney bean are liable to infestation by many phytophagous pests including thrips *Thrips tabaci* (Lind.), aphid spp. (mainly *Aphis gossypii*, *Myzus persicae* and *Aphis craccivora*), whitefly, *Bemisia tabaci* (Genn.) and the two spotted spider mite, *Tetranychus urticae* (Koch). These pests cause serious damage to the infested plants leading to great reduction in both quantity and quality of the resultant yield (El-Saeidy *et al.*, 2013).

Thrips tabaci are a polyphagous that causes a serious damage on vegetables and ornamental plants all over the world (Murai, 2000). Nymphs and adults feed on green leaf tissue, causing direct damage by destroying epidermal cells (Koschier *et al*., 2002) and transmit the tomato spotted wilt virus disease to several crops (Negaraja *et al*., 2005). The whitefly, *Bemisia tabaci* (Genn.) considered one of the most important pests infesting cucumber plants during its three growth stages, seedling, flowering and fruiting. The behavior of this insect makes chemical control difficult, (Mohamed, 2012). The nymph and adult stages of this pest feed on phloem sap and excrete honeydew that hamper photosynthesis and render fruits unmarketable (Lenteren and Noldus, 1984). The aphids are important and widespread pest of many agricultural crops in the Eastern Mediterranean regions (Uygun *et al*., 2001). Members of this family can cause serious damages on many plants by directly feeding on phloem sap or by indirectly secreting excessive sugar in honeydew form. Aphididae are also known as transmitting important viral diseases to many crops (Satar *et al*., 2012).The two-spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae) attacks the broad range of crops including soybean, cowpea and common bean and etc. (Razmjou *et al*., 2009).

In the present study, we will determined the host preference to infestation rate with *T. tabaci* (Lind.), *Bemisia tabaci* (Genn.), aphids (mainly *A. gossypi*, *A. craccivora* and *M. persicae*) and *Tetranychus uticae* (Koch) between cucumber and kidney bean plants, and also relation with some weather factor and anatomical characters on the two host plants, as it are essential to determine the most suitable in order to present an investigated management program for control studies.

Many issues on the role of host plant, climatic factors and anatomical characters on the infestation rate of the above mentioned pests has been done previously Aslam and Gebara (1996); Shalaby (1998); Foda (2000); Legrand and Barbosa (2003); Wei Hong *et al*. (2003); Deligeorgidis *et al.* (2005); Tantawy,Maha (2006); Hanafy (2007); Lee *et al*. (2011); Abou-Zaid (2013) and Maklad *et al. (*2014).

MATERIALS AND METHODS

The abundance of nymphs and adults of *Thrips tabaci* (Lind.), nymphal stages of *Bemisia tabaci* (Genn.), aphids (mainly *A. gossypi*, *A. craccivora* and *M. persicae*) movable stages of *Tetranychus uticae* (Koch.) on the two different host plants, cucumber (Madina cultivar) and kidney bean (Bolista cultivar) was studied. An area of 1050 m^2 was cultivated at Horticultural Research Station at Kaha region, Qalubiya Governorate, Egypt during two successive seasons 2011 and 2012. The experimental area was divided into 6 plots; each tested cultivar was represented by three replicates (175 m^2) which were arranged in a randomized complete block design. Seeds were sown every year in hills in the permanent area on 13th of March during the two studied seasons.

All the recommended agricultural practices were carried out as the needed. The experimental area was kept free from any pesticide treatments, as the plants were left

to the natural infestation.

Three weeks after plantation of the seeds and for 14 weeks later, samples of ten leaves representing from all plant levels were weekly picked from each replicate (30 leaves for each cultivar). The collected leaves were placed directly into paper bags and taken to the laboratory. All stages of *T. tabaci*, aphids, nymphal stages of *B. tabaci* and *T. urticae* movable stages were counted using stereomicroscope.

The mean numbers of the four studied pests were compared statistically on the two host plants. Levels of certain climatic factors (the daily maximum & minimum temperature and daily maximum & minimum relative humidity) were recorded to determine the relationship between the infestation rate of the studied pests and weather factors.

To clarify the relative susceptibility of the tested cultivars, cucumber and kidney bean infestation rate with the four studied pests in relation the anatomical characters of the their leaves, samples of each cultivar were taken throughout the two studied seasons during three periods of plant age (first from planting till 51 days later, the second at the beginning of flowering period and the third one from 65 to the end of the growing season during interaction between flowering and fruiting) and placed in the fixed solution FAA (10 ml formalin+ 5 ml glacial acid + 85 ml ethyl alcohol 70%) for 48 hours. Then after, transverse sections in the leaves were made by using the method by Jackson (1976). The different measurements (in micron) of the thickness of upper epidermis layer, palisade tissue, spongy tissue and lower epidermis layer were determined by using of Compu Eye, Leaf & Symptoms program, Bakr (2005).

Statistical analysis:

The statistical analysis (simple correlation and partial regression) of the obtained data were performed by using SAS program (SAS Institute, 1988). Also the difference between means on the two host plants was conducted by t-test in this program. The daily means of the weather factors during the week proceeding of the sampling date were used in calculating the correlation coefficient value (r), partial regression values between the population of these pests and the four weather factors and their interaction were analyzed by the same program.

The correlation coefficient value (r), partial regression values between the population of these pests and the four tested anatomical characters and their interaction were also analyzed by the same program.

RESULTS AND DISCUSION

Infestation rate of certain pests on the two host plants, cucumber, *C. sativus* L. and kidney bean *P. vulgaris* during two successive seasons 2011 and 2012.

***Bemisia tabaci* nymphs:**

As shown in Tables (1& 2), there were a significant differences between the infestation rates of *B. tabaci* on the tested host plants in the two host plants in the two studied seasons. In 2011 season, leaves of cucumber were infested by the highest number of *B.* tabaci 13.94 nymphs / inch^2. While, the kidney bean plants harboured the lightest mean number, showing a seasonal mean of 8.15 nymphs / inch^2. In the subsequent season, results took the same trend as obtained in the first season and there was a significant difference between the mean relative population densities among the two host plants. The heaviest infestation rate was recorded on cucumber plants, as the recorded seasonal means were 15.79 and 9.84 nymphs / inch^2, respectively.

Table 1: The infestation rates of four different sap-sucking pests on two different host plants, kidney bean and cucumber in Qalubiya Governorate during 2011 season.

Insect / Insp date	whitefly		*Thrips tabaci*		aphids		*Tetranychus urticae*	
	Cucumber	Bean	Cucumber	Bean	Cucumber	Bean	Cucumber	Bean
April, 2nd	2.1	0	5.3	0	3	2.2	5.6	4.3
9th	5	0.8	7.5	0.9	6	3.6	7.4	10.4
16th	5.8	1	9.6	1.3	5	4.3	22.6	19.7
23rd	8.9	2.9	22.3	1.1	4.8	10.5	34.3	23.6
30th	12.5	5.7	35.6	2.9	8	12.8	36.4	32.5
May, 7th	15.6	8.1	40.2	1.5	3.1	28.1	48.1	35.6
14th	32.5	12.3	55.1	1.7	5.6	34.5	35.6	46.7
25th	25	14.1	78.3	2.8	8.2	43.6	55.7	64.1
28th	16.7	20.6	71.1	2.2	11	68.4	58.6	107.4
Jun,4th	20.3	11.2	51.4	2.1	9.2	98.3	41.5	85.2
11th	18.2	14	31.3	0.3	7	119.3	22.5	52.5
18 th	15.6	11.6	18.7	0.8	6.7	65.1	13.6	31.1
25th	7.8	7.6	5.6	0.2	3.2	22.7	7.7	26.5
July, 2nd	9.2	4.2	3.7	0	1.7	6.7	5.6	14
Total	195.2	114.1	435.7	17.8	82.5	520.1	395.2	553.6
Mean ±SE	13.94 ±2.24	8.15 ±1.63	31.12 ±6.73	1.27 ±0.26	5.89 ± 0.71	37.15 ±10.01	28.23 ±5.01	39.54 ±7.85
Prob.	0.0461*		0.001**		0.00001 **		0.0178*	

***Thrips tabaci* (nymphs+ adults):**

Data obtained and recorded in Tables (1&2), indicated that there were significant differences between the two tested cultivars in their infestations with *T. tabaci* throughout 2011 & 2012 seasons. During the first season 2011, cucumber proved as highly infested host by *T. tabaci*, as its leaves harboured throughout the whole season with mean count of 31.12 individuals/ leaf. On the contrary, kidney beans (*Phaseolus vulgaris*) variety was infested with the lowest numbers showing an overall seasonal infestation rate of 1.27 individuals/leaf.

Table 2: The infestation rates of four different sap-sucking pests on two different host plants, kidney bean and cucumber in Qalubiya Governorate during 2012 season.

Insect Insp. date	whitefly		Thrips		aphids		Tetranychus	
	Cucumber	Bean	Cucumber	Bean	Cucumber	Bean	Cucumber	Bean
April, 2nd	2.1	1.5	3	0	0.5	8.5	5.2	6.7
9th	4.6	0.9	9.2	0.2	1.3	5.1	9.4	11.5
16th	5.2	3.5	12.6	0.1	2.7	16.4	12.1	18.7
23rd	10.6	7.6	15.3	0.3	4.8	17.8	28.7	32.4
30th	14.3	7.1	31.7	0.3	5.6	24.2	43.4	54
May, 7th	15.5	9.6	72.5	0.7	8.2	44.5	67.5	73.5
14th	27.8	12.7	98.7	1.2	6.3	88.8	79.6	91
25th	26.1	16.1	135.6	1.8	9.1	71.6	70.8	107.4
28th	21.3	25.2	11.4	2.1	4.3	92.7	81.2	142.1
Jun,4th	25.2	20.6	68.4	2.2	3.3	68.5	49.5	165.4
11th	20.1	14.3	50.3	1.1	5	64.3	38.3	121.6
18th	15.6	10.2	25.5	0.7	2.8	32.8	22.3	83.4
25th	17.2	6.3	19.8	0	3.2	15.3	18.7	61.5
July, 2nd	15.4	2.1	6.1	0	2.9	11.9	9.6	37.2
Total	221	137.7	560.1	10.7	60	562.4	536.3	1006.4
Mean±SE	15.79 ±2.15	9.84 ±1.95	40.01 ±10.71	0.76 ±0.21	4.29 ±0.65	40.17± 8.30	38.31 ±7.33	71.89 ±13.22
Prob.	0.0288 *		0.00001 **		0.00001 **		0.0422 *	

Concerning the second season 2012, (Table 2) also, the cucumber plants showed higher infestation rates with *T. tabaci* with mean count 40.01 individuals / leaf. While, kidney beans plants had significant lower population with seasonal mean number 0.76 individuals/ leaf.

Aphids (mainly *A. gossypii, M. persicae* and *Aphis craccivora*):

Statistical analysis of the tabulated data in Tables (1&2) revealed significant differences between the tested varieties in their infestation abundance by aphids in the two studied seasons 2011and 2012. For the first season 2011, the mean seasonal counts of this pest were found on bean leaves was 37.15 individuals/ leaf. The corresponding counts for the second season, 2012 were 40.17 individuals / leaf. Regarding the cucumber plants, the mean counts of aphids counted on its leaves throughout the two seasons (2011 and 2012) were 5.89 and 4.29 individuals/ leaf, respectively. Finally, it clears that aphid's preferred kidney bean than cucumber plant during two studied seasons.

***Tetranychus urticae* movable stages:**

From data tabulated in Tables (1&2), it seems that the population densities of individuals of the two spotted spider mite, *T. urticae* / $inch^2$ were affected by chosen host plant in the two studied seasons 2011 and 2012. Statistical analysis of the obtained data revealed significant differences between the seasonal mean numbers of *T. urticae* on the two investigated host plant. It clear that the infestation of *T. urticae* was significantly higher on the leaves collected from kidney bean with mean numbers 39.54 and 71.89 in the two seasons, respectively. While, the lowest significant infestation was recorded on cucumber leaves being 28.23 and 38.31 in the two seasons, respectively.

The above mentioned results of the effect of host plants on the population density of the four studied pests agree with obtained by several authors in different countries; Aslam and Gebara (1996) in Egypt, Foda (2000) in Egypt, WeiHong (2003) in china and Lee *et al.* (2011) in China. They stated that the population density of *B. tabaci* was significantly higher on cucumber leaves rather than other host plants, tomato, pepper, okra and kidney bean. Deligeorgidis *et al.* (2005) in Pakistan recorded that *T. tabaci* individuals prefer to infest cucumber leaves than tomato.

The relation between some climatic factors and certain sap sucking pests infesting cucumber and kidney bean plants under field conditions:

One of the most important factors which explain the degree of the susceptibility of tested host plants to the infestation of certain insects is the effect of climatic factors. Tables 3& 4 show the seasonal mean numbers of whitefly, thrips, aphids and two spotted spider mite infesting cucumber and kidney bean plants during two successive seasons 2011 and 2012 and their relation to the maximum & minimum temperature and maximum & minimum of relative humidity.

***Bemisia tabaci*:**

Concerning the correlation coefficient (r) values tabulated in Tables 3&4, the population density of *B. tabaci* on the two host plants were affected by climatic factors. In the first season, statistical analysis of simple correlation revealed that the incidence of *B. tabaci* on cucumber and kidney bean were significantly positive relationship with maximum temperature and maximum relative humidity, the calculated (r) values were 0.57& 0.67 to cucumber and 0.60 & 0.64 to kidney bean, respectively. While, the population density of this pest correlated non-significant and positive with minimum temperature (r values = 0.37 and 0.44 on the two host, respectively).

On the contrary, the minimum relative humidity had negative correlation and non-significant effect (r values were -0.39 and -0.26 on the two hosts, respectively).

Table 3: Relationship between some abiotic factors and the population density of some sap-suking pests on cucumber and kidney bean plants during seasons 2011 at Qalubiya governorate.

Host plant	abiotic Factor	whitefly			Thrips			aphids			*Tetranychus urticae*		
		R	p	E.V. %	r	p	E.V. %	r	p	E.V.%	r	p	E.V. %
Cucumber	Max. temp.	0.57	0. 001	68.00	0.59	0. 001	67.00	0.56	0.001	63.00	0.66	0.001	71.00
	Min. temp.	0.37	0.0513		0.39	0.0238		0.38	0.0293		0.43	0.0281	
	Max. RH%	0.67	0. 001		0.64	0. 001		0.62	0.001		0.70	0.001	
	Min. RH%	-0.39	0.0409		-0.41	0.0196		-0.32	0.0600		-0.47	0.0182	
Kidney bean	Max. temp.	0.60	0.001	68.00	0.62	0.001	71.00	0.59	0.001	64.00	0.62	0.001	72.00
	Min. temp.	0.44	0.0123		0.49	0.0051		0.41	0.0196		0.42	0.0409	
	Max. RH%	0.64	0.001		0.66	0.0001		0.64	0. 001		0.68	0. 001	
	Min. RH%	-0.26	0.0051		-0.26	0.1161		-0.41	0.0196		-0.43.	0.0354	

r: Correlation coefficient p: Probability E.V.% : Explained variance

In the second season, the relationship was significant and positive with maximum & minimum temperature and maximum relative humidity on cucumber and kidney bean as r values were 0.75, 0.65 and 0.54 for cucumber and 0.72, 0.53 and 0.65, to kidney bean, respectively. Minimum relative humidity affected negatively and significant (r= -0.01 and -0.05, respectively).

The amount of variability that could be attributed to the combined effect of the tested weather factors on the nymphal stage of *B. tabaci* population on cucumber and kidney bean

Table 4: Relationship between some abiotic factors and the population density of some sap-suking pests on cucumber and kidney bean plants during season 2012 at Qalubiya governorate.

Host plant	abiotic Factor	whitefly			Thrips			aphids			*Tetranychus urticae*		
		R	p	E.V. %	r	p	E.V. %	r	p	E.V. %	r	p	E.V. %
cucumber	Max. temp.	0.75	0.0001	70.00	0.71	0.0001	71.00	0.66	0.001	67.00	0.76	0.0001	66.00
	Min. temp.	0.65	0.001		0.60	0.001		0.60	0.001		0.70	0.001	
	Max. RH%	0.54	0.0017		0.53	0.0014		0.48	0.0038		0.54	0.0051	
	Min. RH%	-0.01	0.8325		0.01	0.6720		0.03	0.6675		-0.24	0.2040	
Kidney bean	Max. temp.	0.72	0.0001	68.00	0.71	0.0001	69.00	0.68	0.0001	58.00	0.74	0.0001	71.00
	Min. temp.	0.53	0.0026		0.48	0.0073		0.59	0.0015		0.68	0.001	
	Max. RH%	0.65	0.001		0.65	0.001		0.42	0.0140		0.55	0.0033	
	Min. RH%	-0.05	0.6025		-0.05	0.5589		0.02	0.6580		0.01	0.8500	

As the overall explained variance (E.V. %) was 68.0% on the two host plants during first season and 70.0 & 68.0% in the second season on cucumber and kidney bean, respectively.

***Thrips tabaci*:**

Concerning the sensitivity of *T. tabaci* to some weather factors, results took the same trend in case of *B. tabaci* (Tables 3&4). In the first season, statistical analysis of the simple correlation indicated significant positive correlation between the population density of *T. tabaci* and daily maximum temperature & maximum RH%, as the calculated r values were 0.59 and 0.64 to cucumber infestation and 0.62 &0.66 on kidney bean, respectively. While minimum RH% had non-significant correlation and negative effect on the population density of this pest (r values were-0.41 and -0.26 on the two hosts, respectively.

In the second season, the population density of *T. tabaci* correlated positively with the four studied climatic factors on cucumber plants, as the obtained r values were 0.71, 0.60,053 and 0.01 to maximum& minimum temperature and maximum& minimum RH%, respectively. While it correlated positively with the first three factors and negative with the last one on kidney bean plants. (r values were 0.71, 0.48, 0.65 and -0.05, respectively).

It is clear that the infestation rate of *T. tabaci* affected significant with maximum temperature and to maximum RH% on the two tested host plants in the two studied seasons.

The multiple regression analysis indicated that the combined effect (E.V. %) of the four weather factors together on the number of *T. tabaci* were 67.0 & 71.0% and 71.0 % 69.0% on cucumber and kidney bean in 2011 and 2012 seasons, respectively.

Aphids:

In the first season, a highly significant positive relationship between the daily maximum temperature and maximum RH% and aphids infestation was detected for two host plants (cucumber and kidney bean). The calculated correlation coefficient values (r) were 0.56 & 0.62 to cucumber plants and 0.59 &0.64 to kidney bean, respectively. On the contrary, the relationship between minimum RH and aphids population was insignificantly negative for the two studied hosts (r = -0.32 and -0.41, respectively).

The combined effects of the four climatic factors altogether on the infestation of aphids were 63.0 and 64.0 % on the two hosts, respectively.

In the second season, results showed positive relationship between maximum and minimum temperature and infestation of aphids on the two host plants, r values were 0. 66 and 0.60 to cucumber and 0.68 & 0.59 to kidney bean, respectively. On the contrary, there was non-significant and positive effect between the remaining climatic factors and aphids infestation.

The combined effects of the four climatic factors altogether on the population density of aphids infesting cucumber and kidney bean were 67.0 and 58.0% respectively.

***Tetranychus urticae*:**

Regarding to data recorded in Tables 3&4, it is obviously clear that, the relationship between infestation rate of *T. urticae* and climatic factors took the same trend as that occurred in case of the three above mentioned pests.

In the first season, the obtained results showed that a highly significant positive relationship between maximum temperature and maximum RH% and population density of *T. urticae* on the two studied hosts as r values were 0.66 and 0.70 to cucumber plants and 0.62 & 0.68 to kidney bean, respectively. On the other hand,

there are a negative relationship with minimum RH% (r values were -0.47 and -0.43, respectively).

In the second season, the effect of four climatic factors was positively effect on the *T. urticae* infestation on the two host plants except for minimum R.H had a negative relationship on cucumber plant (r = -0.24). On the other hand, the population density of *T. urticae* associated significantly with maximum & minimum temperature and maximum RH% on the two host plants, as r values were 0.76, 0.70, and 0.54 to cucumber plants and 0.74, 0.68, and 0.55 to kidney bean, respectively.

The average rate of changes in *T. urticae* activity due to changes in the combined effect of the four studied climatic factors. The explained variance was 0.71 and 72.0% to cucumber and kidney bean in the first season and 66.0 & 71.0 % in the second season, respectively.

Finally, this means that these two weather factors affected strongly the activity of the above mentioned four pests (*B. tabaci*, *T.* tabaci, aphids and *T. urticae*) and there are unconsidered factors than other the temperature and relative humidity affected the building up these pests.

The above mentioned results of the effect of climatic factors on the population density of *B. tabaci*, *T.* tabaci, aphids and *T. urticae* agree with obtained by several authors; Hanafy (2007) stated that the population density of *T. tabaci* was positively associated with maximum temperature and mean of relative humidity. Ashfaq *et al*., (2010), Kaur *et al.*, (2010) and Sarangdevot *et al.*, (2010). They reported that the whitefly population was positively correlated with mean temperature and negatively correlated with mean of relative humidity. Sharma *et al.*, (2013) found that Aphid and whitefly population was positively correlated with the maximum and minimum temperature and negative with maximum and minimum relative humidity. Kumar *et al.*, (2013) and Maklad *et al.*, (2014) found that the population density of *T. urticae* was positively correlated with maximum temperature.

Relationship between anatomical characters of leaves from cucumber and kidney bean and infestation rates with certain pests.

One of the factors which can explain the degree of the susceptibility of two studied cultivars to infestation of certain insects is the anatomical characters of the leaves. Thickness of leaf is a character that contributes towards resistance and hence effects the pest population. So the difference between the two tested host plants cucumber and kidney bean to the infestation with *B. tabaci, T. tabaci*, *Aphids* spp. *and T. urticae* was related to the anatomical characters of leaves of each plant, such as the thickness of the leaf layers (upper epidermis, palisade, spongy tissues and lower epidermis).

This part of study was done to discover the correlation between these layers and the mean population density of these four pests during three growth stages during the two studied seasons, seedling, flowering and flowering + fruiting stages. Data tabulated in Tables (5&6) give both of the means count on each pest on each host and mean thickness of each of the four tested layers and the correlation coefficient values between these tested factors.

During the first season 2011, the mean count of *B. tabaci* infesting cucumber plants (11.94 individuals / inch^2) during the three tested stages was higher than those infested bean plants (6.13 individuals / inch^2). Also, the upper & lower epidermis and spongy layers of bean leaf (22.70, 20.90 and 93.93 micron) is larger than that of cucumber leaves (14.87, 13.53 and 78.67micron, respectively). In contrary, Cucumber leaves were characterized by somewhat the thickest layer of the palisade tissue (101.03 micron) and the thinnest layer of spongy tissues (78.67 micron).

Table 5: Relation between anatomy of two host plant leaves and population of certain pests during season 2011.

Pest	Host plant	plant stages	Count of pest	Mean diameters of leaf layers (µ)				E.V.%
				Upper epidermis	Palisade tissue	Spongy tissue	Lower epidermis	
B.tabaci	Cucumber	Seedling	5.45	14.50	95.40	86.50	12.90	75.25
		flowering	12.50	13.90	106.20	68.20	13.60	
		fruitting	17.88	16.20	101.50	81.30	14.10	
		mean	11.94	14.87	101.03	78.67	13.53	
		r value		-0.75	0.34	0.90	-0.69	
	Kidney Bean	Seedling	1.18	22.90	68.80	92.40	19.70	70.21
		flowering	5.70	21.50	70.40	98.30	22.20	
		fruitting	11.52	23.70	66.30	90.20	20.80	
		mean	6.13	22.70	68.50	93.63	20.90	
		r value		-0.77	0.62	0.88	-0.83	
T. tabaci	Cucumber	Seedling	11.18	14.50	95.40	86.50	12.90	74.77
		flowering	35.60	13.90	106.20	68.20	13.60	
		fruitting	39.49	16.20	101.50	81.30	14.10	
		mean	28.75	14.87	101.03	78.67	13.53	
		r value		-0.74	0.38	0.86	-0.60	
	Kidney Bean	Seedling	0.83	22.90	68.80	92.40	19.70	61.50
		flowering	2.90	21.50	70.40	98.30	22.20	
		fruitting	1.29	23.70	66.30	90.20	20.80	
		mean	1.67	22.70	68.50	93.63	20.90	
		r value		-0.60	-0.38	-0.10	-0.17	
Aphids	Cucumber	Seedling	4.70	14.50	95.40	86.50	12.90	50.84
		flowering	8.00	13.90	106.20	68.20	13.60	
		fruitting	6.19	16.20	101.50	81.30	14.10	
		mean	6.30	14.87	101.03	78.67	13.53	
		r value		-0.26	0.18	0.63	-0.41	
	Kidney Bean	Seedling	5.15	22.90	68.80	92.40	19.70	75.88
		flowering	12.80	21.50	70.40	98.30	22.20	
		fruitting	54.08	23.70	66.30	90.20	20.80	
		mean	24.01	22.70	68.50	93.63	20.90	
		r value		-0.60	0.69	0.85	-0.75	
T. urticae	Cucumber	Seedling	17.48	14.50	95.40	86.50	12.90	65.45
		flowering	36.40	13.90	106.20	68.20	13.60	
		fruitting	32.10	16.20	101.50	81.30	14.10	
		mean	28.66	14.87	101.03	78.67	13.53	
		r value		-0.59	0.34	0.81	-0.47	
	Kidney Bean	Seedling	14.50	22.90	68.80	92.40	19.70	66.38
		flowering	32.50	21.50	70.40	98.30	22.20	
		fruitting	51.45	23.70	66.30	90.20	20.80	
		mean	32.82	22.70	68.50	93.63	20.90	
		r value		-0.77	0.56	0.76	-0.81	

Statistical analysis of the obtained data in Table (5) revealed that there are a significantly negative relationship between seasonal mean numbers of *B. tabaci* infesting cucumber and thickness of upper and lower epidermis, as the calculated correlation coefficient values (r) were - 0.75 and – 0.69, respectively) while the relation with the palisade and spongy layers was positive (r = 0.34 and 0.90,

respectively); the same trends were estimated for the other host plant (kidney bean), as the correlation coefficient values were -0.77, -0.83, 0.62 and 0.88 for the previously mentioned four layers, respectively.

Concerning *T. tabaci*, the relationship between the four layers and the population of this pest to kidney bean leaves were insignificantly negative in case of lower epidermis, palisade and spongy layers (r = -0.17, -0.38 and -0.10, respectively) while this relation was significant with the upper epidermis (-0.60). For cucumber plants, the population density of *T.tabaci* correlated significantly negative with upper and lower epidermis (r = -0.74 and -0.60, respectively) and significantly positive with spongy tissue (r = 0.86). Only the effect of the palisade layer was insignificantly positive on the occurrence of the pest' individuals (r = 0.38).

The occurrence of aphids population on kidney bean plants were significantly affected by its leave layers, as the upper and lower epidermis layers had a negative effect (r = -0.60 and -0.75, respectively) and palisade & spongy layers was positive (r = 0.69 and 0.85, respectively). On cucumber plants, aphids population correlated negatively with upper and lower epidermis (r values were -.26 and -0.41, respectively), while palisade and spongy tissues layers had a positive relationship with aphids population, as the calculated r values were 0.18 and 0.63, respectively.

Regarding to *T. urticae* infestation on cucumber leaves, results took the same trend of the previously mentioned three insects. A significant negative relationship was observed between *T. urticae* population and both of lower and upper epidermis (r = -0.47 and -0.59, respectively). On contrary, a significant relationship was recorded with other tested two layers, spongy and palisade tissues, as the calculated r values were 0.81 and 0.34, respectively. In case of kidney bean, the same relationship was noticed between the previously mentioned 4 layers and population of this pest (Table 5). The amount of variability that could be attributed to the combined effect of leaf anatomical characters of the two host plants on the different stages of the four tested pests population were 75.25 & 70.21%, 74.77 & 61.50%, 50.84 & 75.88% and 65.45 & 66.38% for *B. tabaci*, *T. tabaci*, *Aphis* spp. and *T. urticae* on cucumber and kidney bean leaves, respectively (Table, 5).

In the second season 2012 season, data calculated and tabulated in Table (6) confirm the same results observed in the first season as a significant negative correlations between seasonal mean population density of the four pests on the two host plants and upper and lower epidermis layers although they varied in their infestation with *B. tabaci*, *T. tabaci*, *Aphis* spp. and *T. urticae* and also varied in their thickness of the two layers.

Besides that, an effective positive effect of the two tissues, palisade and spongy ones on the occurrence of the previously mentioned four pests to the leaves of cucumber and kidney bean. The palisade layer was thicker in cucumber more than kidney bean leaves. However, spongy tissue was thinner in cucumber more than kidney bean leaves.

The obtained results revealed also that, significant effect for the combined effect of the tested leaf layers on the pests activity during second season 2012, as the amount of variability, attributed to the combined effect of the four layers on the four pests population on the host plants were 69.80, 70.74, 62.79 and 74.64% on cucumber plant with *B. tabaci*, *T. tabaci*, *Aphis* spp. and *T. urticae*, respectively. As same as in cucumber, the overall explained variance was 75.5, 69.98, 75.02 and 7033 for the previously mentioned pests with upper& lower epidermis, palisade and spongy layers of kidney bean leaves (Table 6).

Table 6: Relation between anatomy of two host plant leaves and population of certain pests during season 2012.

Pest	Host plant	plant stages	Count of pest	Mean diameters of leaf layers (μ)				E.V.%
				Upper epidermis	Palisade tissue	Spongy tissue	Lower epidermis	
B.tabaci	Cucumber	Seedling	5.63	15.80	96.30	88.70	12.10	69.80
		flowering	14.30	14.50	108.20	69.50	13.00	
		fruitting	20.47	15.80	101.90	82.60	14.80	
		mean	13.46	15.37	102.13	80.27	13.30	
		r value		-0.78	0.71	0.84	-0.67	
	Kidney Bean	Seedling	3.38	23.10	69.10	92.00	18.90	75.50
		flowering	7.10	20.90	71.20	97.40	20.80	
		fruitting	13.01	23.20	68.10	90.00	18.30	
		mean	7.83	22.40	69.47	93.13	19.33	
		r value		-0.78	0.74	0.75	-0.66	
T. tabaci	Cucumber	Seedling	10.03	15.80	96.30	88.70	12.10	70.74
		flowering	31.70	14.50	108.20	69.50	13.00	
		fruitting	54.26	15.80	101.90	82.60	14.80	
		mean	31.99	15.37	102.13	80.27	13.30	
		r value		-0.78	0.60	0.79	-0.59	
	Kidney Bean	Seedling	0.15	23.10	69.10	92.00	18.90	69.98
		flowering	0.30	20.90	71.20	97.40	20.80	
		fruitting	1.09	23.20	68.10	90.00	18.30	
		mean	0.51	22.40	69.47	93.13	19.33	
		r value		-0.77	0.78	0.82	-0.56	
Aphids	Cucumber	Seedling	2.33	15.80	96.30	88.70	12.10	62.79
		flowering	5.60	14.50	108.20	69.50	13.00	
		fruitting	5.01	15.80	101.90	82.60	14.80	
		mean	4.31	15.37	102.13	80.27	13.30	
		r value		-0.66	0.61	0.81	-0.80	
	Kidney Bean	Seedling	11.95	23.10	69.10	92.00	18.90	75.02
		flowering	24.20	20.90	71.20	97.40	20.80	
		fruitting	54.49	23.20	68.10	90.00	18.30	
		mean	30.21	22.40	69.47	93.13	19.33	
		r value		-0.82	0.76	0.79	-0.70	
T. urticae	Cucumber	Seedling	13.85	15.80	96.30	88.70	12.10	74.64
		flowering	43.40	14.50	108.20	69.50	13.00	
		fruitting	48.61	15.80	101.90	82.60	14.80	
		mean	35.29	15.37	102.13	80.27	13.30	
		r value		-0.72	0.57	0.86	-0.71	
	Kidney Bean	Seedling	17.33	23.10	69.10	92.00	18.90	70.33
		flowering	54.00	20.90	71.20	97.40	20.80	
		fruitting	98.12	23.20	68.10	90.00	18.30	
		mean	56.48	22.40	69.47	93.13	19.33	
		r value		-0.78	0.70	0.72	-0.79	

In similar work Shalaby (1998) in Egypt, found that common bean, Giza variety which characterized by higher palisade and spongy tissue thickness in micron proved to be less susceptible to infestation with *B. tabaci* and *Aphis spp*., while, the infestation of these insects increased on Bronco variety which possessing the lower

thickness of palisade and spongy tissues. Legrand and Barbosa (2003) reported that increased plant morphological complexity decreased the efficiency of *Coccinella syptumpunctata* adults with aphids *Acyrthosiphon pisum* on pea plants. Tantawy, Maha (2006) indicated that the population density of aphids and whitefly were positively correlated with lower & upper epidermis and negatively correlated with palisade and spongy tissues. On the other hand, *T. tabaci* population was positively associated with palisade and spongy layers and negatively with upper and lower epidermis. Abou-Zaid (2013) stated that the population density of *T. urticae* infesting cucumber plants was negatively correlated with upper & lower epidermis and palisade layers and positive with spongy tissue layer.

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ARABIC SUMMERY

مقارنة بين معدلات الإصابة لأهم الأفات على محصولى الخيار والفاصوليا وعلاقة الإصابة بالعوامل الجوية والصفات التشريحية.

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تم زراعة محصولى الخيار والفاصوليا فى محطة بحوث البساتين بمنطقة قها بمحافظة القليوبية خلال موسمى ٢٠١١-٢٠١٢ وذلك لدراسة التفضيل العوائلى لأهم الأفات التى تصيب هذين المحصولين وهى حشرات الذبابة البيضاء، تربس البصل، المن و العنكبوت الأحمر العادى. كما تم دراسة العلاقه بين معدلات الإصابة بهذه الأفات وبعض العوامل المناخية والصفات التشريحية لأوراق المحصولين (الخيار والفاصوليا). أظهرت نتائج الدراسة أن حشرتى الذبابة البيضاء وتربس البصل قد فضلت نباتات الخيار عن نباتات الفاصوليا حيث تعرضت للإصابة بأكبر عدد معنوى منهما. فى حين أن حشرات المن والعنكبوت الأحمر العادى قد سجلت أعلى تعداد لها على نباتات الفاصوليا.

كما أوضحت النتائج أيضا أن إصابة المحصولين بالأفات محل الدراسة قد تأثرت تأثرا واضحا بالعوامل المناخية حيث تبين وجود علاقة موجبة ومعنوية بين تعداد هذه الأفات مع كلا من درجات الحرارة العظمى والرطوبة النسبية العظمى بينما تبين وجود علاقه موجبة وغير معنوية مع درجات الحرارة الصغرى للأربعة أفات المختبرة. على العكس من ذلك فقد أشارت النتائج أن الكثافه العدديه للأربعة أفات المختبرة للمحصولين محل الدراسة قد أرتبطت إرتباطا سالبا وغير معنويا مع الرطوبة النسبية الصغرى.

كما تم دراسة العلاقة بين معدلات الإصابة بهذة الأفات و الصفات التشريحية لأوراق المحصولين (الخيار والفاصوليا) لمحاولة تفسير أسباب الإصابة حيث تم عمل قطاع عرضى لأوراق المحصولين فى ثلاث مراحل (طور البادرة، بداية الإزهار ومرحلة التداخل بين الإزهار والإثمار) حيث تم قياس سمك طبقات البشرة العليا والسفلى والنسيج العمادى والإسفنجى بالميكرون وذلك لقياس درجة الإرتباط بين الإصابة وهذه الصفات التشريحية. وقد بينت النتائج إختلاف سمك هذه الطبقات فى المحصولين حيث بينت النتائج أن سمك طبقات البشرة العليا والسفلى والنسيج الإسفنجى كانت أكبر فى الفاصوليا عن الخيار فى حين أن طبقة النسيج العمادى كانت أكبر سمكا فى الخيار عن الفاصوليا. حيث أوضحت النتائج فى كلا المحصولين وجود علاقة سالبة بين الإصابة بهذه الأفات وسمك البشرة العليا والسفلى اى أن الإصابة تزيد كلما قل سمك هاتين الطبقتين فى حين وجدت علاقة موجبة مع سمك طبقتى النسيج العمادى والأسفنجى أى أن الإصابة بهذة الأفات تزيد بزيادة سمك هاتين الطبقتين.

وقد بينت نتائج الدراسة أن العوامل المناخية والصفات التشريحية للأوراق على كلا المحصولين قد لعبت دورا هاما فى الإصابة بالأربعة أفات محل الدراسة حيث أثرت بنسبة أكبر من ٦٠% على شدة الإصابة بهذة الأفات.