COLONIZATION OF *BEMISIA* SPECIES COMPLEX ON CERTAIN HOST PLANTS IN DAKAHLIA GOVENORATE, EGYPT.

Abdel-Baky, N. F.; A.H. Abdel-Salam and Hala A. K. El-Serafi
Economic Entomology Department, Faculty of Agriculture, Mansoura University, Mansoura-35516, EGYPT.
E-mail:nafabdel@mum.mans.eun.eg

ABSTRACT

The life stages of *Bemisia* species complex were surveyed on thirty plant hosts belonging to thirteen botanical families in Dakahlia Governorate, Egypt, to estimate the degree of pest colonization on each host during 1997 & 1998. Among these families are Solanaceae, Euphorbiaceae, Curciferae, Cucurbitaceae, Leguminaceae, Malvaceae, which were the most preferable for the reproductive process of *Bemisia* spp. Meanwhile, other plant families showed a little colonization degrees of its life stages. However, cabbage, squash, cotton, tomato, caster bean, cauliflower, labannet el-homara weed and potato harbored the highest populations of the insect. The other hosts established moderate or small colonies of *Bemisia* spp. in both years. The effect of growing seasons on the degree of *Bemisia* spp. colonization was discussed. Summer and perennial plant-hosts were apparently favored by *Bemisia* spp. for reproduction during the warmer weather. Meanwhile, winter host plants were as significant overwintering sites. Generally, the degrees of the insect population densities differed according to plant species and leaf age of the same plant. The correlation coefficient parameters between *Bemisia* spp. life stages were highly significant and positive.

Keywords: *Bemisia* species complex, *B. argentifolii*, *B. tabaci*, host plant, life stages, insect-plant interaction, insect colonization.

INTRODUCTION

Bemisia species complex are the most noxious insect pests attacking agronomic and ornamental plants throughout the world. Historically, *Bemisia* spp. problems occurred after the introduction of intensive cropping systems with high inputs of feritilzers and pesticides (Byrne et al., 1990). The introduction of the more damaging *B. tabaci* biotypes possibly caused a change in pest status from sporadic to a major pest (Brown et al., 1995). *Bemisia* complex appears to be a combination of the insect innate characteristics, and the particular control practices employed in the affected fields. Some of these characteristics can be classified as biological attributes of the species, that may help the insect to arise to a pest status (Gerling & Kravchenko 1995). Moerover, these problems are not merely a specific crop problem (i.e. field or vegetable crops), but one of the general “crop ecology” problems (Watson, 1994). These conditions evolved the insect from a localized pest to a pest of world-wide prominence, which might have pushed the growers to increase their insecticidal use to combat this insect pest (Jonhson et al., 1982 and Dittrich et al., 1990).

Developing and implementing the effective IPM program for *Bemisia* sp. and virus management require an information on its population dynamics, biology and selection of the plant-hosts. Therefore, it is necessary to understand the relationship bteween *Bemisia* spp. and plant-hosts, preferrence and sequential to develop provincial management tactics (Watson et al., 1992). In addition to the role of the cultivated field crops, the ornamental plants and weed hosts, as well as certain winter crops such as potatoes, lettuce, cabbage, broad beans and sweet peas could serve as overwintering hosts for whiteflies (Gerling 1983 and 1984). At least 155 host plants have been listed early in Egypt by Azab et al., (1969). In addition to crop and pest-specific information, knowledage is also needed about the vartiaton of pest intensity among plant species, varieties and among the seasons (Gerling and Kravchenko, 1995).

Depending on the subsequent comparisons of the differences in plant-host ranges and preferences, plant virus transmissibility, host-plant response, insecticide resistance and randomly polymorphic DNA (RAPD) polymerase chain reaction (PCR) and esterase patterns in populations of *B. tabaci* involved, several biotypes of *B. tabaci* were implicated (Perring et al., 1993; Bellows et al., 1994; Coats et al., 1994; De Barro & Driver 1997; Guirao et al., 1997; Abdel-Baky & Abdel-Salam 2000). This means that distinguishing between *Bemisia* biotypes has become a puzzle and complicated. Therefore, the researcher should give careful consideration to what kind of biotypes are they working with? (Perring 1995).

The occurrence and distribution of the Life stages of both *Bemisia tabaci and B. argentifolii* happened similarly on cotton (Van Lentran & Noldus 1990; Naranjo & Flint 1994), and melons (Riely & Palumbo 1995). The females of both species likewise prefer young leaves for ovipostion. This proves that these biotypes may be closely found at a time in the same field. Since the distribution of those biotypes on the plant-hosts is undefinite, *Bemisia* species complex terminology will be used to refer to *Bemisia* biotypes on all plant hosts involved in this study. The new biotypes of *Bemisia* are receiving an increasing research attention since the first one was discovered in Florida on poinsettia plants in 1986. Since then, the growers suffered significant economic damage (Cohen et al., 1992; Jimenez et al., 1995). Among all biotypes, both “B” and “Q” are completely adapted to the world-wide agroecosystems more than the old biotype “A”. The biotype “B” or silverleaf whitefly was found attaking the crops world-wide. In contrast, the biotype “Q” is distributed in certain countries threatining the agriculture production in Spain, Portugal, Sudan and Egypt (De Barro 1995; Abdel-Baky & Abdel-Salam 2000).

Undoubtedly with the recent appearnce of the new biotypes of *Bemisia* in Egypt, a number of additional plants may be added to *Bemisia* hosts list. Thus, with such a large world-wide host plants list, it may be useful to identify the plants present in a particular locality which may be important hosts. The subject of this study is not new, but the emergence of the new *Bemisia* biotypes or species led to renew interest to shed light on its relationship with the plant-hosts. Moreover, detailed information has been needed for years regarding the effects of crop sequence, around and in close proximity to a given cultivated region, on the growth and development of *Bemisia* spp. populations in that agrecosystem. This can help determine what the relationships are to the timing and duration of various host crops grown in sequence within a given specified area. Therefore, this paper presents the results pertaining to plant hosts preference of *Bemisia* complex or their colonization under the field conditions in Egypt. The qusetion to be answered is: does *Bemisia* spp. have the ability to prefer between plants of different species, and if so, does the selection also happen between the leaves of different age on the same plant ?.

MATERIALS AND METHODS

A general survey was conducted during 1997 and 1998 to estimate the degrees of colonization of the insect pest on certain plant-hosts (Table 1) throughout Dakahlia Governorate. During the survey, the plant-hosts were classified into three categories namely; summer hosts, winter hosts and perennial hosts. The survey also covered field and vegetable crops, as well as ornamental plants. A common weed hosts were also involved (Table 1).

- **Field information**:

The research was carried out in three regions of Dakahlia Governorate, namely Mansoura, Talkaha and Aga. The regions were simillar regarding weather conditions, type of soil and irregation system. Severe winter conditions are rare, providing whitefly with a favourable temperature environment throughout the year. Insects such as *Bemisia* spp. are best able to expolit these climatic circumstances, because the insect has no dormant overwintering stage. The area of each plant host particulary summer and winter hosts was about 4200 m^2 and the hosts were given all normal agronomic practices. Regarding ornamental, fruit orchard hosts and weeds, the survey was carried out at the nursery, gardns at Mansoura region, Mansoura University campus and Aga region.

- **Sampling Methods:**

The following methods were applied to estimate the population density of *Bemisia* spp.:

1. Yellow sticky cards:

Whitefly adults were monitored using yellow sticky cards (YSC) 7.6 x 7.6 cm. Twenty YSC were placed vertically in each crop field with 30 cm above the ground surface. The cards were distributed randomly to cover all field edges and the center. With regard to the ornamental and fruit orchard trees, YSC were hanged with clips in the lower half at the center of the tree. The cards were collected weekly and replaced with new ones till the harvest of the crop, which this continued for a year with perennial hosts.

2. Visual examination:

To estimate the population density of *Bemisia* immatures (eggs, nymphs and pupae), twenty-five plants were chosen at random across a diagonal transect of each field. Weekly samples were taken by collecting three leaves of each plant, one from every third (upper, middle and lower) of the main stem. The leaves removed from each

Table (1): Host plants and their botanical families harbouring *Bemisia* spp. during 1997 and 1998 in three regions of the Dakahlia Governorate.

#	Common name	Family Name	Scientific Name
1	Cotton	Malvaceae	*Gossypium barbadense* L.
2	Hibiscus	Malvaceae	*Hibiscus rosa-sinensis* L.
3	Althaea	Malvaceae	*Althaca rosea* L.
4	Broad Bean	Leguminaceae	*Vicia faba* L.
5	Sweet peas	Leguminosae	*Pisum sativum* L.
6	Cowpea	Leguminaceae	*Vigna sinensis* L.
7	Cabbage	Cruciferae	*Brassica oleracea var. capitata* L.
8	Lettuce	Compositae	*Lactuca sativa* L.
9	Potato	Solanaceae	*Solanum tuberosum* L.
10	Tomato	Solanaceae	*Lycopersicon esculentum* Mill.
11	Sweet potato	Convolvulaceae	*Ipomaea batatas* L.
12	Pepper	Solanaceae	*Capsicum anuum* L.
13	Egg plant	Solanaceae	*Solanum melongena L.*
14	Table Grape	Vitacea	*Vitis vinifera* L.
15	Lemon Gauva	Myrtaceae	*Psidium guajava* L.
16	Squash	Cucurbitaceae	*Cucurbita pepo* L.
17	Cucumber	Cucurbitaceae	*Cucumis sativus* L.
18	Suger Beet	Chenopodiaceae	*Beta vulgaris* L.
19	Caster been	Euphorbiaceae	*Ricinus communis* L.
20	Poinsettia	Euphorbiaceae	*Euphorbia pulcherrima* Willd.
21	Labanett el-homara	Euphorbiaceae	*Euphorbia prunifolia* Jacq.
22	Lantana	Verbenaceae	*Lantana camara* L.
23	Duranta	Verbenaceae	*Duranta plumeri var. variegata* L.
24	Globe Artichoke	Compositae	*Cynara scolymus* L.
25	Corn	Geminaecea	*Zea mayis* L.
26	Egyptian Mallow	Malvaceae	*Malva parviflora* L.
27	Soybean	Leguminosae	*Glycin max* L.
28	Mung bean	Leguminosae	*Vigna ridiata* L.
29	Cantalope	Cucurbitaceae	*Cucumis sativus* L..
30	Cauliflower	Brassicaceae	*Brassica oleraceae var. botrytis* L.

category were put in a plastic bag and transferred to the laboratory for investigation. The leaf area was divided to three sectors and one cm^2 from each sector was examined by the stereomicroscope and *Bemisia* immatures, were counted and recorded. The caster bean plants infested by two whitefly species (*Bemisia* spp. and *Trialeurods ricini*). Therefore, the differentiation between *Bemisia* spp., which involved in this study and the other species, were carried out on the base of the shape of both nymphs and pupal stage.

- **Statisteical analysis**:

The total number of adults recorded on YSC, the total number of eggs and nymphs on twenty-five plants were chosen weekly in each crop to compute the percentages of degrees of colonization for each year and the means in two years. The percentages of each season plants were also calculated by the same way. All experimental data concerning the above characters were analyzed with one way analysis of variance (ANOVA). Comparisons of means of biological characters were made with the Duncan's Multiple Range Test (Costat Software, 1990). Besides, the correlation coefficient was applied to estimate the degrees of correlation between each stage and its development to the next stage.

RESULTS

I. Effect of botanical families on *Bemisia* species complex colonization:

The plant-hosts of *Bemisia* spp. belong to thirteen botanical families given in figure, which also shows the percentages of *Bemisia* colonization on each family. It may be obvious that the plants of family Solanaceae were the most favorable hosts to *Bemisia* spp. under field conditions, with a percentage of 17.60% of the insect settlement. The families Euphorbiaceae, Curcifereae, Cucurbitaceae, Leguminaceae, Malvaeceae and Verbenaceae ranked 2nd to 7th place with 14.96, 13.84, 13.83, 12.98, 11.67 and 6.27%, of *Bemisia* spp. colonization, respectively. On the contrary, the families Convolovulaceae, Myrtaceae, Geminaceae, Compositae, Vitaceae and Chenoppodiaceae harbored the lowest populations of *Bemisia* spp. adults and immatures (Fig. 1).

2. Establishment of *Bemisia* species complex colonies on thirty plant hosts:

Table (2) indicates the percentages of settlement of *Bemisia* spp. on thirty host plants, which could be divided into three groups according to the degree of colonization. Of these hosts, cabbage plants were the most preferred for *Bemisia* life stages, which occupied the first place with 8.34 and 8.82 % of the total percentages in 1997 and 1998, respectively. Squash plants came in the next with 7.71 in 1997 and 8.82% of *Bemisia* spp. colonization in 1998, followed by cotton, tomato, caster bean and cauliflower which showed the 3rd, 4th, 5th and 6th rates. On the contrary, lettuce, Egyptian mallaw, and globe artichoke recorded the lowest percentages of *Bemisia* population which represented (0.67, 0.83); (0.39, 0.41) and (0.30, 0.40) of the total percentages in both years in succession. The plants mentioned before as well as cowpea, guava, pepper, corn, table grape, broad bean, sweet peas and althaca ranked among the light settlement group. Meanwhile, the other plant hosts exhibited different percentages of the insect population on the basis of being accepted as hosts for the insect (Table 2) The group including labnnet el-homara weed, potato, soybean, mung-bean, egg plant, poinsettia, lantana, cucumber, hibiscus and cantaloupe harbored moderate populations of *Bemisia* spp. The percentages of settlements ranged from 5.11 to 3.01% in 1997 and 5.36 to 2.88 % in 1998. The colonization degrees of *Bemisia* species complex were confirmed by the statistical analysis, of the total insects recorded per each plant-host, which pointed out to significant differences of the population size of *Bemisia* life stages ($P \geq 0.05$).

3. Seasonal plant-hosts and their effectiveness on colonization of *Bemisia* spp.:

3.1 Summer plant hosts:

The data in figure (2) indicate that the summer plants were highly acceptable to *Bemisia* spp. Among the fifteen summer host plants, squash plants were the best host for *Bemisia* spp. colonization, occupying the first place with 13.28 and 14.19% of the total population size of the insect in 1997 and 1998, successively. Cotton plants came next (12.67% in 1997 and 13.60% in 1998), while tomato, labannet el-homara weed, soybean, mung-bean, eggplant, lettuce and cantaloupe plants ranked 3rd to 10th, consecutively. It was interesting that the summer hosts have significant differences in the degree of pest settlement ($P \geq 0.05$).

Table (2). Percentage of *Bemisia* spp. colonization on certain plant hosts during two successive years.

Rank	Scientific Name of The plant host	Colonization % of WF on plant hosts		
		1997	1998	Mean
1	*Brassica oleracea* var. *capitata* L.	8.34	8.82	8.58
2	*Cucurbita pepo* L.	7.61	7.89	7.75
3	*Gossypium barbadense* L.	7.26	7.56	7.41
4	*Lycopersicon esculentum* Mill.	6.66	5.98	6.32
5	*Ricinus communis* L.	6.05	6.21	6.13
6	*Brassica oleraceae var. botrytis* L.	4.87	5.61	5.24
7	*Euphorbia prunifolia* Jacq.	5.11	5.36	5.24
8	*Solanum tuberosum* L.	5.37	4.96	5.17
9	*Glycin max* L.	4.86	4.41	4.64
10	*Vigina ridiata* L.	4.58	4.32	4.45
11	*Solanum melongena* L	4.57	3.94	4.26
12	*Euphorbia pulcherrima* Willd.	3.55	3.60	3.58
13	*Lantana camara* L.	3.26	3.44	3.35
14	*Ipomaea batatas* L.	3.90	2.58	3.24
15	*Cucumis sativus* L.	3.30	2.98	3.14
16	*Hibiscus rosa-sinensis* L.	2.98	3.21	3.10
17	*Cucumis sativus* L.	3.01	2.88	2.95
18	*Duranta plumeri* var. *variegata*	2.92	2.91	2.92
19	*Vigna sinensis* L.	2.21	2.28	2.25
20	*Psidium guajava* L.	1.95	1.83	1.89
21	*Capsicum anuum* L.	1.45	2.30	1.88
22	*Zea mayis* L.	1.38	1.29	1.34
23	*Vitis vinifera* L.	1.02	1.06	1.04
24	*Vicia fabae* L.	0.76	1.02	0.89
25	*Pisum sativum* L.	0.80	0.75	0.78
26	*Althaea rosea* L.	0.82	0.72	0.77
27	*Lactuca sativa* L.	0.67	0.83	0.75
28	*Beta vulgaris* L.	0.46	0.48	0.47
29	*Althaea rosea* L.	0.39	0.41	0.40
30	*Cynara scolymus* L.	0.30	0.40	0.35

3.1.a. Occurrence of *Bemisia* life stages on the summer host plants:

- **The adult stage**:

Table (3) presents the average numbers of each life stage of *Bemisia* spp. per sampling unit. Regarding the adult stage, squash fields were preferred for *Bemisia* adults, being the best summer host. The average numbers of adults per YSC were 843.2±65.0 and 943.2±71.02 in 1997 & 1998, respectively, followed by tomato. While cotton and labannet el-homara weed came later exhibiting different percentages of harbored adults. The other host plants were also differently attractive to the adults (Table 3). Sweet peas and table grape were the least preferred by the adults in both years. Generally, the host plants varied significantly ($P \geq 0.05$) regarding the population of *Bemisia* adults (Table 3).

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fig

- **Immature stages**:

Table (3) indicates that the females of *Bemisia* spp. deposited the highest number of eggs/cm^2 in squash plants on the leaves on all positions on the main stem. The average number of eggs/cm^2 reached 57.9±2.5, 48.3±3.7, 21.39±1.9 and 54.29±3.19, 46.2±2.9, 14.6±1.02 for upper, middle and lower leaves in 1997 and 1998, successively. A similar picture occurred for the nymphs on the same plant in both years. Meanwhile, cucumber plants came next with regard to the average number of nymphs/cm^2 during the two successive years (Table 3). The average numbers of deposited eggs/cm^2 on cucumber leaves were 25.77±1.4, 11.69±0.39, 6.13±0.23 and 23.87±1.96, 11.7±0.38, 5.94±0.22 in 1997 & 1998 for upper, middle and lower leaves, respectively. The average numbers of *Bemisia* spp. eggs and nymphs varied on cotton, labannet el-homara weed, soybean, mung-bean, eggplant, sweet potato, cantaloupe, cowpea and pepper (Table 3). Among all summer plants, corn and table grape were less preferred for oviposition and nymphs development. There were no eggs deposited on the lower leaves of corn (Table 3). The data also indicate that the upper leaves of the main stem of all host plants were preferred for oviposition, followed by middle leaves, while the lower ones harbored the lowest numbers of eggs (Table 3). No nymphs were observed on the upper leaves of all plants. The number of eggs and nymphs varied significantly ($P \geq 0.05$) according plant species and leaf age.

3.2. Colonization on the winter host plants:

Figure (2) proves that the percentages of *Bemisia* colonization on certain winter plants were higher than some summer and perennial host plants. It can be noted that the cabbage plants harbored higher percentages of *Bemisia* spp. population than the other winter, summer and perennial plants. Cabbage plants likewise listed first place (37.94% in 1997 and 37.96% in 1998), while potato plants occupied the second place with 24.45% in 1997 and 21.33% of the total insects in 1998. The other plants showed different numbers of the total life stages in both years. All winter hosts have significant differences in the degree of pest settlement in the two successive years of study ($P \geq 0.05$).

3.2.b. Occurrence of *Bemisia* life stages on the winter host plants:

- **The adult stage**:

The data in table (4) indicate that cabbage, potato and cauliflower were the best-preferred hosts to *Bemisia* spp., which recorded high population density of the insect life stages in both years. The cabbage plant occupying the first place with 590.8±51.53 and 689.8±70.77 individuals/YSC in 1997and 1998, respectively. While, potatoes and cauliflower came next in the second and third place, with 402.1±23.68 and 317.8±23.95 in 1997 and 429.7±31.69 and 428.4±40.9 adults/YSC in 1998, consecutively. In the contrary, sugar beet, globe artichoke and the Egyptian mallow colonized light population densities of *Bemisia* adults (Table 4). The number of *Bemisia* adults varied significantly ($P \geq 0.05$) among the plant hosts.

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Immature stages:

The numbers of *Bemisia* spp. eggs and nymphs likewise were higher on cabbage, potato and cauliflower, while other hosts recorded low numbers per sampling unit in 1997 and 1998 (Table 4). On the contrary, globe artichoke plants were not preferred to egg oviposition, particularly, the upper leaves (zero eggs/cm^2). Statistically, *Bemisia* immatures were significant differed (P≥0.05) according to the type of the winter hosts and leaf age.

3.3. Colonization of *Bemisia* spp. on the perennial host plants:

Of the perennial hosts, caster plants were the best perennial host for feeding and development of *Bmisia* spp. (Fig. 2), which recorded 29.22 and 29.26% of *Bemisia* population during 1997 & 1998, respectively. While other perennial hosts (poinsettia, labanett el-homara, lantana, hibiscus, duranta and gauva), recorded different percentages of *Bemisia* populations (Fig. 2).

3.3.c. Occurrence of *Bemisia* life stages on the perennial host plants:

- **The adult stage:**

The number of *Bemisia* adults reached 215.2±23.77 and 247.6±26.25 individuals/YSC on the caster bean during 1997 and 1998, respectively, while poinsettia came next with 134.1±15.94 adults/YSC in 1997 and 149.2±18.27 adults/YSC in 1998. In the contrary, guava plants recorded low numbers of *Bemisia* adults during the two years of study (Table 5).

- **Immature stages**

Caster bean plants occupying the first place, which recorded 7.64± 0.39, 5.19±0.24, 2.98±0.24 and 8.14±0.56, 4.46±0.35, 2.82±0.11 eggs/cm^2 for the upper, middle and lowers leaves in 1997 and 1998, respectively. Similar results were obtained regarding number of nymphs on the caster bean host (Table 5). On the other hand, the numbers of *Bemisia* immature were varied on the other perennial hosts according to the leaf ages and type of host.

Table (6). Correlation coefficient between *Bemisia* spp. complex on different plant hosts.

Year	*Bemisia* spp. life stages relationships		Correlation coefficient parameters			
	X variable	Y variable	Corr. (r)±SE	Slope (b)	Y Int. (a)	P
1997	Adults	Eggs on upper leaves	0.6598±0.080	0.0360	- 0.1567	***
		Eggs on middle leaves	0.6661±0.079	0.0280	- 1.3209	***
		Eggs on lower leaves	0.6596±0.081	0.0124	- 0.2820	***
	Eggs on upper Leaves	Nymphs on middle leaves	0.7232±0.074	0.2425	2.5651	***
		Nymphs on lower leaves	0.6834±0.078	0.2693	4.2355	***
	Eggs on middle Leaves	Nymphs on middle leaves	0.5359±0.090	0.2335	3.3850	***
		Nymphs on lower leaves	0.5072±0.092	0.2597	5.1439	***
	Eggs on lower Leaves	Nymphs on middle leaves	0.5333±0.090	0.5188	3.2464	***
		Nymphs on lower leaves	0.5012±0.092	0.5730	5.0012	***
	Nymphs on M. L.	Nymphs on lower leaves	0.5333±0.081	0.5484	0.2371	***
	NY. on L. L.	Adults	0.6772±0.070	31.4685	41.5323	***
1998	Adults	Eggs on upper leaves	0.7269±0.073	0.0331	- 0.7618	***
		Eggs on middle leaves	0.7120±0.075	0.0256	- 1.5053	***
		Eggs on lower leaves	0.6482±0.081	0.0081	0.3314	***
	Eggs on upper Leaves	Nymphs on middle leaves	0.7118±0.075	0.2686	2.3049	***
		Nymphs on lower leaves	0.6822±0.078	0.3310	4.1589	***
	Eggs on middle Leaves	Nymphs on middle leaves	0.5303±0.091	0.2564	3.1598	***
		Nymphs on lower leaves	0.4989±0.093	0.3101	5.2411	***
	Eggs on lower Leaves	Nymphs on middle leaves	0.5410±0.089	0.7482	2.6554	***
		Nymphs on lower leaves	0.5401±0.090	0.9604	4.4878	***
	Nymphs on M. L.	Nymphs on lower leaves	0.5411±0.054	0.3912	0.7926	***
	NY. on L. L.	Adults	0.5868±0.065	26.3070	94.2140	***

M. L.= Middle leaves **L.L. = Lower leaves** **N. Y. = Nymphs**

4. Correlation coefficients between all life stages:

Correlation coefficient analysis between every two life stage was fulfilled under field conditions to indicate the relationships between these life stages of *Bemisia* spp. (Table 6). The results showed that the relationships between all life stages were highly significant. The values of "r" were positive and exceeded half of "r" value (50%) in the two experimental years. The correlation coefficients between life stages on different leaf positions were significantly high during 1997 and 1998 (Table 6).

DISCUSSION

The biology of *Bemisia* species complex is very complicated and the population growth throughout the year is directly related to the factors influencing the biology of the insect (Watson et al., 1992; Watson 1994). Initiation of *Bemisia* spp. infestation is correlated with one or more factors (biotic and abiotic) that affect the insect colonization. Synchronization of insect life cycle with the type of plant-host and developmental phase are determined mainly by some of biochemical, morphological and physical characteristics, which distinguish the plant-host (Zangerl & Berenbaum 1993; Chu et al., 1995; Heinz & Zalom 1995). The interaction between plant-host and *Bemisia* spp. is equally important in the development of the insect life stages. Since *Bemisia* spp. has no dormant overwintering stage, the growth of its population will continue within the year but at a much reduced rate during the winter months (Coudrit et al. 1985). Therefore, the success of *Bemisia* spp. colonization depends on a succession of plant-hosts, both cultivated and wild, throughout the year. Among all whiteflies, *Bemisia* species complexes are polyphagous insects. This means that *Bemisia* spp. have the widest host range in tropical and sub-tropical areas of the world, which is apparently an important element in changing the pest status. The present results have confirmed that the differences of *Bemisia* life stages colonization between plant families are associated with the variations of plant species and growing season (Fig. 1). In this connection, the families of host plants of *Bemisia* spp. were arranged in the following descending order: Solanceae, Euphorbidaceae, Curciferae, Cucurbitaceae, Leguminaceae, Malavaceae, Verbenaceae, Convolvulaceae, Myrtaceae, Geminaceae, Compositae, Vitaceae, and Chenoppodiaceae. These findings were partly inconsistent with the results reported by Servin & Martinez-Carrillo (1999) for the silverleaf whitefly, *Bemisia argentifolii* Bellows & Perring. In addition, Summers et al. (1995) surveyed *Bemisia argentifolii* on 82 ornamental and landscape plants belonging to 42 plant families in southern California. They noticed that most of these plants were reproductive hosts of the insect, which apparently the present results. They also found another sixty-three ornamental plant species unfavorable for the insect colonization or development. Moreover, Secker et al. (1998) referred to the ability of *B. argentifolii* to colonize over 900 different plant species throughout the world.

Identification of key host plant, host sequences and its role in building up the population of *Bemisia* spp. within its normal range are essential factors in approaching regional management, particularly, the succession, abundance and quality of hosts available within the entire year. Barbehenn et al. (1999) reported that the successful growth, development and reproduction of insects obviously depend upon the plant nutritional value, and the attainment of the nutrition qualitative and quantitative requirements. Therefore, the insect demography, seasonal and geographic distribution and its abundance relay on the host quantity and biochemical stimulation (Zangerl & Berenbaum 1993). Of the thirty plant-hosts studied, cabbage, squash, cotton, tomato, caster bean and cauliflower were the best hosts for feeding, oviposition and development of immature stages. These hosts harbored huge numbers of adults, eggs and nymphs in both years (Table 2). Other hosts differed regarding the degree of settlement of *Bemisia* life stages. Some of these were able to colonize moderate populations, while the others supported light colonies. In a variable environment, *Bemisia* spp. may encounter several plant species that differ substantially in suitability for the phytophagous pests. However, host suitability may also vary significantly among individuals of a given plant species, as well as among parts of a given plant.

The results also indicate that the numbers of adults recorded on the yellow sticky cards did not precisely mean that the plant-host was preferred for *Bemisia* colonization. This means that the host might be suitable for adult feeding but did not contains the essential nutritional requirements for reproductive purposes of *Bemisia* spp. (Herakly & El-Ezz 1970; Byrne & Draeger 1989; Watson et al. 1992). The settlement degrees of *Bemisia* species complex varied with the growing season. In spite of the reduced establishment of the insect, it colonized its host with low numbers during winter months. During the early weeks of April, the population of the insect increased slowly showing higher numbers from June till the first week of December. These may be correlated with the effect of climatic factors on the biological characteristics of *Bemisia* spp., together with the features of the plant-host, which change from plant to another. The densities of *Bemisia* spp. also varied throughout the growing season depending on the type of plant-host and its nutritional value. With regard to crop protection, some of these hosts may serve as significant overwintering sites for *Bemisia* spp. or as important sites for development of the associated beneficial organsims (Gerling 1983 and 1984). Meanwhile, weeds certainly play an important role in manintaning *Bemisia* spp. population in the agrecosystem (Coudriet et al., 1985 & 1986). Morever, plant-hosts cultivated in the spring, summer and fall stimuli the production process of the insect which helps in acceleration of growth and development to reach outbreaks. Summers et al., (1995) noticed that *B. argentifolii* colonized succeseeffuly on six table grape varities at California with different degrees according to the plant variety.

The oviposition site selection by females of *Bemisia* spp. has a profound effect on their fitness. Higher numbers of nymphs were established down on the lower leaves followed by the middle leaves. There were no nymphs found on the upper leaves. This is a general phenomenon of *Bemisia* spp. which oviposit more eggs on younger leaves than older ones of different host plants including tomato (Liu and Stansly 1995), cotton (Naranjo and Filnt 1994), poinsettia (Liu et al., 1993), peanut (Lunch and Simmons 1993), chrysanthemum and gerbera daisy (Liu et al., 1993) and squash (Abdel-Baky and Abdel-Salam 2000). The rate of ovipostion and formation of nymphs on each host plant (Tables 4, 5 & 6) provide an important clue concerning the ability of the host to support a complete life (Coudriet et al., 1985 & 1986).

Thompson (1998) and Cardoza et al. (2000) likewise pointed out that the relationship between selection of ovipostion sites and growth survival and reproduction of offspring is a central element in the evolution of host association between *Bemisia* spp. and its host plants. Difference within-plant oviposition site colonization may occur as a result of nutritional factors (Skinner and cohen 1994; Bentz et al., 1995), leaf age and its morphological physiological features or leaf position on the main stem of plant (Liu and Stansly 1995, Veenstra & Byrne 1998). Van Lentran and Noldus (1990) and De Ponti et al. (1990) also reported that the adults of *Bemisia* spp. preferred specific host plants in a mixture of plant species and preferred certain leaves for feeding and ovipostion within a plant. In addation, leaf age is a key factor influencing *Bemisia* population on the same plant, and females prefer young leaves for oviposition (Khalifa & El-Khidir 1994; Gameel 1974; Ohnsesorge et al., 1980; Cardoza et al. 2000). However the present results suggest that *Bemisia* spp. have a range of fitness on various host plants. The movement of the insect to other hosts for feeding or oviposition is an indicator to its wider distribution and ability to adapt on any host plant and large population may develop. Finally, the previous characteristics of this insect concerning its wide range of host plants and high reproductive rate make the control measures very difficult.

Table (6). Additional plant-hosts supported *Bemisia* spp. colonization.

#	Common Name	Scientific Name	Botanical Family	Growing season
1	Sunflower	*Helianthus annus* L.	Compositae	Summer
2	Common purslane	*Portulaca oleracea* L.	Portulaceae	Summer
3	Annual sonthistle	*Sonchus oleracous* L.	Compositae	Winter
4	Wild Beet	*Beta Vulgaris* L.	Chenopodiaceae	Winter
5	Turnips	*Brassica rapa* L.	Curciferae	Winter
6	Canola (Oilseed rape)	*Brassica napus* L.	Curciferae	Winter
7	Radish	*Raphanus sativus* L.	Curciferae	All Year
8	White Postashia	*Adhatoda vasica* L.	Acanthaceae	Perennial
9	**Kafoor	*Eucalyptus rostrata* Bairly	Myraceae	Perennial
10	**Sofsaf	*Salix safsaf* L.	Solicaceae	Perennial

** means of whitefly nymphs and eggs only

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درجات التوطين لحشرات الذباب الأبيض *Bemisia species* complex على بعض العوائل النباتية فى محافظة الدقهلية – مصر.

نجدى فاروق عبد الباقى – عادل حسن عبد السلام - هالة أحمد كامل الصيرفى
قسم الحشرات الإقتصادية –كلية الزراعة – جامعة المنصـــورة

أجريت الدراسة فى ثلاث مراكز تابعة لمحافظة الدقهلية (المنصورة – أجا- طلخا) خلال عامى 1997 و 1998 وذلك لتقدير درجات التوطين لحشرة الذبابة البيضاء على ثلاثون عائل نباتى والذين شملتهم الدراسة. أظهرت الدراسة أن العائلات النباتية التالية كانت من أكثر العائلات المفضله لتكاثر ونمو وتطور الحشـــرة: Solanaceae - Euphorbiaceae – Curciferae – Cucurbitaceae – Malvaceae - Leguminaceae حيث بلغت النسبة المئوية لتوطين الحشرة حسب ترتيب العائلات 17.6، 13.83،14.96، 12.98، 11.67 و 6.27% على التوالى. وكانت عائلةChenopodiaceae أقلها تفضيلا. أما من حيث العوائل النباتيةسجلت الحشرة أعلى تعدادا لها على نبات الكرنب يليه كل من نباتات الكوسة – القطن – الطماطم – الخروع – القنبيط –حشيشة لبنة الحمارة.

أظهرت النتائج أيضا أن العوائل الصيفية تعتبر من العوائل التى ساهمت بدور فعال فى تكاثر وتطور الحشرة بالإضافة إلى العوائل الحولية خصوصا فى المناخ الدافىء. أما العوائل الشتوية فلعبت دورا خلال أشهر الحرارة المنخفضة. كذلك أوضحت Overwinteringفى المحافظة على بقاء الحشرة فى فترة الدراسة أن درجة إرتباط أطوار الحشرة ببعضها البعض كان مرتفع المعنويه مما دل على زيادة الكفاءة التناسلية للحشرة ومقاومتها للظروف البيئية الأمر الذى أدى الى حدوث فوران Outbreakفى تعداد الحشرة تحت الظروف البيئية الملائمة.

Table (3). Mean number of *Bemisia* spp. life stages per sampling unit, recorded on fifteen summer plant hosts during 1997 & 1998 in Dakahelia Governorate.

	1997						1998					
s	MEAN NO. OF *BEMISIA* SPP. ADULTS/ YSC ± SE	Mean No. of *Bemisia* spp. Eggs/cm^2 ± SE			Mean No. of *Bemisia* spp. nymphs/ cm^2 ± SE		MEAN NO. OF *BEMISIA* SPP. ADULTS/ YSC ± SE	Mean No. of *Bemisia* spp. Eggs/cm^2 ± SE			Mean No. of *B* spp. nymphs/	
		Upper leaves	Middle leaves	Lower Leaves	Middle Leaves	Lower Leaves		Upper leaves	Middle Leaves	Lower Leaves	Middle Leaves	
	843.2±65.0 a	57.9±2.5 a	48.3±3.7 a	21.39±1.9 a	9.94±0.53 b	11.35±0.7 c	943.2±71.02 a	54.3±3.19 a	46.2±2.9 a	14.6±1.02 a	9.82±0.55 b	
	279.9±22.7 k	24.2±2.1 b	4.01±0.25 e	1.21±0.17 e	10.9±0.67 b	14.08±1.5 b	701.9±74.6 b	23.9±2.06 b	5.98±0.29 c	0.72±0.07 fg	11.28±0.78	
	719.4±54.5 b	4.44±0.37 f	2.13±0.17 g	1.24±0.09 e	2.57±0.14 d	7.53±0.12 d	481.3±48.9 c	5.01±0.34 e	2.5±0.19fgh	1.5±0.12 efg	2.78±0.21 d	
-homara	418.1±47.1 c	8.5±0.49 d	6.7±0.37 cd	0.75±0.03 f	10.14±0.44	13.56±0.5 b	394.5±41.8 e	9.14±0.51 d	6.95±0.47 c	0.66±0.02 fg	10.97±0.78	
	402.1±31.3 d	9.31±0.83 d	5.9±0.45 de	2.95±0.1 cd	7.14±0.55 c	9.06±0.65 d	399.1±62.98 d	9.53±07 d	6.32±0.55 c	3.64±0.11 c	6.72±0.68 c	
n	382.4±31.3 e	6.71±0.43 e	4.25±0.27 e	3.85±0.22 c	7.51±0.48 c	8.05±0.62 d	321.9±27.48 h	6.11±0.57 e	4.08±0.28 e	3.25±0.22 d	4.32±0.28 d	
	344.5±45.2 l	00.00 l	5.19±0.24 d	2.56±0.05cd	2.5±0.09 de	4.17±0.21 e	327.2±29.27 f	00.00 l	4.46±0.29 d	2.27±0.14 d	2.56±0.14 d	
	369.4±21.1 f	25.77±1.4 b	11.67±0.39	6.13±0.23 b	15.85±0.99	16.3±1.17 a	287.9±42.29 I	23.87±1.96	11.7±0.38 b	5.94±0.22 b	18.24±1.19	
ato	367.1±25.6 g	3.14±0.19 fg	2.55±0.18 fg	1.55±0.06de	3.97±0.15 d	5.25±0.23 e	362.4±15.76 e	3.01±0.22 g	3.1±0.15 efg	1.70±0.08 e	4.18±0.19 d	
e	346.5±13.1 h	17.11±0.53	7.47±0.27 c	5.34±0.22 b	8.27±0.26 c	11.93±0.52	326.1±14.68 g	18.54±0.43	6.75±0.26 c	4.75±0.17 b	7.72±0.4 c	
	287.9±15.9 j	3.43±0.2 fg	2.17±0.11 g	1.55±0.1def	2.7±0.15 de	4.72±0.27 e	326.1±14.69 g	2.53±0.0.18	2.5±0.18 fgh	1.5±0..07 ef	2.26±0.14 e	
	101.5±19.3 m	2.14±0.05 g	1.63±0.0.5 g	0.97±0.03 e	2.14±0.07 e	3.10±0.19 fg	183.4±22.65 j	2.85±0.15 g	1.7±0.16 gh	0.45±0.02 fg	2.7±0.23 de	
	184.7±14.3 l	1.26±0.19 h	1.01±0.11 g	00.00 f	1.52±0.08 e	1.82±0.08 g	186.7±11.96 j	1.74±0.21 h	1.0±0.1 hi	00.00 g	1.61±0.07 e	
	86.4±5.7 o	1.35±0.03hi	0.75±0.06 h	0.73±0.04 f	1.10±0.05 e	1.89±0.05 g	99.1±6.67 k	1.40±0.05 h	0.68±0.02 I	0.61±0.03 fg	1.14±0.1 e	
s	89.2±10.2 n	4.67±0.26 f	2.45±0.24 fg	1.28±0.17 e	2.83±0.26 d	3.70±0.26 e	90.22±10.95 L	4.38±0.51 fg	2.5±0.22 fgh	1.62±0.16 e	2.58±0.18 d	

Means in each row followed by the same letter in a column are not significant (P≤0.05).

Table (4) Mean number of *Bemisia* spp. life stages per sampling unit, recorded on nine winter plant hosts during 1997 & 1998 in Dakahelia Governorate.

Winter Plant Hosts	1997						1998				
	MEAN NO. OF *BEMISIA* SPP. ADULTS/ YSC ± SE	Mean No. of *Bemisia* spp. Eggs/cm^2 ± SE			Mean No. of *Bemisia* spp. nymphs/ cm^2 ± SE		**MEAN NO. OF *BEMISIA* SPP. ADULTS/ YSC ± SE**	Mean No. of *Bemisia* spp. Eggs/cm^2 ± SE			Mean No. o spp. nymph
		Upper Leaves	Middle leaves	Lower Leaves	Middle leaves	Lower Leaves		Upper leaves	Middle Leaves	Lower Leaves	Middle Leaves
Cabbage	590.8±51.6 a	16.6±1.04 a	8.8±0.52 b	5.15±2.02 b	7.72±3.99 ab	12.78±4.36a	689.8±70.8 a	15.08±5.44a	8.13±2.06 b	4.28±1.92 b	7.36±2.55 a
Potato	402.1±23.7 b	15.9±1.05 a	17.7±1.1 a	6.91±2.43 a	8.63±3.79 a	12.29±5.47a	429.7±31.7 b	10.8±3.44b	15.5±4.31 a	6.83±1.88 a	6.74±3.32 b
Cutflowers	317.8±23.95 c	17.1±1.35 a	8.95±0.68 b	4.11±1.75 b	6.35±2.45 b	11.71±5.80 a	428.4±40.9 b	14.28±3.85a	7.95±3.35 b	4.05±1.95 b	8.35±3.14 a
Athaca	26.3±3.11 f	5.07±0.3 b	2.67±0.29 c	1.23±0.96 c	2.66±1.72 cd	4.75±2.45 b	28.13±2.64 e	4.38±1.57 c	1.99±0.52 c	0.85±0.18 c	2.51±0.85 c
Bean	52.8±3.8 e	4.63±0.26 b	1.99±0.18 cd	1.29±0.69 c	2.86±1.1 c	1.26±0.29 c	86.5±6.19 d	5.17±1.92 c	2.23±0.86 c	1.22±0.39 c	3.01±1.32 c
Lettuce	80.6±3.8 d	2.88±0.18 d	1.45±0.07 cd	0.89±0.31 c	1.13±0.27 cd	2.4±0.68 bc	109.9±7.63 c	3.06±0.88 d	1.92±0.50 c	1.16±0.28 c	1.61±0.42 c
Sugar beet	11.3±1.01 I	3.66±0.16 bc	2.14±0.14 cd	1.15±0.45 c	2.75±0.87 c	4.2±0.71 b	14.2±1.28 g	3.89±0.86 cd	2.31±0.35 c	1.21±0.65 c	3.05±0.75 c
Kobeza	19.4±1.5 g	3.11±0.08 cd	2.4±0.14 cd	1.38±0.38 c	1.85±0.35 cd	2.5±0.80 bc	22.4±1.95 f	3.67±0.41 cd	2.33±0.67 c	1.41±0.53 c	1.63±0.31 c
Globe Artichoke	15.8±0.69 h	00.00 e	0.84±0.05 d	0.68±0.13 c	0.93±0.16 cd	0.95±0.56 c	21.9±1.8 f	00.00 e	1.74±0.86 c	1.26±0.36 c	0.80±0.25 d

Means in each row followed by the same letter in a row are not significant (P≤0.05).

Table (5) Mean number of *Bemisia* spp. life stages per sampling unit, recorded on six perennial plant hosts during 1997 & 1998 in Dakahelia Governorate.

Perennial Plant Hosts	1997						1998				
	MEAN NO. OF *BEMISIA* SPP. ADULTS/ YSC ± SE	Mean No. of *Bemisia* spp. Eggs/cm^2 ± SE			Mean No. of *Bemisia* spp. nymphs/ cm^2 ± SE		**MEAN NO. OF *BEMISIA* SPP. ADULTS/ YSC ± SE**	Mean No. of *Bemisia* spp. Eggs/cm^2 ± SE			Mean No. of spp. nymphs
		Upper leaves	Middle leaves	Lower leaves	Middle leaves	Lower Leaves		Upper leaves	Middle leaves	Lower Leaves	Middle Leaves
Caster Oil	215.2±23.8 a	7.64±1.96 a	5.19±1.19 a	2.98±1.19 a	5.29±1.93a	9.39±2.63 a	247.6±26.3 a	8.14±2.79 a	4.46±1.74 a	2.82±0.56 a	4.66±1.74 a
Poinsettia	134.1±15.9 b	3.83±0.74 cd	1.75±0.61 c	1.25±0.35a	2.11±0.91 b	3.8±1.35 b	149.2±18.27 b	4.11±1.52 b	2.11±0.78 bc	1.40±0.51 ab	1.89±0.70 b
Lantana	122.1±15.9 c	2.66±0.87 cd	2.03±0.66 bc	1.48±0.58a	1.73±0.81 b	4.3±1.76 c	141.9±17.29 c	2.85±1.59 b	2.14±0.67 bc	1.59±0.53 ab	1.89±0.75 b
Hibiscus	114.3±8.39 d	2.1±0.51 d	1.64±0.20 c	0.89±0.11a	1.35±0.37 b	3.48±0.96 d	138.3±12.59 d	2.6±0.70 b	1.73±0.22 c	0.98±0.14 b	1.48±0.65 b
Duranta	109.2±10.6 e	4.22±1.13 bc	2.6±1.11 bc	1.69±0.58 a	2.66±1.19 b	3.9±1.59 e	111.2±12.39 e	4.39±1.03 b	2.8±0.44abc	1.86±0.63 ab	2.48±1.54 b
Guava	58.1±6.44 f	5.87±1.85 ab	3.8±1.71 ab	2.01±0.71 a	2.37±0.91 b	3.23±0.9 f	57.3±4.63 f	6.82±2.92 a	3.93±1.43 ab	2.62±0.71 ab	2.46±0.36 b

Means in each row followed by the same letter in a row are not significant (P≤0.05).