

SENSITIVITY OF THREE SOYBEAN VARIETIES FOR *BEMISIA ARGENTIFOLII* (HEMIPTERA: ALYROIDAE) INFESTATION AND ROLE OF THE INTERNAL LEAF BIOCHEMICALS

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Abstract

Three soybean varieties (Giza 21, Giza 35 and Giza 82) were selected to study their sensitivity to SLWF infestation under field condition in 2001 and 2002 growing seasons. Data revealed that SLWF eggs increased gradually through soybean growing season. In 2001 season, there was no significant difference in the average number of SLWF eggs between Giza 21 and Giza 35, while the difference was significant between both varieties and Giza 82 until the 3rd week of July. Also, data showed that Giza 21 harbored the highest number of SLWF nymphs followed by Giza 35 and Giza 82. Generally, Giza 21 variety was the most susceptible variety for the SLWF infestation followed by Giza 35 and Giza 82, respectively, during the course of study.

In addition, both eggs and nymphs were higher in 2002 than in 2001 season. The eggs were positively correlated with nymphal stage in all soybean tested varieties. There were clear differences in the population of SLWF between soybean varieties.

Leaf bio-chemical structure affected on SLWF ovipositions and nymphal colonizations among soybean varieties. It could be noticed that soybean varieties varied in their components tested which resulted in a significant difference in most cases between cultivars.

INTRODUCTION

Bemisia argentifolii Bellows & Perring, is an important constraint pest on the production of food and fiber crops throughout the world (Inbar, 2003). Right now *B. argentifolii* is a key pest in both greenhouses and outdoor crops. Therefore, the situation is worsened by the rapid development of new biotypes progeny, which can complete their life cycle in less than three weeks under optimum conditions (Bethke *et al.*, 1991 and Byrne and Bellows, 1991). As well as, mobilization and spread of the viruses diseases by the insect world-wide threat the agricultural industries (Lipa, 1999 and Abdullahi *et al.*, 2003). The problem reached a crisis level in both small-scale and large production systems (Brown, 1994 and Zanac *et al.*, 2003). The increase of worldwide

concern regarding the adverse impact of *B. argentifolii* in crop production systems emphasizes the need to develop control strategies based on its biology, population dynamics, varietal resistance and distribution in relation to cultivated and wild host ecosystem (Henneberry and Faust, 1999 and Naranjo *et al.*, 2003).

Whiteflies recognition of their plant hosts has attracted the attention for a long time (Lanteren and Noldus, 1990). Because of the plant leaf odour and color influence *B. argentifolii* accepted to their hostes before Landing (pickett *et al.* 1992), the chemical cues of plant leaf detected by the pest after landing may play a more important role during the final acceptance of the host for feeding. Since, *Bemisia* species are phloem feeder, chemical stimuli from leaves offeres attractants or no contacts with deterrents, the test probing will switch to exploratory probing. The stylet will probe deeper and deeper unittl it reaches the phloem and feed. Exploratory probing seems to be a trial and error procedure, it needs time for the insect to find the phloem. This is why the probing speed is fast. The chemical composition of the leaf wax is very complex, evoloved with plant secondary substances. It may play an imporatnt role in the insect feeding preference behavior (Wenru *et al.*, 1992).

Although chemicals have been proposed as a means to control *B. argentifolii* on soybean used for seed production, the application costs are high. (El-Kady and Devine, 2003 and Otoidobiga *et al.*, 2003). In addition, chemicals may be determintal to humans and other animals. An alternative strategy for controlling this pest is the identification and development of soybean cultivars resistant to SLWF feeding damage. Development of effective management stratigies for the pest requires an understanding of the mechanisms of internal plant compoment involoved in plant selection. Identification of soybean varietal resistance to the insect pest is essential for varitial enhancement and cultivar development.

Therefore, the goal of this study was to evaluate three soybean varities against SLWF infestation and the role of certain internal leaf chemical in inducing the plant resistance.

MATERIALS AND METHODS

1. Field Studies. The research was preformed at the Experimental Research Station, Faculty of Agriculture, Mansoura University, to evaluate three soybean varities to the SLWF (*B. argentifolii*) during 2001 and 2002 growing seasons. Three soybean (*Glycin max* L.: Leguminosae) varities namely, Giza-21, Giza-35 and Giza-82 were chosen in this study. The varieties were cultivated in May, 17th and 23rd through 2001 and 2002 seasons, respectively.

II. Silverleaf whitefly. To evaluate SLWF populations, 15 plants from each host were selected randomly (three plants from each corner and three from the center of

the area). As well as, three leaves from each plant were selected as follows: one from upper, one from middle and the other from the lower level of plant stem. Samples of plant leaves were transferred directly to the laboratory in plastic bags, whereas SLWF eggs and nymphs were counted and recorded. The samples were taken at weekly intervals, starting from the vegetative stage until the samples became free from whitefly population or the harvest. To count SLWF eggs and nymphs on each host leaves, 7 leaf sectors (3 cm² each) from leaves margin was used and investigated under stereomicroscope at the laboratory.

111. Laboratory studies.

Estimation of the soybean leaf components. Chlorophyll "A", "B", carotene, amino acids, phenol, and humidity in soybean leaves were estimated at different time intervals to determine the relationship between these plant components and SLWF density under field conditions in 2002 season. These components were estimated as follows:

Soybean Leaf pigments or colors. Pigments or leaf colors (chlorophyll "A", "B" and carotene) were estimated according to Saric *et al.* (1967).

Amino acid estimation. Extraction of soybean leaf amino acids and its estimation were done as in Jayaramen (1985).

Phenol estimation. Phenol preparation and estimation of its concentration in soybean leaf samples were calculated according to A. O. A. C. (1970) and Dancil and George (1972)

Humidity estimation in soybean leaves. The humidity is one of the factors that plays an important role in insects attractiveness to the host plant. So, A. O. A. C. (1970) method was used to determine the water content in soybean leaves.

IV. Statistical Analysis. Analysis of variance of insect populations among the varieties was done by Costat program (1990).

RESULTS AND DISCUSSION

I. SLWF Field Studies:

A. Rates of SLWF eggs and nymphs on the three soybean varieties. Table (1) represents the differences among soybean varieties regarding SLWF oviposition and nymphal colonization. Giza 21 variety was at the head of three varieties and showed to be the most suitable host for SLWF oviposition, which harbored a higher eggs and nymphal numbers (Table 1). The average SLWF oviposition and nymphal rates reached 31.33 and 29.91 eggs/cm² and 240.79 and 181.03 nymphs/cm² in 2001 and 2002 respectively. The next variety was Giza 35, which average numbers of eggs were 22.113 and 5.73/cm², whereas, the mean number of nymphs/cm² listed 175.06 and

67.58 in the two successive seasons in succession. In contrast, Giza 82 was not suitable host for both eggs oviposition and nymphal colonizations (Table 1). This means that Giza 86 is the resistant variety for SLWF infestation. Statistical differences were detected in both eggs and nymphs average numbers among the three varieties ($P \geq 0.05$)

B. Seasonal infestation of *B. argentifolii* within three soybean varieties:

***B. argentifolii* eggs.** Figure 1 shows that SLWF eggs increased gradually through soybean growing season. At L. S. D. values of 0.54 and 0.38 and $P \geq 0.05$ %, there were no significant differences in the average number of SLWF eggs between Giza 21 and Giza 35, while the difference was significant between both varieties and Giza 82 at 1st and 3rd week of July 2001. Through the period from 3rd week of July to the 2nd week of August, SLWF deposited the highest number of eggs on Giza 35 followed by Giza 21 and Giza 82, respectively. Significant difference in the average number of SLWF eggs was found between Giza 21, Giza 35 and Giza 82 at sampling dates of 3rd, 4th weeks of August and 1st week of September, respectively. (F values = 11.70 and 85.53).

SLWF eggs in 2002 season were represented in Figure 2 on three soybean varieties. *B. argentifolii* eggs reached its maximum number at the 4th week of August for both Giza 21 and Giza 35. Meanwhile, the population reached its maximum average in Giza 82 through the 3rd week of August. No significant differences observed in the average number of SLWF eggs between Giza 35 and Giza 82 at the dates of 2nd week of August, and 1st and 2nd weeks of September, respectively.

At L. S. D. values of 7.65 and 8.86 (F value = 346.12 and 349.05), there was a significant difference in the average number of SLWF eggs between Giza 21, Giza 35 and Giza 82. Generally, Giza 21 was the most susceptible variety for SLWF infestation followed by Giza 35 and Giza 82, respectively. This confirmed with the results shown in 2001 season.

Table 1. Rates of SLWF eggs oviposition and nymphal colonization on different soybean varieties during 2001 and 2002 seasons

Seasons	SLWF life stages	Soybean varieties		
		Giza 21	Giza 35	Giza 82
2001	SLWF Eggs	31.33 a	22.13 b	1.39 c
2002		29.91 a	05.73b	2.91 c
2001	SLWF Nymphs	240.79 a	175.06 b	25.59 c
2002		181.03 a	67.58 b	14.99 c

Means within a row followed by the same letter are not significantly different ($P \geq 0.05$).

B. argentifolii nymphs. Population densities of SLWF nymphal stage on soybean varieties are shown in Figures 3 and 4. In 2001 season, Figure 3 indicates that the highest number of SLWF nymphs were colonized on Giza 21 followed by Giza 35 and Giza 82. There were significant differences in the average number of SLWF nymphs among three soybean varieties (At L. S. D. values ranged between 1 2.047 2nd 26.43 and $P \geq 0.05$).

Data in Figure 4 show that SLWF nymphs infestation was lower through the period from 4th week of June to the 1st week of August 2002. Then SLWF nymphs increased among soybean varieties.

Significant differences in the average number of whitefly nymphs between Giza 21, Giza 35 and Giza 82 in August 2002 at L. S. D. values ranged between 7.38 and 34.60 and $P \geq 0.05$ % ($F = 109.33, 196.947$ and 792.33). At 1st and 2nd weeks of September, 2002, the population of SLWF nymphs disappeared from Giza 35 while Giza 21 infested by highest number of SLWF nymphs and represented a significant difference compared to Giza 82. number of nymphs recorded on the foliage of soybean varieties after 2nd week of September.

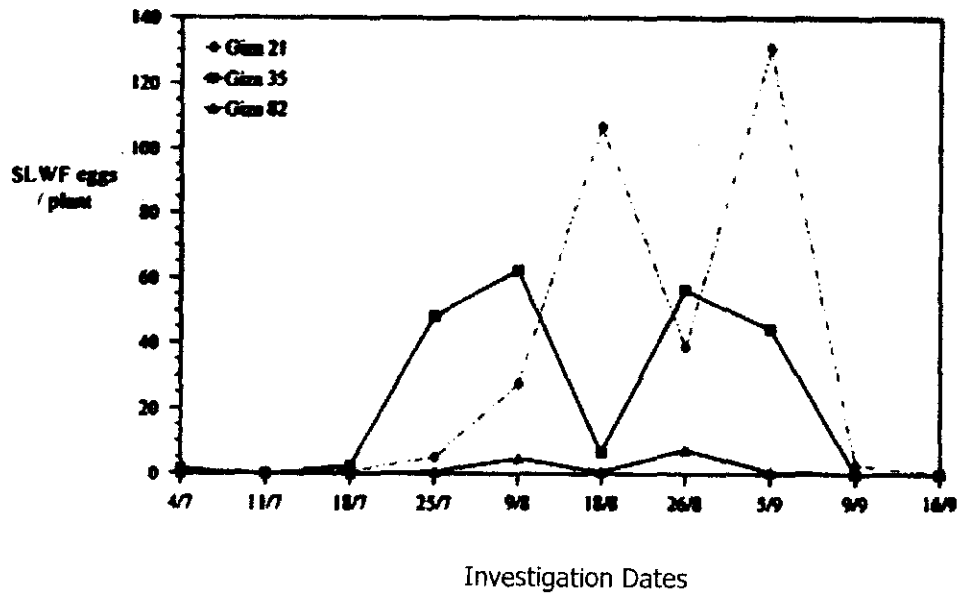


Fig. 1. Seasonal abundance of *Bemisia argentifolii* eggs on three soybean varieties in 2001 season.

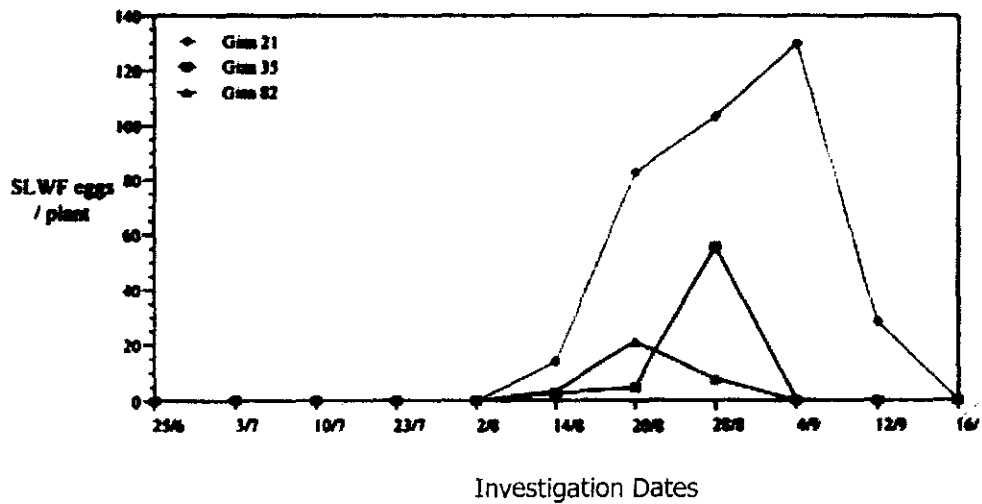


Fig. 2. Seasonal abundance of *Bemisia argentifolii* eggs on three soybean varieties in 2002 season.

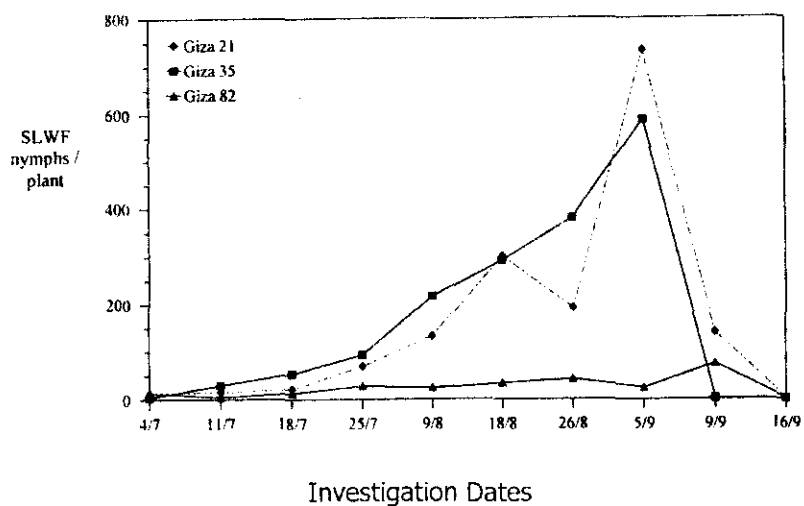


Fig. 3. Seasonal abundance of *Bemisia argentifolii* nymphs on three soybean varieties in 2001 season.

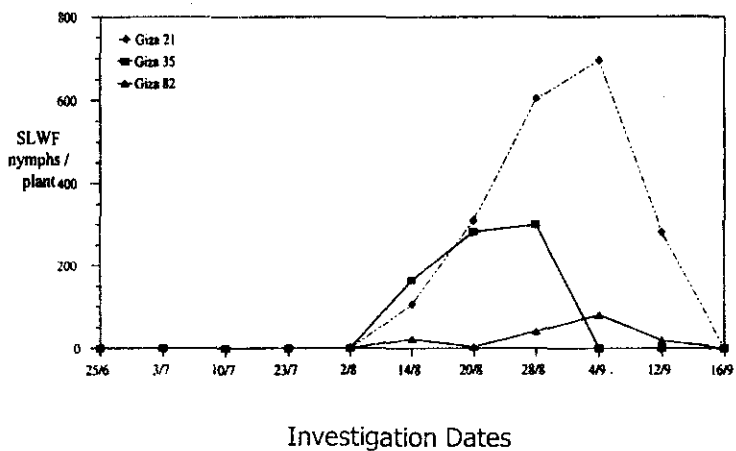


Fig. 4. Seasonal abundance of *Bemisia argentifolii* nymphs on three soybean varieties in 2002 season.

II Chemical components of soybean varieties:

I-Chlorophyll "A", "B" and carotene in soybean leaves . Chlorophyll "A", "B" and carotene concentrations of soybean varieties showed in Table 2. Regarding, chlorophyll "A" (at L. S. D. value of 5.41 and F = 5.872) there were significant difference in its concentration in soybean leaves between Giza 21 and both Giza 35 and Giza 82 in the 2nd week of July. The concentration of chlorophyll "A" reached its maximum level during the 1st week of August then decreased up to 73.88, 82.58 % in the 3rd week of August.

Chlorophyll "B" showed slight difference in its concentration among soybean varieties during the season. As well as, no significant difference in the concentration of chlorophyll "B" detected between the soybean varieties through the 2nd and 3rd weeks of August at L. S. D. values 4.315 and 5. 025 (P = 0.05 %), respectively (Table 2).

On the other hand, carotene concentration reached its maximum level through the 1st week of August. Slight difference in carotene concentration was found among soybean varieties. Carotene concentrations ranged between 6.081-59.077 mg/100 gm dried leaves for Giza 21, while it ranged between 5.363 - 49.664 and 4.833 - 29.587 mg/100 gm dried leaves for Giza 35 and Giza 82, respectively (Table 2).

Table 2. Average of chlorophyll A, B and carotene concentration in leaves of different varieties of soybean.

Leaf components	Sampling date	Soybean variety*			L. S. D.
		Giza 21	Giza 35	Giza 82	
Chlorophyll A (mg/100 gm dried leaves)	9/7	13.984 ^a	8.31 ^a	6.797 ^b	5.41
	5/8	63.012 ^a	63.081 ^a	32.97 ^b	4.755
	20/8	16.455 ^a	23.598 ^a	27.229 ^a	11.18
	10/9	39.152 ^a	29.147 ^{ab}	25.127 ^b	12.74
Chlorophyll B (mg/100 gm dried leaves)	9/7	3.075 ^a	2.775 ^a	2.96 ^a	4.315
	5/8	23.195 ^a	23.979 ^a	13.563 ^b	5.993
	20/8	5.874 ^a	8.682 ^a	8.287 ^a	5.410
	10/9	13.859 ^a	9.219 ^a	6.311 ^b	7.110
Carotene (mg/100 gm dried leaves)	9/7	6.39 ^a	5.363 ^a	7.568 ^a	5.023
	5/8	59.077 ^a	49.664 ^a	29.587 ^b	17.981
	20/9	11.88 ^a	16.457 ^a	19.292 ^a	12.688
	10/9	6.081 ^a	5.71 ^a	4.833 ^a	4.850

^a Means within a row followed by the same letter are not significantly different (P ≥ 0.05).

B- Amino acids, phenols and humidity in soybean leaves. No significant differences in amino acids concentration observed among soybean varieties through the period from the 2nd week of July until the 3rd week of August (Table 3). As well

as, slight significant difference found between Giza 82 and both Giza 21 and Giza 35 at the 2nd week of September at L. S. D. of 8.710 ($F = 9.233$, $P \geq 0.05$ %).

Regarding phenol concentration in soybean leaves, Data in Table 3 shows that there was a significant difference in phenol concentration between Giza 21, Giza 35 and Giza 82 at L. S. D. value of 0.51 ($F = 994.32$, $P \geq 0.05$ %) through the 2nd week of July. Phenol concentration increased gradually until the end of soybean growing season representing high significant difference between the three soybean cultivars.

Taking into account the difference in water content in soybean leaves, expressed as humidity percent, it is appear that there were no significant differences in humidity percent between Giza 35 and Giza 82 at different time intervals, while Giza 21 showed significant differences compared with both Giza 35 and Giza 82, respectively (Table 3).

Table 3. Average of amino acids, phenol concentration and humidity in leave of different soybean varieties during 2002 season.

Leaf components	Sampling date	Soybean variety*			L. S. D.
		Giza 21	Giza 35	Giza 82	
Amino acids	9/7	08.31 ^a	8.202 ^a	8.41 ^a	6.211
	5/8	20.10 ^a	20.96 ^a	20.84 ^a	8.476
	20/8	04.79 ^a	6.331 ^a	5.843 ^a	4.315
	10/9	20.32 ^a	25.871 ^a	10.589 ^b	8.710
Phenols	9/7	00.94 ^a	0.00 ^c	0.459 ^b	0.051
	5/8	000.017 ^a	0.019 ^a	0.019 ^a	0.0167
	20/8	00.191 ^a	0.102 ^c	0.157 ^b	0.008
	10/9	00.181 ^b	0.125 ^c	0.247 ^a	0.009
Humidity	9/7	49.50 ^b	81.0 ^a	86.0 ^a	12.53
	5/8	41.00 ^b	73.0 ^a	79.0 ^a	11.003
	20/8	37.00 ^b	68.0 ^a	64.0 ^a	13.101
	10/9	17.00 ^b	63.0 ^a	69.0 ^a	11.183

* Means within a row followed by the same letter are not significantly different ($P \geq 0.05$).

CONCLUSION

One of the most ideal IPM strategies for field crops is the use of varieties that are resistant to insects (Buntin *et al.*, 1992). Term sensitivity used here is definition as "the ability of certain varieties to support large population of an insect, induced internal and external changes of plant structure and affecting the plant yield". There are many benefits of using insect resistant varieties. The most obvious is the savings to the grower by not applying pesticides, or in reducing the amount of pesticides applied. In addition to the economic benefits accrued by reduced pesticide usage, environmental and social benefits transcend to all citizens of the world. In this study, SLWF immatures were lower in June and July of both years and rose steadily until SLWF densities peaked in mid-to late September. Giza 21 variety is the most susceptible for infestation by SLWF followed by Giza 82 and Giza 35, respectively. Both eggs and nymphs were higher in season 2002 than 2001 season (Abdel-Baky *et al.*, 2004). A clear difference in SLWF population observed among soybean varieties. The variation may be due to varying in foliar pubescence between varieties, the difference in trichome density, as well as, the internal leaf chemical. The results were in harmony with McAuslane (1996) studies, who demonstrated that in choice tests, *B. argentifolii* adults laid significantly more eggs on the hirsute and pubescent isolines than on the glabrous isolate. In no-choice tests, the within-plant distribution of eggs laid on the 3 isolines differed and was related to trichome density. However, significantly more eggs were laid on hirsute soybean than on glabrous soybean in between-isoline choice tests. Therefore, it is likely that the partial resistance of soybean varieties observed in the field is caused, in part, by reduced ovipositional preference related to lack of foliar pubescence. However the effect of trichomes on oviposition preference is less pronounced when *B. argentifolii* are closely confined with host plants.

In addition, Lambert *et al.* (1995) showed that unifoliate leaves became infested with SLWF nymphs and eggs four weeks after planting. Meanwhile, LA88-3 and F90-700 varieties had significantly higher total SLWF populations than 11 and 8 varieties, respectively, at growth stage V7. They concluded that there were significant differences in soybean varietal response to *B. argentifolii* population densities and it can be used effectively to screen soybeans for resistance to whiteflies. On the other hand, Bhattacharya *et al.* (1999) studied the inheritance of resistance to yellow mosaic virus spread by *B. tabaci* in Glycine soybean. Resistance reactions of F1 and F2 plants, and individual F2 derived F3 families indicated that resistance was controlled by a single dominant gene.

Regarding leaf bio-chemical structure, it could be noticed that soybean varieties varied in their components tested which resulted in a significant difference in most cases between cultivars. Color is a very important factor in SLWF host selection before landing (Husian and Trehan; 1940, Mound, 1962 and van Lentern and Noldus, 1990). Since, chlorophyll A, B, and carotene are leaf pigments that affected SLWF host selection. Therefore, increasing concentrations of chlorophyll A and B pigments mean that soybean leaf color will be a dark/green and this not preferred to SLWF. On the other hand, increasing carotene concentration compared with other pigments studied (chlorophyll A and B), this will turn soybean leaves to be a yellow/green color and then the leaves will be more attractive for SLWF adults to feed and oviposit its eggs as SLWF adults and immatures affected greatly by leaf pigments because they feed on cell sap. So, increasing SLWF infestation will decrease the leaf pigments and then affected plant by reduction of the net photosynthetic rate (Lin *et al.*, 1999). Moreover, they indicated that the reduced of photosynthetic rate was associated with reductions in chlorophyll variable fluorescence (F_v/m) and fluorescence yield. This finding indicates that SLWF infestation impairs, either directly or indirectly, the photochemical reaction of the photosynthetic system in cotton plants.

Furthermore, Chhabra *et al.* (1993) mentioned that the host mechanism of resistance revealed higher percents of reducing and non-reducing sugars, total phenols and free amino acids in the resistant genotypes than in the controls and susceptible genotype. In this respect, Bi *et al.* (2000) reported that applied nitrogen linearly increased densities of SLWF adult and immatures. Also, the nitrogen treatments linearly enhanced plant foliar photosynthetic rates and altered concentrations of soluble proteins, soluble amino acids and several soluble carbohydrates such as glucose, fructose and sucrose in cotton petiole. They also correlated glucose levels with densities of SLWF adults during the peak population size. In addition, Butter *et al.* (1992) reported that plant cultivars having higher total phenolic and o-dihydroxyphenolic contents in leaves supported fewer whitefly eggs.

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حساسية ثلاثة أصناف من فول الصويا للأصابه
بـ (Hemiptera: Alyerodidae) *Bemisia argentifolii*
ودور الصفات الكيميائية للعائل

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١ . معهد بحوث وقاية النباتات - الدقى - جيزة

٢ . قسم الحشرات الاقتصادية - كلية الزراعة - جامعة المنصورة

أختبرت حساسية ثلاثة أصناف من فول الصويا (جيزة ٢١ - جيزة ٣٥ - جيزة ٨٥) حقلية للإصابة بـ *B. argentifolii* خلال موسم ٢٠٠٢، ٢٠٠١ تشير النتائج أن وضع البيض للحشرة زاد تدريجيا من الزراعة وحتى الحصاد خلال موسمي الدراسة . أيضا لم يسجل إختلافات معنوية فى المتوسط تعداد البيض بين صنفى جيزة ٢١ وجيزة ٣٥ فى موسم ٢٠٠١ ولكن سجلت إختلافات معنوية بين كلا الصنفين وصنف جيزة ٨٥ حتى الأسبوع الثالث من يوليو بالإضافة إلى ذلك فإن حوريات الحشرقو كونت مستعمرات بكثافة عالية على صنف جيزة ٢١ يليه صنف جيزة ٣٥ ، بينما أنخفض تعداد الحوريات على صنف جيزة ٣٥ .

عموما ، يعتبر صنف جيزة ٢١ أكثر الأصناف تفضيلا للحشرة ومن ثم أكثرها حساسية للإصابة بالحشرة بلية صنفى جيزة ٣٥ وجيزة ٨٥ على التوالى خلال فترة الدراسة . أيضا دلت النتائج على إرتفاع معدلات وضع البيض وتعداد الحوريات فى موسم ٢٠٠١ .

خلصت الدراسة إلى أن التركيب الكيميائى للورقة أثر على معدلات الحشرة لوضع البيض وأختبار الحوريات للعائل المناسب بين الأصناف الثلاث موضع الدراسة . ومن ثم يمكن ملاحظة أن أصناف فول الصويا أختلفت فى تركيبها الكيميائى ، الأمر الذى ادى على تفاوت درجة الإصابة بين الأصناف الثلاث.