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STUDIES ON THE BIOLOGICAL ASPECTS OF SILVER LEAF WHITEFLY *Bemisia argentifolii* (BELLOWS AND PERRING)WITH REFERENCE TO SQUASH LEAF CURL VIRUS(SLCV) INFECTION AT LABORATORY CONDITION.

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ABSTRACT

This study was carried out to estimate the effect of virus infection on the silver leaf whitefly, *Bemisia argentifolii* (Bellows and Perring). The insect spent three different generations for this study. The incubation period of insect which did not significantly affected in this study ranged from 2 – 5 days for the different insect state and generations. However, there were not clearly observed differences between the different insect life cycle of the two insect sexes in the different three generations. The lowest duration period in different tested replicates was recording 11 days in case of healthy insect state in the third generation and the highest value was recorded 18 days. However, the longevity period of the adult female was highly significant between the different insect three generation and this effect was not recorded between the different healthy insects and infected once. The lowest longevity period of adult males was recorded 8.2 days in the case of healthy insects of the third generation. But the longest longevity duration period of insect 19 days was determined when the adult females were exposed the infection with the virus.

INTRODUCTION

Commercial squash crop in Egypt was widely affected by aphidborne viruses. Whiteflies (Homoptera: Aleyrodidae) are small plant-feeding insects with piercing-sucking mouthparts, and both immature and adult whiteflies feed on the undersides of leaves. Adult whiteflies have the ability to both walk and fly, and females lay eggs either singly in a haphazard manner or in spirals or circles on the undersides of leaves. Whitefly eggs are ovoid and have a peg-like pedicel that is inserted into a slit made by the female's ovipositor in the leaf surface. Whitefly, one of the most difficult pests to control, pose a special challenge to gardeners. Whitefly numbers grow dramatically in the heat, most strains are resistant to pesticides, and the pests infect a huge range of hosts including bedding plants, strawberries, tomatoes, and poinsettias.The sweet potato whitefly, *Bemisia tabaci* (Gennadius) is highly adaptive and polyphagous on taxonomically diverse species of plants on a global scale, Simons *et al.,* (2008). Just as the name implies, whitefly are small, fly-like insects with white colored wings. They hide on the underside of leaves where they multiply rapidly. Whitefly feed on plant juices and, in large numbers, can consume a considerable amount of nutrients, causing plants to pale in color. Like aphids, they also excrete honeydew, attracting black sooty mold fungus. Recently, these pests have been found to spread viruses. *Bemisia tabaci* was reported to transmit at least five cucurbit viruses, including pumpkin yellow mosaic virus (PYMV) from India (Capoor and Ahmed, 1975); lettuce infectious yellow virus (LIYV) from California and Arizona (Brown and Nelson 1986), (Duffus *et al.,* 1986); squash leaf curl virus (SLCV) from the United States, Mexico, and some South American countries (Brown,. 1990).This whitefly transmits numerous plant viruses, including Begomoviruse (Geminiviridae). The so-called silver leaf symptom is seen on cucurbits infested by the silver leaf whitefly, *Bemisia argentifolii* (Bellows and Perring) biotype B, but is not associated with SLCV. SLCV causes severe losses of squashes, melons and related cucurbits in Arizona and California (USA) (Duffus & Flock, 1982). Although recorded to infect *Phaseolus vulgaris*, there is no indication that it has any importance on that host (Brown, 1990). It has been suggested that it could be due to infection by another virus (Bharathan *et al.,* 1992), but it is now generally thought to be induced physiologically by the feeding of biotype B (hence its proposed name *B*. *argentifolii*).The major foliar pest of poinsettia in Egyptian greenhouses is the silver leaf whitefly, *B.argentifolii*. Most whitefly species are arrhenotokous, and females are produced from fertilized eggs. Males are haploid and eclose from unfertilized eggs. The ratio of male and female whiteflies in a population changes over time and is affected by both temperature and male longevity Hong and Ling. (1997). Males tend to live for shorter periods and populations appear female biased as a result. First instar nymphs which hatch from eggs are mobile, and walk a short distance before selecting sites where they settle to commence feeding. This ambulatory first instar is referred to as the crawler, and crawlers may walk for several hours and cover distances up to 30 mm before settling. After settling, crawlers insert their mouthparts into leaf tissue, and the stylet passes between host cells until the phloem is penetrated and sap extraction begins. Much of what is known about whitefly biology comes from research on pest species, such as sweet potato whitefly, *B.tabaci*, greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood), and silver leaf whitefly, *Bemisia argentifolii* Bellows and Perring (also referred to as the B strain or biotype B of *B. argentifolii*). The objective of this study was determining the effect of squash leaf curl virus SLCV on whitefly different biological aspects on healthy plant leaves at laboratory conditions.

MATERIALS AND METHODS

Silver leaf whitefly, *Bemisia argentifolii* Biotype "B" was reared under laboratory conditions at 22 - 27 ºC and 40 - 65 % RH on squash plants(*Cucurbita pepo).* The stock culture of silver leaf whitefly, *B.argentifolii* Biotype "B" established by exposing potted squash plants to adult of *B. tabaci "*B" collected from the field using aspirator. The adults were kept for 12 hours on the plant leaves for eggs laying after which potted plants were transferred to wooden cage (100 x 135 x 135 cm) with nylon gauze sides. The insect was classified in to 2 groups, healthy plants and virus infected plants (infected). It has been made 5 replicates from each one as the white flies has been left for 48 hours to put the eggs then it has been settled free (flying it) out of the cages and the present eggs has been counted and taken certain number of the leaves that percents on it eggs for continuing the experiment. Each of the newly emerged crawlers was transferred to a new leaf en circled in the same manner and observed daily until adult emergence. The incubation period was determined as time elapsing from the first oviposition until the emergence of first crawler. Incubation period, life cycle and longevity of silver leaf *B.argentifolii* Biotype "B" males and females reared on squash plants were recorded for three successive generations under laboratory conditions. In each generation adult stage, both the healthy insect and infected insect were counted. The obtained results were subjected to one-way analysis of variance (ANOVA) and means were separated by Duncan's multiple range test, Duncan (1955).

RESULTS AND DISCUSSION

Incubation period:

Statistical analysis of obtained data in Table (1) and illustrated in Figure. (1) indicated that the mean duration of egg stage differed according to the generation and the state of the insect (healthy or infected with virus). However, in case of the first insect generation the incubation period of infested insect was 3.2 days in comparison with healthy once (3.6 days). On the other hand and in the case of the second generation the increasing of incubation period of insect was noticed in case of infected insect (3.6 days) longer than the healthy insect (3.4 days), Fig. (2). The same Table also, indicated that the third generation had the same trend of the first once, where the infected taken period was slightly increased (3.0 days) than normal case (2.8 days), Fig. (3). The statistical analysis of showed data denoted that there was in significant differences between the different incubation period replicates in case of insect state (healthy and infected) and the number of insect generation the first , the second and third generation) (L.S. D. at 0.05 level = 0.802 for insect state and 0.9826 for the insect generation, Table (2).

Life cycle:

The influence of virus infection to whitefly on the life cycle can be summarized in Table (1) and graphically illustrated in Figs. (1, 2 and 3), which revealed that the mean duration period of this period was slightly differed between the health insect and infected one. The period lasted 15.6 days in case of infected insects and 15.0 days in case of healthy insects in case of the generation number one. However, in case of second generation, there was low significant difference between the infected insect and free one. The life cycle time in the 2nd generation took 14.0 days in absence of virus, but when the virus infested the insect, this period changed to 15.8 days. On the other hand and in case of the insect generation number three the difference between the infected and healthy insect was obviously observed, 15.2 and 13.8 days for infected and healthy insects, respectively. Statistical analysis revealed that virus infection to whitefly longed with non-significantly differenced between the different generations and insect case (L.S. D. at 0.05 level = 1.695 for the different insect generations and 2.0776 for the insect case, Table (2).

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Longevity:

In general and as shown in Table (1) and graphically illustrated in Figs. (1, 2 and 3), the adult females took long periods in their life period than those of insect males. However, the infection of virus to the whitefly insect was affected significantly in case of adult females only, but this effect not observed in case of whitefly adult males. The longevity period in case of infected male first generation was 8.0 days in comparison with 7.6 days in case of healthy insects. The same trend was clearly observed in case of the second and 3rd generations, 7.8 and 6.4 & 8.22 and 8.2 days, respectively, Table (1). The insect females durated 14.6, 11.2; 16.6, 12.6 and 15.8 and 11.4 days in case of infected and healthy insects for 1st, 2nd and 3rd insect generations, respectively. Statistical analysis of obtained data in this study indicated that there was no any significant differences between the healthy and infected insects and also between the different insect generations of male individuals, L.S. D. at 0.05 level = 1.348 for generations and = 1.651 for insect state. While in case of adult insect female longevity the obtained data showed very highly significant differences between the different insect female generations and absence of significance manners between the different insect states (L. S. D. at 0.05 = 2.0776 for generations and 2.5445 for insects states, Table (2). Similar results were observed,by Lin *et al.,* (1997)who reared the silver leaf *B.argentifolii* on poinsettia under various constant temperatures. The highest survival probability from egg to adult was observed at 25 degrees C (94.5 %) and 28 ºC (94.3%). The developmental period decreased as temperature increased from 20 to 28 ºC. The low temperature thresholds for the development of the egg and 1st, 2nd , 3rd and 4th instar nymphs were 12.7, 14.8, 10.4, 3.8 and 17 ºC, respectively. The highest fecundity (193.2 eggs/female) and longevity (21.4 days) were observed at 28 ºC. A report by Costa *et al.,* (1991) demonstrated that whitefly maintained on pumpkin for ≈ 6 years had a higher rate of survival on virus-infected pumpkin compared to healthy pumpkin out of six virus-plant hosts evaluated, including tomato. Also, McKenzie *et al*., (2002) found healthy plants infested with ToMoV-infected whiteflies consistently had 2.5-fold more eggs and 4.5 fold more nymphs than plants with nonviruliferoud whiteflies 56 days after infestation with the same number of whitefly. Also, the same authors noticed that whiteflies carrying ToMoV deposited significantly more eggs than nonviruliferous whiteflies when provided a healthy tomato host. Simmons *et al.* (2008) recently found the Sweet Potato Leaf Curl Virus (SPLCV) in South Carolina and since conducted studies on the role of *B. tabaci* as a vector for this virus.

Fig. (1) : Effect of virus infection on whitefly biological aspects in the first generation

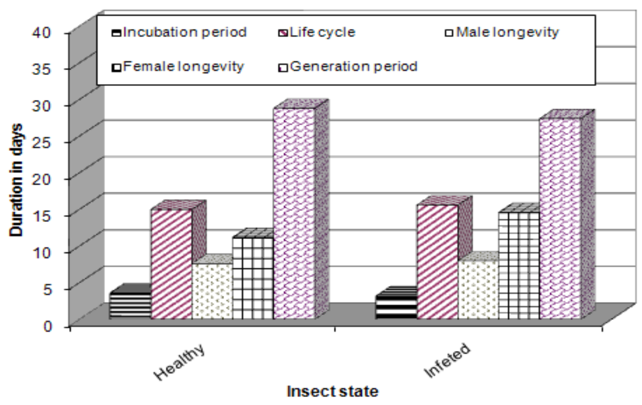

Fig. (2) : The effect of virus infection on whitefly biological aspects in the second generation

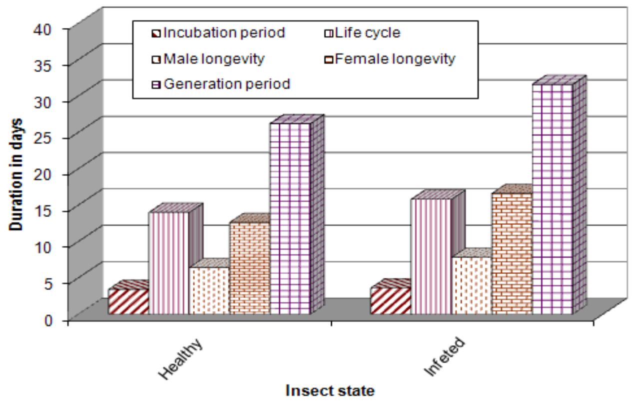

Fig. (3) : Effect of virus infection on the whitefly biological aspects (third generation

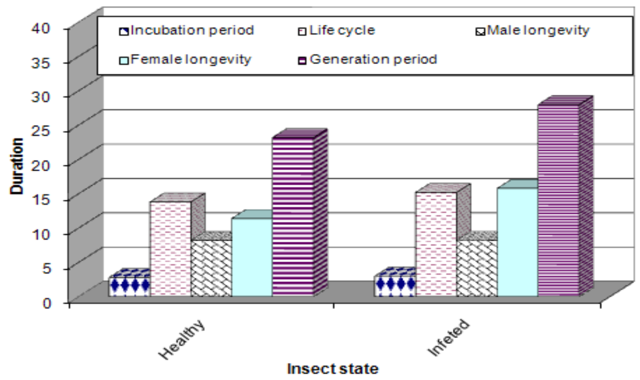

Table (2): Biological aspects of the silver whitefly *Bemisia argentifolii* for the insect three generations

Biological aspect	Mean	S.D.	Minimum	Maximum	L.S.D. at 0.05	
					Insect state	Generation
Incubation period	**3.27**	**1.02**	**2**	**5**	**0.802 n.s.**	**0.9826 n.s**
1st larval stage	1.57	0.50	1	2	0.401 n.s	0.4913 n.s
2nd larval stage	2.57	0.73	1	4	0.567 n.s	0.6948 n.s
3rd larval stage	2.53	0.51	2	3	0.401 n.s	0.491 n.s
4th larval stage	4.87	1.11	2	6	0.841 n.s	0.997 n.s
Life cycle	14.9	2.19	11	18	1.695 n.s	2.0776 n.s
Generation period	27.53	4.78	20	38	3.320 n.s.	4.071 n.s
Male longevity	7.7	1.74	5	10	1.3481 n.s.	1.6511 n.s
Female longevity	13.7	3.29	6	19	2.0776 ***	2.5445 n.s.

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دراسة الصفات البيولوجية للذبابة البيضاء *Bemisia argentifolii*(Bellws and Perring) عند الاصابةبفيروس تجعد والتفاف اوراق الكوسة SLCV

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اجريت هذه الدراسة لتقدير تأثير الاصابة بالفيروس على المظاهر البيولوجية للذبابة البيضاء *Bemisia argentifolii* (Bellows and Perring) النوع B عند ظروف المعمل من ٢٢ – ٢٧ درجة مؤية ورطوبة نسبية مقدارها من ٤٠ – ٦٠ % وذلك عند ثلاث اجيال للحشرة. ومن الدراسة لوحظ ان الحشرة تاثرت بشكل طفيف عند اصابتها بالفيروس مقارنة بالحشرات السليمة والتى لم تتعرض للاصابة. واتضح من الدراسة ان فترة وضع البيض للحشرة لم تتاثر عند اصابة الحشرة بالفيروس واستغرقت فترة من ٢ – ٥ ايام للحشرة وذلك فى الاجيال الثلاثة المختلفة للحشرة. ايضا ثبت من الدراسة ان فترة دورة الحياة Life cycle لكل من الذكور والاناث لم تتأثر بشكل معنوى عند اصابة الحشرة بالفيروس مقارنة بالحشرات السليمة حيث استغرقت اقل فترة لها ١١ يوما للحشرات السليمة فى الجيل الثالث مقارنة باعلى قيمة ١٨ يوما فى نفس الجيل. ومن الدراسة اتضح ايضا ان فترة حياة الافراد البالغة Longevity للاناث هى الوحيدة التى قد تأثرت بوجود الفيروس مع الحشرة حيث كان هذا التاثير واضح ومعنوى ولكن فى حالة الافراد الذكور لم يلاحظ وجود هذا التاثير سواء اكانت الحشرة سليمة او مصابة وكانت اقل فترة مسجلة لهذه المدة هى ٨ ايام فى حالة الافراد الذكور السليمة فى الجيل الثالث للحشرة وسجلت اعلى قيمة لها للافراد الاناث المصابة بالفيروس حوالى ١٩ يوما.

Table (1): Effect of SLCV virus infection on the biological aspects of the whitefly *Bemisia tabaci*.

Generations	Insect state	Biological aspect (Mean ± S.D.) in days								
		Egg	1st larval stage	2nd larval stage	3rd larval stage	4th larval stage	Life cycle	Male longevity	Female longevity	Generation period
1st	Healthy	3.6±1.14 (2-5)	1.6 ±0.5 (1-2)	3.0±0.71 (2-4)	2.4±0.55 (2-3)	4.4±1.14 (3-6)	15.0±2.6 (12-18)	7.6±2.07 (5-10)	11.2±3.4 (6-15)	28.8±7.3 (21-38)
	Infected	3.2±1.3 (2-5)	1.4±0.55 (1-2)	2.6±0.89 (2-4)	2.8±0.45 (2-3)	5.2±0.84 (4-6)	15.6±2.1 (13-18)	8.0±1.87 (5-10)	14.6±3.2 (11-19)	27.4±4.2 (23-33)
2nd	Healthy	3.4±1.14 (2-5)	1.6±0.55 (1-2)	2.6±0.55 (2-3)	2.4±0.55 (2-3)	4.0±1.58 (2-6)	14.0±3.3 (11-18)	6.4±1.52 (5-9)	12.6±1.5 (11-15)	26.2±4.6 (22-32)
	Infected	3.6±1.14 (2-5)	1.6±0.55 1-2)	2.6±0.89 (2-4)	2.6±0.55 (2-3)	5.4±0.89 (4-6)	15.8±0.8 (15-17)	7.8±1.78 (6-10)	16.6±2.1 (9-14)	31.6±2.1 (29-43)
3rd	Healthy	2.8±0.83 (2-4)	1.4±0.55 (1-2)	2.2±0.84 (1-3)	2.4±0.55 (2-3)	5.0±1.0 (4-6)	13.8±2.7 (11-18)	8.2±1.3 (7-10)	11.4±2.1 (9-14)	23.2±2.6 (20-27)
	Infected	3.0±0.71 (2-4)	1.8±0.45 (1-2)	2.4±0.54 (2-3)	2.6±0.55 (2-3)	5.2±0.83 (4-6)	15.2±0.8 (14-16)	8.22±2.0 (6-10)	15.8±3.6 (10-19)	28.0±3.8 (23-33)