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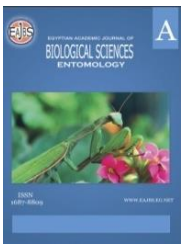

Influence of Five Host Plants on Development and Life Table Parameters of *Aphis gossypii* Glover (Hemiptera: Aphididae)

Ali I. Farag; Saadiya M. Said; Ahmed M. Abd El- Raheem; Nehal O. Swalem and Omayma l. Ataa,
Economic Entomology and Agriculture Zoology Department, Faculty of Agriculture Menoufia University.
***E-mail:** omaymaibrahim97@gmail.com

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ABSTRACT

Aphis gossypii Glover (Hemiptera: Aphididae), is a significant piercing-sucking pest that feeds on many kinds of plants. The aim of this study is to investigate the biology, reproduction and life table parameters of *A. gossypii* on five different host plants: eggplant, okra, pepper, sowthistle and tomato at 25°C and 60% RH., to study the effects of host species. The results revealed that the shortest preadult stage of *A. gossypii* was 4.75 days on pepper. Both the maximum reproduction and the reproductive period of *A. gossypii* on pepper (12.0 days) and eggplant (11. days) were significantly longer than those on the other three hosts. The cotton aphid had the maximum fertility on pepper (62.60 nymphs per female), followed by eggplant (55.20 nymphs per female), which was likewise higher than on tomato, okra, and sowthistle. As shown by the higher intrinsic rate of increase and net reproductive rate, pepper and eggplant were found to be more favorable plants for the growth of *A. gossypii*, showing a shorter preadult stage, longer lifespan, and better fecundity than the other three species. The intrinsic rate of increase (r_m = 0.480 ♀/♀/day), the net reproduction rate (R_0 = 62.6 offspring/ indv.), and the Gross reproduction rate (*GRR*) (71.7 /♀) values were higher on the pepper plants.

INTRODUCTION

Horticultural production especially vegetables play a very important role in global food security. They constitute an important item of Egyptian food, supplying vitamins, carbohydrates, minerals, fats, proteins, calcium and potassium (Kahlon *et al.* 2007 and Saifullah & Rabbani, 2009). Because of their economic worth, growing vegetables has become increasingly important every year. Egyptian farmers prefer to cultivate such crops which represent one of the main sources of their income. Among vegetables, Eggplant, *Solanum melongena* L.; Pepper *Capsicun annuun* L.; Tomato, *Lycopersicum esculentum* Mill, (Solanaceae) and okra, *Abelmoschus esculentus* L. (Malvaceae) are of the most favorite vegetable crops for their high quality of nutrients.

The cotton aphid, *Aphis gossypii* Glover (Hemiptera: Aphididae), is a significant piercing-sucking pest that feeds on many kinds of plants (Margaritopoulos *et al.*, 2006). Vegetables in fields and greenhouses are the primary targets of Aphis gossypii attacks

(Baniameri and Nasrollahi 2003 and Isikber, 2005). A decrease in fruit quality and productivity from direct feeding and the formation of honeydew are among the damages, along with harm from the spread of more than 50 plant viruses (Roistacher *et al*., 1984 and Blackman and Eastop, 2000).

For analyzing and understanding how host plants and outside factors impact the growth, survival, reproduction, and intrinsic rate of expansion of insect populations, the life table is a useful and crucial tool (Chi and Su, 2006). Population ecology study requires a life table analysis, which provides important population growth metrics and a detailed description of a population's survivability, development, stage differentiation, and reproduction (Yousaf *et al.* 2018). Computer simulations can be used to project the population using a life table (Abou-setta *et al.*, 1986).

Thus, the study aims to determine the biology, reproduction and life table parameters of *Aphis gossypii* on five different host plants and the study effects of host species. The results of this study could help develop future pest control strategies for aphid species and improve our understanding of the survival, reproduction, development, and potential of aphids feeding on these significant vegetables.

MATERIALS AND METHODS

Host Plant Used:

Five host plants Eggplant, *Solanum melongena* L.; and Tomato. *Lycopersicum esculentum* Mill, Pepper *Capsicun annuun* L. (Solanaceae), okra (*Abelmoschus esculentus* L.) and sowthistle, *Sonchus oleraceus* L. (Asteraceae).

Biological Aspects of *Aphis gossypii*:

This experiment was performed at the graduate laboratory, Department of Entomology, Faculty of Agriculture, Menoufia University. The cultivation was carried out in plastic plates particularly constructed for the experiment at a temperature of 25 degrees Celsius and 60% humidity, with duplicates of each plant host. Laboratory colonies of *A. gossypii* were started with field-collected aphids from okra plants. Colonies were maintained on okra seedlings under laboratory conditions. Every 15 days aphids from healthy colonies were transferred from infested plants to young clean plants to maintain the colony.

Throughout the experiment, the seeds were cultivated in a greenhouse environment after being sown in plastic pots. Ten plastic pots with a diameter of 10 cm were used for every type of plant. The soil in the containers was a 2:1 mixture of sand substrate and peat moss.

Lifetable Parameters of *Aphis gossypii*:

More than a hundred adult *A. gossypii* were placed on okra leaves for the life table investigation. Newly born nymphs were individually placed on the leaf discs (2 cm in diameter) of each of the five host plants after 12 hours. The leaf disc was positioned inverted on a sponge pad soaked in water within a plastic dish measuring 10 cm in diameter and 1.5 cm in height. To create a water fence, a piece of filter paper with a hole in the middle measuring two centimeters was placed on top of the leaf disk. Every twelve hours, until all the aphids were dead, the molting and reproduction of *A. gossypii* were watched and documented. Every study was conducted at 25% RH and 25°C in climatic incubators. Daily observations were made until every adult died. Aphids that had just emerged were counted every day and moved to new Petri plates. Every four days, leaves were replaced in Petri dishes.

Lifetable parameters were calculated using nymphs and adults of Aphid survival rates. Age-specific survival rate (l_X) and age-specific fecundity (m_X) for each age interval

(x) were used to construct a lifetable based on the females reared on five host plants according to Birch (1948) and calculated using a BASIC computer program by Abou-Setta *et al.* (1986). Whereas: the net reproductive increase ($R0$) = $\Sigma\, l_x m_x$; the mean generation time (T) = $\ln R0/r_m$; the intrinsic rate of increase (r_m) = $\ln R0/T$; the doubling time (DT) = $\ln 2/r_m$; $GRR = \Sigma\, m_x$.

Statistical Analysis:

One-way ANOVA was used to assess the effects of prey species on developmental time, fecundity, and duration of adult female reproductive phases. Tukey's multiple comparison difference was then used to perform a mean comparison. $P > 0.05$ was the level of significance. The SAS software was used for the analysis (2003).

RESULTS AND DISCUSSION

The duration periods of different instars and stages when *A. gossypii* reared on five different host plants: eggplant, okra, pepper, sowthistle and tomato at 25°C and 60% RH Tables (1 &2).

Development period and survival rate:

The developmental times for the immature stages of cotton aphids at 25°C and 60% RH are presented in **Table (1).** The data exhibit that the time needed for the development of nymphal instars differs significantly with the host plant (P <0.05). For the first, second, third, and fourth nymphal instars to feed on pepper leaves, the shortest developmental times were 1.25, 1.2, 1.1, and 1.2 days. On tomato leaves, however, the longest durations were 1.80, 1.70, 1.50, and 1.60 days. According to statistical data, tomato plants had the longest period (6.60 days) and pepper plants had the greatest time (4.75 days) for the nymphal stage to fully mature.

In general, in each instar, the developmental times of *A. gossypii* were the shortest on pepper plants and longest on tomato plants.

Adult Longevity and Reproduction:

Pre-reproductive, reproductive, and post-reproductive ages of adult longevity for each host were separated. Results obtained for the effect of five host plants on the durations of the cotton aphid, *A. gossypii* adult are summarized in Table (1), the length of the adult stage was significantly influenced by the host plant, according to statistical analysis of the data: pre-parturition, parturition, post parturition and longevity periods. On pepper, the adult stages had the longest durations, being 1.15, 12.0, 1.25, and 14.40 days, respectively. On the other hand, the shortest duration occurred on okra, being 1.80, 9.60, 1.40, and 12.80 days, respectively.

Also, data indicated that the host plant affected both *A. gossypii* longevity and fecundity significantly as shown in Table (1). The highest recorded average nymph production (number of offspring per female) for *A. gossypii* was 62.60 nymphs on pepper, while the lowest recorded rates were 34.20 nymphs per female on okra leaves. According to comparable findings by Molla Shahi and Tahmasebi (2009), the cucumber's shortest preadult development stage lasted 4.98 days. Doryanizadeh *et al.* (2016) found that cucumber genotypes had an impact on preadult length. Girtap had the highest preadult duration (5.20 days), while Pouya had the shortest (4.32 days). The population of aphids was shown to rise with decreasing temperature, according to Shakeel *et al.* (2015); the lowest population was observed on tomatoes at 32.5°C, while the largest population was identified at 27.5°C. Hong *et al.* (2019) reported that the green peach aphid, *Myzus persicae* Sulzer was reared on five host plants: faba bean, pepper, radish, rapeseed, and tobacco. Faba bean, radish and tobacco constituted more suitable host plants for *M. persicae* and were associated with a shorter preadult stage and highest fecundity rapeseed.

Moreover, the intrinsic rate *r* of the aphids was also significantly higher on faba bean. Ali *et al.*, (2021) evaluate the life history traits of *M. persicae*, feeding on five different host plants, cabbage, Chinese cabbage, chili pepper, crown daisy and eggplant. The highest fecundity (69.65 individuals), the intrinsic rate of increase (r = 0.425 ♀/♀/day), net reproductive rate (R_0 = 69.65 offspring/female), and shortest mean generation time (T = 9.964 days) were recorded on the chili pepper plant. While lower fitness occurred in cabbage.

Table 1: Mean developmental period and longevity in days (± SD) of *Aphis gossypii* reared on different host plants at 25°C and 60% RH.

Life stages	Pepper	Eggplant	Sowthistle	Tomato	Okra	F-value	LSD 0.05
First instar nymph	1.25±0.26 c	1.40±0.21 c	1.60±0.21 b	1.80±0.25 a	1.60±0.38 b	12.34	0.16
Second instar nymph	1.20±0.25 c	1.40±0.21 bc	1.50±0.32 ab	1.70±0.41 a	1.50±0.46 ab	5.60	0.21
Third instar nymph	1.10±0.21 d	1.20±0.25 cd	1.40±0.21 ab	1.50±0.32 a	1.30±0.25 bc	7.92	0.15
Forth instar nymph	1.20±0.25 c	1.30±0.25 bc	1.40±0.38 abc	1.60±0.38 a	1.50±0.32 ab	4.75	0.20
Pre-adult	4.75±0.53 d	5.30±0.41 c	5.90±0.38 b	6.60±0.38 a	5.90±0.68 b	40.48	0.30
Pre-reproductive	1.15±0.24 c	1.30±0.25 c	1.60±0.38 b	1.80±0.25 a	1.80±0.25 a	22.19	0.17
Reproductive	12.00±1.45 a	11.20±1.20 b	10.60±0.82 b	11.00±0.92 b	9.60±1.05 c	12.56	0.69
Post-reproductive	1.25±0.26 b	1.40±0.38 ab	1.60±0.39 a	1.41±0.38 ab	1.40±0.35 ab	2.37	0.22
Adult longevity	14.40±1.47 a	13.90±1.35 a	13.80±0.95 a	14.20±0.83 a	12.80±1.06 b	5.68	0.72
Fecundity (offspring/♀)	62.60±7.27 a	55.20±5.60 b	47.40±3.15 c	42.00±4.10 d	34.20±3.58 e	99.24	3.12
Mean offspring /day	5.23±0.40 a	4.93±0.13 b	4.48±0.10 c	3.83±0.36 d	3.61±0.55 e	78.60	0.22
Life span	19.15±1.61 bc	19.20±1.40 bc	19.70±1.06 b	20.80±0.83 a	18.70±1.20 c	8.27	0.78

Means (± SD) followed by the same letters in the same row are not significantly different by Student LSD test ($P < 0.05$).

Lifetable Parameters of *A. gossypii*:

Lifetable parameters of *A. gossypii* on five host plants are presented in Table (2). The lifetable parameters *T*, r_m, λ, and *R0* differed between the five host plants. The shortest mean generation time (*T*) on pepper was 8.60 days, and the longest on tomato was 10.75. The highest intrinsic rate of increase (rm) value was 0.480♀/♀/day on pepper, while the lowest one was 0.345♀/♀/day on tomato plants. The highest net reproductive rate (*R0*) value was 62.6♀/♀ on *pepper*. The gross reproductive rate (*GRR*) increased from 37.7 on okra to 71.7 offspring/ individuals on pepper. The shortest doubling time (*DT*) was 1.44 days on pepper, and the longest on tomato was 2.01 days.

The age survival rate of *A. gossypii* reared on various host plants. Age-specific survival rate (l_X) and age-specific fecundity (m_X) curves *A. gossypii* are illustrated in (Fig. 1). Pepper had the highest daily age-specific survival rate. The highest amount of offspring generated (6.3 nymph/♀/day) when fed pepper, and the lowest amount (4.02/♀/day) when fed okra. When fed pepper and eggplant, the females' survival rate was 100%, however when fed okra, it was only 0.95%.

Table 2: Life table parameters of *Aphis gossypii* reared on different host plants at 25°C and 60% RH.

Parameters	Pepper	Eggplant	Sowthistle	Tomato	Okra
Pre-adult survival rate %	100.0	100.0	100.0	98.0	95.0
Mean generation time (T) [a]	8.60	9.08	9.68	10.75	9.46
Doubling time (DT) [a]	1.44	1.57	1.70	2.01	1.89
Net reproductive rate (R_o) [b]	62.6	55.2	51.7	41.16	32.49
Intrinsic rate of increase (r_m) [c]	0.480	0.441	0.407	0.345	0.367
Gross reproduction rate (GRR) [b]	71.7	62.1	57.4	45.0	37.7

[a]Days, [b]♀/♀,[c]♀/♀/day, [d] offspring/individual, $R_0 = \Sigma(lx \times m_x)$; $T = \Sigma(x \times l_x \times m_x) / \Sigma(l_x \times m_x)$; $r_m = Ln(R_0)/T$; $DT = Ln(2)/ r_m$, $\lambda = \exp(r_m)$ and GRR= Σmx.

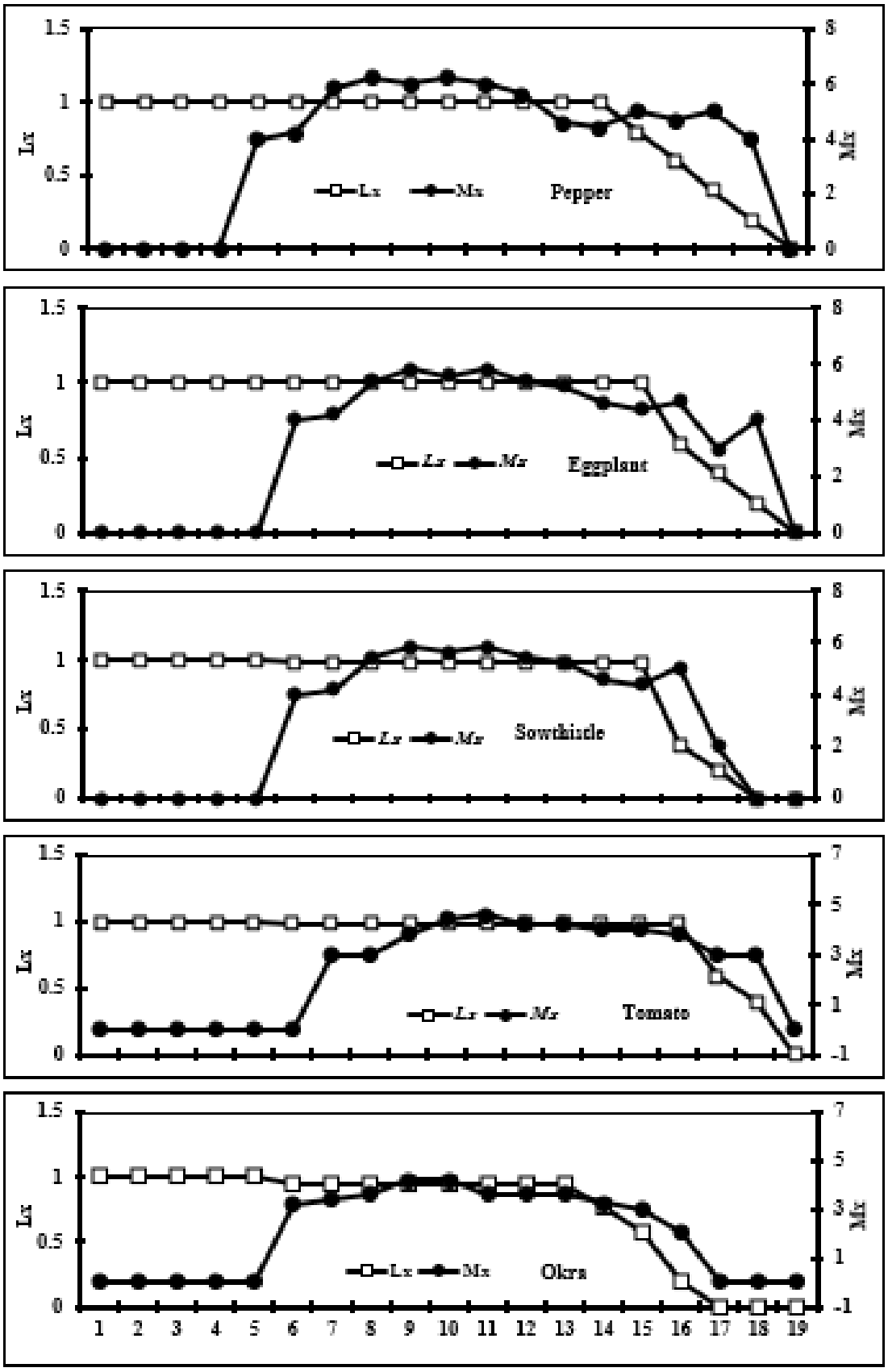

Fig.1: Age specific survivorship (Lx) and age specific fecundity (Mx) for Aphis gossypii reared on different host plants at 25°C and 60% RH

These results accordance with the findings by According to Satar *et al.* (2005), the immature stages of *A. gossypii* had developmental times ranging from 10.8 days at 15°C to 4.1 days at 30°C and 32.5°C in a laboratory setting. In the laboratory, the R0 was likewise noticeably greater. Melon flies reared in a lab at 25°C showed a similar outcome, with a greater net reproduction rate in the field (Huang and Chi 2013). Hosseini-Tabesh *et al.* (2015) showed that the intrinsic rate of increase (*r*), net reproductive rate (*R*0), the finite rate of increase were 0.271 and 17.87 when *A. gossypii* fed on *Hibiscus syriacus* L., and the men generation time was 10.61 days and gross reproductive rate was 22.81 nymphs/ female. Doryanizadeh *et al.* (2016) showed that the lowest net reproduction rate (R0) was 43.70 on the cucumber "Bushehr," cultivar, whereas for "Pouya," it was 92.39 nymphs per individual. In "Gilan," the intrinsic rate of increase was found to be the lowest at 0.378 and the finite rate of increase (λ) to be 1.460 day-1; in "Pouya," the greatest values were found at 0.471 and 1.602 day-1, respectively. According to *A. gossypii* life table parameters, populations were impacted by Cucumis cultivars, as demonstrated by Akköprü (2018). In comparison to other cultivars, the Bt Balıkesir cultivar had a greate intrinsic rate of rise (0.4214 day-1), finite rate of increase (1.5242 day-1), and net reproductive rate (51.80 offspring) of the pest, although the mean generation time increase was lower (9.36 days).

Declarations:

Ethical Approval: Ethical Approval is not applicable.

Competing interests: The authors declare no conflict of interest.

Funding: No funding was received.

Availability of Data and Materials: All datasets analysed and described during the present study are available from the corresponding author upon reasonable request.

Acknowledgments: Not applicable

REFERENCES

Abou-Setta, M.M., Sorrell, R.W. and Childers, C.C. (1986). Life 48: A basic computer program to calculate life table parameters for an insect or mite species. *Florida Entomologist*, 69(4): 690–697.

Akköprü, E.P. (2018). The effect of some cucumber cultivars on the biology of *Aphis gossypii* Glover (Hemiptera: Aphididae). *Phytoparasitica*, 46(2): 1-10.

Ali, M.Y.; Naseem, T.; Arshad, M.; Ashraf, I.; Rizwan, M.; Tahir, M.; Rizwan, M.; Sayed, S.; Ullah, M.I.; Khan, R.R.; Amir, M.; Pan, M. and Liu, T.X. (2021). Host-Plant Variations Affect the Biotic Potential, Survival, and Population Projection of *Myzus persicae* (Hemiptera: Aphididae). *Insects*, 12, 375.

Baniameri, V. and Nasrollahi, A.A. (2003). Status of IPM program in greenhouse vegetables in Iran. *IOBC/WPRS Bulletin, Additional Abstracts/Papers*, 26 (10): 1-3.

Birch, L.C. (1948) The intrinsic rate of natural increase of an insect population. *Journal of Animal Ecology*, 17: 15–26.

Blackman R.L. and Eastop V.F. (2000). Aphids on the worlds crops: an identification and information guide, 2nd ed. Wiley, London, UK, 414 pp.

Chi, H., and Su, H.Y. (2006). Age-stage, two-sex life tables of *Aphidius gifuensis* (Ashmead) (Hymenoptera: Braconidae) and its host *Myzus persicae* (Sulzer) (Homoptera: Aphididae) with mathematical proof of the relationship between female fecundity and the net reproductive rate. *Environmental Entomology*, 35: 10–21.

Doryanizadeh, N., Moharramipour, S., Hosseininaveh, V., and Mehrabad, M. (2016).

Effect of eight Cucumis genotypes on life table and population growth parameters of melon aphid: An approach to assess antibiosis resistance. *Journal of Agricultural Science and Technology,* 18, 1819–1832.

Hong, F.; Han, H.-L.; Pu, P.; Wei, D.; Wang, J.; Liu, Y.; Kumar, S. (2019). Effects of five host plant species on the life history and population growth parameters of *Myzus persicae* (Hemiptera: Aphididae). *Journal of Insect Science,* 19(5): 1–8.

Hosseini-Tabesh, B.; Sahragard, A.; Karimi-Malati, A.A. (2015). Laboratory and field condition comparison of life table parameters of *Aphis gossypii* Glover (Hemiptera: Aphididae). The Journal of Plant Protection Research (JPPR). 2015, *55*, 1–7.

Huang Y.B. and Chi H. (2013). Life tables of *Bactrocera cucurbitae* (Diptera: Tephritidae): with an invalidation of the jackknife technique. *Journal of Applied Entomology*, 137 (5): 327–339.

Isikber, A.A. (2005). Functional response of two coccinellid predators, *Scymnus levaillanti* and *Cycloneda sanguinea*, to the cotton aphid, *Aphis gossypii*. *Turkish Journal of Agriculture Forestry*, 29: 347–355.

Kahlon, T.S.; Chapman, M.H. and Smith, G.E. (2007). In vitro binding of bile acids by okra beets asparagus eggplant turnips green beans, carrots and cauliflower. *Food Chemistry,* 104: 676-680.

Margaritopoulos, J.T.; Zortzi M.Z.; Arpas, K.D.; Sitsipis, J.A. and Blackman, R.L. (2006). Morphological discrimination of *Aphis gossypii* (Hemiptera: Aphididae) populations feeding on Compositae. *Bulletin of Entomological Research*, 96: 153-165.

MollaShahi, M., and Tahmasebi, A. (2009). Demographic parameters of *Aphis gossypii* glover (Homoptera: Aphididae) on greenhouse cucumber under laboratory conditions. *Journal of Agricultural Sciences and Natural Resources,* 16(3), 100–109.

Roistacher C.N., Bar-Joseph M. and Gumpf D.J. (1984). Transmission of tristeza and seedling yellows tristeza virus by small populations of Aphis gossypii. *Plant Disease,* 68 (6): 494–496.

Saifullah M. and M.G. Rabbani (2009). Evaluation and characterization of okra (*Abelmoschus esculentus* L. Moench.) genotypes. *SAARC Journal of Agriculture,* 7: 92-99.

SAS Institute (2003) SAS Statistics and graphics guide, release 9.1.3. SAS Institute, Cary, North Carolina, 27513, USA.

Satar S., Kersting U., and Uygun N. (2005). Effect of temperature on development and fecundity of *Aphis gossypii* Glover (Homoptera: Aphididae) on cucumber. *Journal of Pest Science,* 78 (3): 133–137.

Shakeel, M.; Akram, W.; Hamza, A.; Ali, M. A. and Ali, A. (2015). Population dynamics of aphid (*Aphis gossypii* G.) on tomato agro-ecosystem in Faisalabad Region. *International Journal* of *Agricultural Science* Research, 1(3): 2348-3997.

Yousaf, H. K.; Shan, T.; Chen, X.; Ma, K.; Shi, X.; Desneux, N.; Biondi, A. and Gao, X. (2018). Impact of the secondary plant metabolite Cucurbitacin B on the demographical traits of the melon aphid, *Aphis gossypii*. *Scientific Reports.* 8: 16473.

ARABIC SUMMARY

تأثير خمسة عوائل نباتية على التطور ومقاييس جدول الحياة لحشرة من القطن

علي إبراهيم فرج، سعدية محمد سعيد، أحمد محمد عبد الرحيم، نهال أمية سويلم، أميمة إبراهيم عطا
قسم الحشرات الاقتصادية والحيوان الزراعي كلية الزراعة جامعة المنوفية

منّ القطن، *Aphis gossypii* Glover، هو آفة ثاقبة ماصة هامة تهاجم مجموعة واسعة من العوائل النباتية. تهدف هذه الدراسة إلى تحديد الخصائص البيولوجية والتكاثرية وجدول الحياة لمن القطن على خمسة عوائل نباتية مختلفة: الباذنجان، البامية، الفلفل، الجعضيض والطماطم عند درجة حرارة 25 درجة مئوية و60% رطوبة نسبية، لدراسة حساسية العوائل للاصابة بالمن. أظهرت النتائج أن أقصر فترة ما قبل البلوغ وفترة ما قبل التكاثرلحشرة المن كانت 4.75 و1.15 يوم على الفلفل، على التوالي. كان أعلى تكاثر لـ *A. gossypii* على الفلفل (12.0 يومًا) والباذنجان (11. يومًا) أطول بكثير من ذلك على العوائل الثلاثة الأخرى، كما كانت فترة التكاثر. سجلت أعلى خصوبة لـ *A. gossypii* على الفلفل (62.60 حورية لكل أنثى)، يليه الباذنجان (55.20 حورية لكل أنثى) كانت أيضًا أكبر من تلك الموجودة على نبات الجعضيض، والطماطم، والبامية. وقد ثبت أن الفلفل والباذنجان أكثر النباتات تفضيلا فنمو *A. gossypii* يظهر في مرحلة ما قبل البلوغ أقصر، وطول عمر أطول، وخصوبة أكبر من الأنواع الثلاثة المتبقية، كان المعدل الجوهري للزيادة (r_m = 0.480 ♀/♀/ يوم)، وكان معدل التكاثر الصافي (R0 = 62.6 حورية لكل أنثي)، ومعدل التكاثر الإجمالي 71.7 أنثي لكل أنثي أعلى في نباتات الفلفل.