EFFECT OF HOST PLANT ON DEVELOPMENT AND FECUNDITY OF *APHIS GOSSYPII* GLOVER (HEMIPTERA: APHIDIDAE)

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ABSTRACT: *Aphis gossypii* is considered as important and polyphagous species on many host plant all over the world. During the study, some biological aspect of this insect pest was evaluated under constant condition (T= 26 ± 1 ºC, RH% = 60 ± 5, L:D = 16:8) on three detached cucumber and potato leaves in the laboratory of Seed and Plant Certification and Registration Institute Karaj, Iran. On cucumber (Mega-Sahra variety) the results showed that developmental period of immature stage was 4.75 and life cycle was assigned 9.90 days. Also, reproductive period with adult longevity were accounted 4.05 and 5.05 days. Net reproduction rate (R_o) and r_m (innate rate of increase) were estimated 60.40 and 0.481 at this temperature. Cotton aphid could not rear on potato varieties; Agria and Sante. Apparently, cucumber is better host than potato for studying developmental stages.

KEY WORDS: *Aphis gossypii*, potato, cucumber, fecundity, developmental time

Aphis gossypii Glover (Hemiptera: Aphididae) has been spread in different parts of Iran on Malvaceae, Solanaceae and Cucurbitaceae family (Khanjani, 2005; Forghani et al., 2018, 2009) fruit trees and citrus orchards (Gholamian et al., 2018) also, many other plants in worldwide as cosmopolitan aphid (van Emden & Harrington, 2007). The mentioned aphid showed considerable damages on vegetables and ornamentals in fields and green-house (Leaclant & Deguine, 1994) with a great deal of viral diseases in very large range of plants (Chan et al., 1991). These insects causing direct loss by sucking sap in the first attack (Takallozadeh, 2010) and may have negative role by transmitting viruses to plants principally (Fontes et al., 2006). In this pest, depend on temperature and host plant was clarified various development and fecundity related to geographical regions (Komazaki, 1982; Akey & Butler, 1989; Aldyhim & Khalil, 1993; Satar et al., 1998). Population parameters are mentioned as species growth capacity that use as bioclimatic indices in assessing of potential pest population growth (Southwood and Henderson, 2000) that have been showed different capacity in numerous pests (Gotoh, 1987; Bonato et al., 1995; Honarparvar et al., 2012). It is famous to say that fertility life table parameters are valuable data may use for dynamic population and estimating population growth in animals (Maia et al., 2000). Information fecundity and the other developmental time are considered precious findings which as some demographic parameters (Carey, 1993, 2001). In this regards, development cycle and reproductive parameters of *A. gossypii* may show various results with the host plant also, make changes in behavior and affecting fertility or other biology variable (Metcalf & Luckmann, 1994). Thus, the

information life table parameters for *A. gossypii* on some host plants in a region may use to considering in crop management strategy (Akey & Bulter, 1989).

This research was aimed to provide information on developmental rate and fecundity of cotton aphid on potato with cucumber to evaluate host conditions for developmental times. Thus, two important potato varieties Agria and Sante with one of the most important cucumber Mega-Sahra were selected into the experiments.

MATERIAL AND METHODS

Rearing of cotton-aphid

Aphis gossypii were collected from green-house cucumber of Seed and plant Certification and Registration Institute Karaj, Iran. Aphids were reared in lab condition (T=26± 1 °C, Rh%= 60±5, L:D= 16:8) into the growth chamber. After few generations some females were selected for rearing in Petri-dish (Kindlmann & Dixon, 1989; Satar et al., 2005).

Experimental performance

The experiments were carried out on leaf-discs of potato and cucumber in Petri-dish (10cm in diameter) with 20 replications. Each Petri-dish was contained an upside-down leaf disc with cotton wool and solution of water agar (1%) with one newly hatched nymph. Around each 3 days, leaf discs and cotton wools with solution water agar were renewed moreover, observations and recording data was conducted daily.

Analysis of data

Developmental time, fecundity and longevity were compared using proc GLM and means (*ls* means) procedures (SAS, 2002). If the model was significant then, means comparison were made using the Tukey test ($p<0.05$). Since all data are whole number standard deviation may be proportional to the mean and their effects might be multiplicative, so they were logarithmically, transformed (Gomes & Gomes, 1983). Life table data were analyzed based on the age-stage, two-sex life table theories (Chi & Liu, 1985; Chi, 1988) using the TWOSEX – MS chart program. Population parameters were evaluated (the means and standard errors) using the Bootstrap method. Age specific survival rate (S_{xj}) (where x is the age and j is the stage, age-stage specific fecundity (f_{xj}), age specific survival rate (l_x), age-specific fecundity (m_x), and population parameters consist of intrinsic rate of increase (r_m), net reproduction rate (R_o) accordingly. The intrinsic rate of increase (r_m) is computed using interactive bisection method:

$$1= \sum_{x=0}^{\omega} l_x^{\infty} m_x e^{-r m(x)}$$

With age indexed from 0 (Goodman, 1982). To take stage differences into consideration, the l_x and m_x estimated by the subsequent formulae:

$$l_x= \sum_{j=1}^{k} S_{jx}$$

$$m_x = \sum_{j=1}^{k} S_{jx} f_{jx} \Big/ \sum_{j=1}^{k} S_{jx}$$

Where k is the number of stages (Chi & Liu, 1985). Since regarding this life table is extremely time consuming and replication is impractical, the Bootstrap method was used instead for calculating life table parameters. The mean generation time is clarified as the time, when a population needs to increase R_o-fold of its size ($e^{rT}=R_o$ or $\lambda^T=R_o$) at the stable age-stage distribution. Also, calculation life expectancy (e_x) is included in the raw data analysis ($e_x= T_x/l_x$) by the TWOSEX-MS chart program is available at http://140.120.197.172/ecology (Chi, 1988; Chi & Su, 2006).

RESULTS AND DISCUSSION

In present work, biological parameters were determined for *Aphis gossypii* at constant temperature close to temperature farms in Iran. The mean developmental times of this aphid was clarified in table 1. Our findings showed that *A. gossypii* in the laboratory circumstances rear on cucumber (Mega-sahra) and continue growth activity however, newly nymphs could not survive on potato hosts; Agria and Sante varieties, because of the fact that they died after 1-3 days of birth with no other growth activity. On Agria the nymphs survived just for 2.05 days also, on Sante with the same condition survived for 1.70 days averagely. A broad range of host plants with world-wide distribution of *A. gossypii* has been observed, however no consideration of host suitability was claimed (Ebert & Cartwright, 1997; Jones & Luchsinger, 1986). In our study, cotton aphid generated different stages and grew up until the death. This variety of cucumber against two varieties potato had more favorable circumstances. The nymph stage of *A. gossypii* at 26°C in comparison with Satar et al. (2005) was the same at temperatures 25 and 27.5 °C on cucumber moderately. This parameter was different partially on some cotton varieties Bakhtegan and Sealand (Razmjou et al., 2006) with BRS Rubi, BRS Safira and BRS Verde (Correa et al., 2013). Daily fecundity in our study was accounted little more than observation of Satar et al. (2005) on the same host (4.6 and 4.3 numbers at the same temperatures) also, further than cottons for Cukurova (2.3) in Turkey (Kersting et al., 1999) and PEACO-SL (3.0) in Brazil (Pessoa et al., 2004). Similarly, it was revealed in life cycle for the aphid on the same literatures.

Regarding, population parameters were present for cucumber Mega-Sahra variety in table 2. It can be clearly seen that intrinsic rate of increase (r_m) named quantification index is more proper indicator related to temperature affect on growth population and reflect on development and survival aphid. This parameter with R_o (Net reproduction rate) were computed at the same level by Satar et al. (2005) with Darvishzadeh & Jafari (2016) on Pierro with Super Pretty varieties, whereas higher than Correa et al., (2013) on cotton and Shirvani & Hoseini Naveh (2003) on Pumkin. Also, doubling time (*DT*) was presumed alike Darvishzadeh & Jafari (2016) on Pierro variety and had no significant difference in comparison with Correa et al. (2013) on cotton.

It was leveled out daily age-specific survival rate (l_x) on the first day's life, gradually declined up to 12th day and then, decreased from 13th to 24th day

dramatically. The rate of daily egg was maximum on day 12 (Fig. 1) with 10.92 days in this aphid for life expectancy (*ex*) was accounted (Fig. 2). In addition, Darvishzadeh & jafari (2016) with Satar et al. (2005) obtained similar results on some varieties cucumber particularly on age-specific survival rate (l_x) with fecundity (m_x). In similar manners death of the last female happened for the some variety cucumbers; Pierro and Dominus (ps) were look like in present work at the age of 32 and subsequently, 34, 35 and 36 day for TN-94-203, Davos Π and Negin varieties (Darvishzadeh & jafari, 2016).

On the whole, biology or demographic parameters of *Aphis gossypii* has been studied on few plant hosts such as cotton, melon, chrysanthemum by many scholars. According to characteristics of host plant, fecundity or growth stages may clarify different results (Guldemond et al., 1994; Kersting et al., 1998; Van-lerberghe-Masutti & Chavigny, 1998). In this research, *Aphis gossypii* reared and produced offspring on cucumber, even though two potatoes were no suitable host for cotton aphid. In agreement with Forghani et al. (2019) and Forghani (2018) this study provides some information of demographic parameters of *Aphis gossypii* on cucumber. It seems that *Aphis gossypii* has been faced with variation performance and life cycle on different plants. As a case in point, non-genetic aspects e.g. physiological changes, nutrient materials and ecological environments may lead to various performance of this aphid during the generation (Schweissig & Wilde, 1979; Mackenzie, 1990). Moreover, this aphid is probably differentiated into few genotypes that have various adaptations (Jaenike, 1981; Diehl & Bush, 1984). As a result, Mega-Sahra cucumber is appropriate host for cotton aphid, but Agria and Sante potatoes are not suitable host to growth and development.

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Table 1. Means for some biological parameters of *Aphis gossypii* at constant condition in the lab (T=26± 1 ℃, Rh%= 60±5, L:D= 16:8) on cucumber variety, Mega-Sahra.

Daily fecundity	Reproductive period	Total Mortality	Female Longevity	Nymphal stage	Life cycle
5.30± 1.56	4.05± 0.84	2.20%	5.05± 0.38	4.85± 0.77	9.90± 0.76

Table 2. Population parameters of *Aphis gossypii* at constant condition in the lab (T=26± 1 ℃, Rh%= 60±5, L:D= 16:8) on cucumber variety, Mega-Sahra.

R_o aphids aphid^{-1}	R_m aphids aphid $^{-1}$ day^{-1}	DT day	λ
60.40	0.481	1.441	1.618

$R_{o=}$ Reproduction rate, R_m=Intrinsic rate of increase, DT=Doubling time, λ= Finite rate of increase

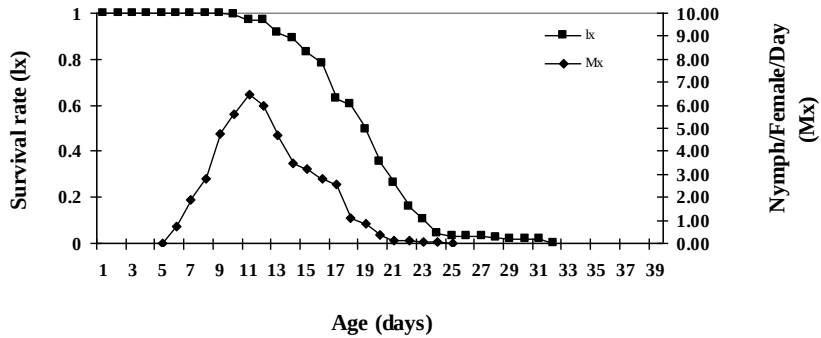

Figure 1. Age-specific fecundity and survivorship of *Aphis gossypii* at (T=26± 1°C) on cucumber (Mega-Sahra), l_x is the proportion of alive cotton aphids at age x; m_x is the mean number of nymphs per female at age x.

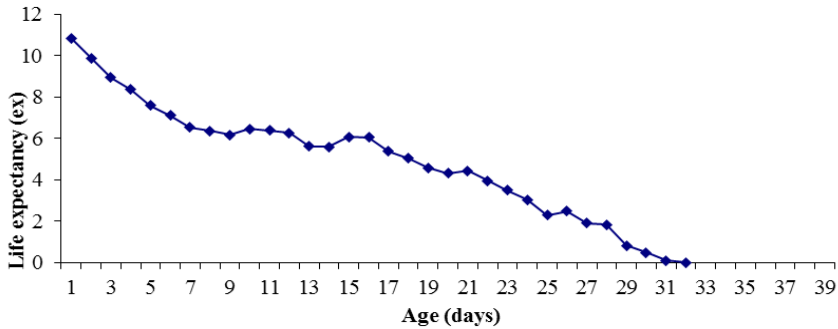

Figure 2. Life expectancy (e_x) of *Aphis gossypii* at (T=26± 1°C) on cucumber (Mega-Sahra).