

Effects of Host Plants and Various Temperatures on Population Growth Parameters of *Aphis gossypii* Glover (Hom.: Aphididae)

Hadji Mohammad Takaloozadeh

Faculty of Agriculture, Shahid Bahonar University, Kerman, Iran

Abstract: Effects of two host plants, including cucumber (*Cucumis sativus* L.) and Cotton (*Gossypium hirsutum* L.) and constant temperatures 16, 23 and 30± 2°C on population growth parameters of *Aphis gossypii* Glover were studied under controlled conditions (55±5% R.H., L:D 14:10 H.) during 2009- 2010 in Kerman, Iran. Results indicated that net reproduction rate (R_0) of aphids at 16± 2°C on cucumber and cotton was 40.602 and 29.862, respectively. Gross reproductive rate (GRR) on these host plant was also 43.686 and 32.10, respectively. At 23± 2°C, R_0 and GRR on cucumber were 61.201 and 69.19 while on cotton they were 46.096 and 46.715, respectively. At 30± 2°C these parameters were on cucumber 29.6937 and 33.306 and on cotton 44.181 and 46.02, respectively. The stable population parameters of cotton aphid include intrinsic rate of natural increases (r_m), finite rate of increases (λ), intrinsic birth rate (b), intrinsic death rate (d), doubling time (DT), mean generation time (T) and rate of weekly multiplication (r_w) which were calculated under mentioned temperatures on both host plants. On cucumber (r_m) and (T) at 16, 23 and 30° C were 0.2464; 15.0317 and 0.3471; 11.8530 and 0.3873; 8.7553 while on cotton they were 0.1860; 18.2607 and 0.3182; 12.0387 and 0.3521, 10.7591, respectively. Results of this investigation indicated that the development, survivorship and reproduction of melon or cotton aphid are strongly influenced by temperature and quality of food.

Key words: Cotton aphid • *Aphis gossypii* • Cucumber • Growth parameter • Temperature

INTRODUCTION

Cotton aphids are small, soft-bodied and slow moving yellowish or dark green insects. Adults are varying in color from light to dark green and have dark siphunculi [1]. At high temperatures and in crowded environments, adult aphids are pale yellow in color [2]. The length of an adult cotton aphid is approximately two millimeters and the insects are pear shaped.

There are both winged and wingless asexual adult aphids that can be seen in cotton field.

The cotton or melon aphid, *Aphis gossypii* Glover (Hom. Aphididae) is a cosmopolitan, polyphagous species widely distributed in tropical, subtropical and temperate regions [3].

This aphid is attacking to more than 70 various plants and is one of the most pests on cotton, cucurbits, citrus, greenhouse-grown vegetables, beet and tomato. It has also occasionally seen on pistachio trees in Iran.

A. gossypii causes direct damage to the plants by sucking liquid and draws sap from the phloem tissue by using its piercing-sucking mouthparts. Direct feeding of

cotton aphids causes plant deformation and general reduction in plant vigor that can reduce yield. Indirect damages include spreading honeydew and virus transmission in host plants.

Honeydew causes black sooty mold fungus cover substantial portions of leaves and inhibiting photosynthesis, reducing plant vigor and inhibiting proper plant growth. Molds develop on honeydew and as a result, plant leaves may become wilted.

This aphid is also found to be a vector of 76 virus diseases in a very large number of plants [4]. The main diseases which are transmitted by this aphid are Bean common mosaic, Bean yellow mosaic, Cucumber mosaic, Lettuce mosaic, Beet mosaic, Cabbage black ring spot and Citrus tristeza.

To provide an effective control management program determining the influence of host plants and various temperatures on growth parameters and reproduction rate of pests are essential. Comparison of aphid population growth parameters with the same values obtained for their parasitoid wasps will determine the efficiency of the parasitoids in controlling the aphid damage.

Investigations by Kersting *et al.* [5] on population growth parameters of this aphid showed that the intrinsic rate of increase (r_m) at 30 and 15°C were 0.413 and 0.177 female/female/day, respectively. Effect of nine constant temperatures on development and fecundity of *A. gossypii* on cucumber plants were studied by Satar *et al.* [6]. They found that at 25°C the highest average reproduction was 82.1 nymph /female.

The aim of the present study was to determine the influence of various temperatures and different host plants on reproduction and development of population of *A. Gossypii*.

MATERIALS AND METHODS

Cotton and cucumber plants used in the present studies were grown in greenhouse at Kerman University. Three seeds of cotton (cultivar Varamin) and cucumber were planted in plastic pots with 12 cm height and 10 cm diameter. After germination seedlings were thinned to one seedling per pot.

The experiment was conducted at three constant temperatures (16, 23 and 30± 2°C) and on two host plants cotton and cucumber. During the experiment R.H was kept constant at 55±5% and a photo period of 14:10 h (L: D). The replicates were done for each treatment.

One adult apterous female aphid that has been reared at the same condition was placed on plants that were at 4 true-leaf stage. These adults were monitored daily and when the first nymphs were produced, the adult and all of new born nymphs except one were removed.

Individual nymphs were also monitored every 24 h and nymphal duration and mortality was recorded until they reached adulthood. Adult aphids were observed daily and newly born offsprings were counted and removed until the last individual from each treatment was died. All observed data distinctly recorded at special tables. These results were used to make life table and age specific life table.

According to equation presented in Table 1 net reproduction rate (R_0), gross reproduction rate (GRR) and approximate amount of T_c and r_m were determined. The actual amount of the intrinsic rate of increase (r_m) was then determined by iteratively solving the Lutka equation as given below.

$$1 = \sum e^{-rx} l_x m_x$$

In which x is the age in days (including immature stages), r is the intrinsic rate of increase, l_x is the proportion of individuals alive at time x of an original cohort (including immature mortality). The variable m_x is the mean number of offspring produced per surviving aphid during the age interval x (1 day).

Using the values obtained for actual amount of the intrinsic rate of increase (r_m) other parameters like finite rate of increase (λ), doubling time (DT), mean generation time (T_c) and rate of weekly multiplication (r_w) were calculated by the methods described by Andrewartha and Birch [7], Sing *et al.* [8], Birch [9], Carey [10] and Wyatt and White [11].

The parameters and there equation are presented in Table 1.

Table 1: The stable population parameters of cotton aphid *Aphis gossypii*

Parameter	Formula	Unit
Gross reproductive rate	$\Sigma m_x = \text{GRR}$	Offspring female/female
Net reproductive rate	$\text{NRR}(R_0) = \Sigma l_x m_x$	Offspring female/female
Nymphs (eggs) per female- day	$= \Sigma l_x m_x / \Sigma l_x$	Offspring female/day
Intrinsic rate of increase(r_m)	$1 = \Sigma e^{-rx} l_x m_x$	1/t
Finite rate of increase(λ)	$\lambda = e^r$	Daily
Intrinsic birth rate	$b = 1 / \Sigma e^{-rx} l_x$	1/t
Intrinsic death rate	$d = b - r$	1/t
Doubling time	$\text{DT} = \log_e 2 / r$	Day
Mean generation time	$T = \log_e R_0 / r$	Day
Rate of weekly multiplication	$r_w = (e^r)^7$	time
Intrinsic rate of increase(r_m)	$r_m = 0.74 (\log_e \text{FD}) / D$	1/t

RESULTS AND DISCUSSION

The parameters that affected fecundity and growth population of cotton aphid are presented in Table 2. As the results are showing net reproduction rate (R_0) and gross reproduction rate (GRR), were higher at 23°C, than amount of these parameters at 16 and 30°C on both host plants. This subject indicated that 23°C among these three experimented temperatures are the fittest for development and reproduction of *A. gossypii*. Values of R_0 at 16, 23 and 30°C are showing that population of cotton aphid at end of generation would increase to 40.602, 51.201 and 29.694 times on cucumber and 29.862, 46.096 and 44.181 times on cotton, respectively. The cotton aphid displayed higher fecundity on cucumber than on cotton. Thus for *A. gossypii* cucumber appears to be of higher nutritional value than cotton plants. Both food quality and temperature are shown to play a distinct role in cotton aphid population increase. [5].

Razmjou *et al.* [12] studied parameters of cotton aphid on five cotton cultivars and showed that the highest offspring per female was 29.6 on Sahel and lowest was 15.3 on Sealand cultivar. Fertility life table parameters of *A. gossypii* were studied on cucumber, pumpkin and squash by Shirvani *et al.* [13] and showed that values of R_0 and r_m on cucumber was higher than on pumpkin and squash.

The intrinsic rate of increase (r_m) was 0.1860, 0.3182 and 0.3873 on cucumber and 0.1860, 0.3182 and 0.3521 on cotton, respectively. These results are in agreement with those of Razmjou *et al.* [12]. They calculated r_m on

different cotton cultivars at 27.5°C and their results showed that r_m was ranged from 0.272 to 0.382. Also these results are in accordance with r_m value on various temperatures on cucumber plants that computed by Satar *et al.* [6] and r_m was determined 0.208 at 15°C and 0.526 at 25°C.

These results showed that with increase temperature from 16 to 30°C values of r_m increased on both host plant and on the contrary doubling time (DT) and mean generation time (T_c) decreased.

Satar *et al.* [3] reported a higher fecundity of cotton aphid on common mallow than on cotton. The development periods of immature stages varied from 10.3 days at 16°C to 4.4 days at 30°C on cotton and from 9.4 days at 16°C to 4 days at 30°C on cucumber. These results are in agreement with those of Zamani *et al.* [14]. They studied the effect of six constant temperatures on population growth parameters of *A. gossypii* on cucumber plants and reported that developmental periods of immature stages varied from 20.70 days at 10°C to 3.81 days at 30°C and the average adult longevity ranged from 8.56 days at 30°C to 17.00 days at 25°C.

Survivorship and fecundity of test aphids held at three constant temperatures and on two host plants are presented in Figures 1 and 2.

Results of this study indicate that optimum temperature ranges from 25 to 30°C for cotton aphid development, reproduction and population increase and cucumber is a more suitable host than cotton for this aphid.

Table 2: The stable population parameters of cotton aphid *Aphis gossypii* at three temperatures and two host plants

Parameters	temperature					
	16 °C		23°C		30°C	
	Cucumber	Cotton	Cucumber	Cotton	Cucumber	Cotton
Net reproductive rate (R_0) NRR (Female/female)	40.602	29.862	61.201	46.096	29.6937	44.181
Gross reproductive rate GRR (Female/female)	43.686	32.1	69.19	46.715	33.306	46.02
Intrinsic rate of increase (r_m) (Female/female/day)	0.2464	0.1860	0.3471	0.3182	0.3873	0.3521
Finite rate of increase (λ)	1.2794	1.2044	1.4149	1.3746	1.4730	1.4220
Intrinsic birth rate (b)	2.6975	1.3499	2.5409	1.3385	1.6312	1.7288
Intrinsic death rate (d)	2.4511	1.1639	2.1938	1.0203	1.2439	1.3767
Doubling time	2.8131	3.7266	1.9970	2.1783	1.7897	1.9686
Mean generation time	15.0317	18.2607	11.8530	12.0387	8.7553	10.7591
Rate of weekly multiplication	5.6114	3.6766	11.3555	9.2757	15.0458	11.7599
Intrinsic rate of increase (r_m) [11]	0.2526	0.1921	0.3872	0.3348	0.4345	0.3863

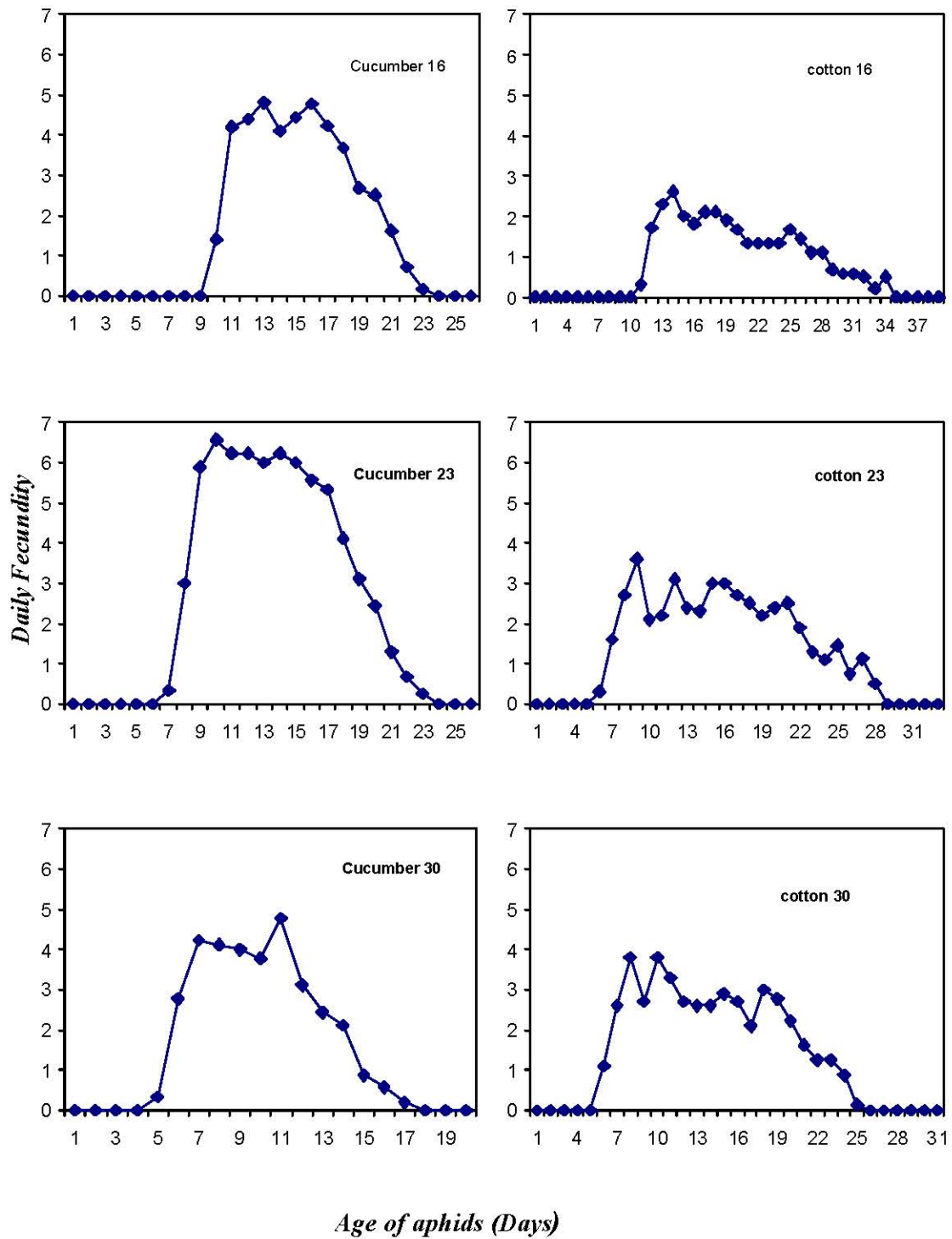


Fig. 1: Mean daily female offsprings of *Aphis gossypii* on cotton and cucumber raised at three constant temperature 16, 23 and 30°C

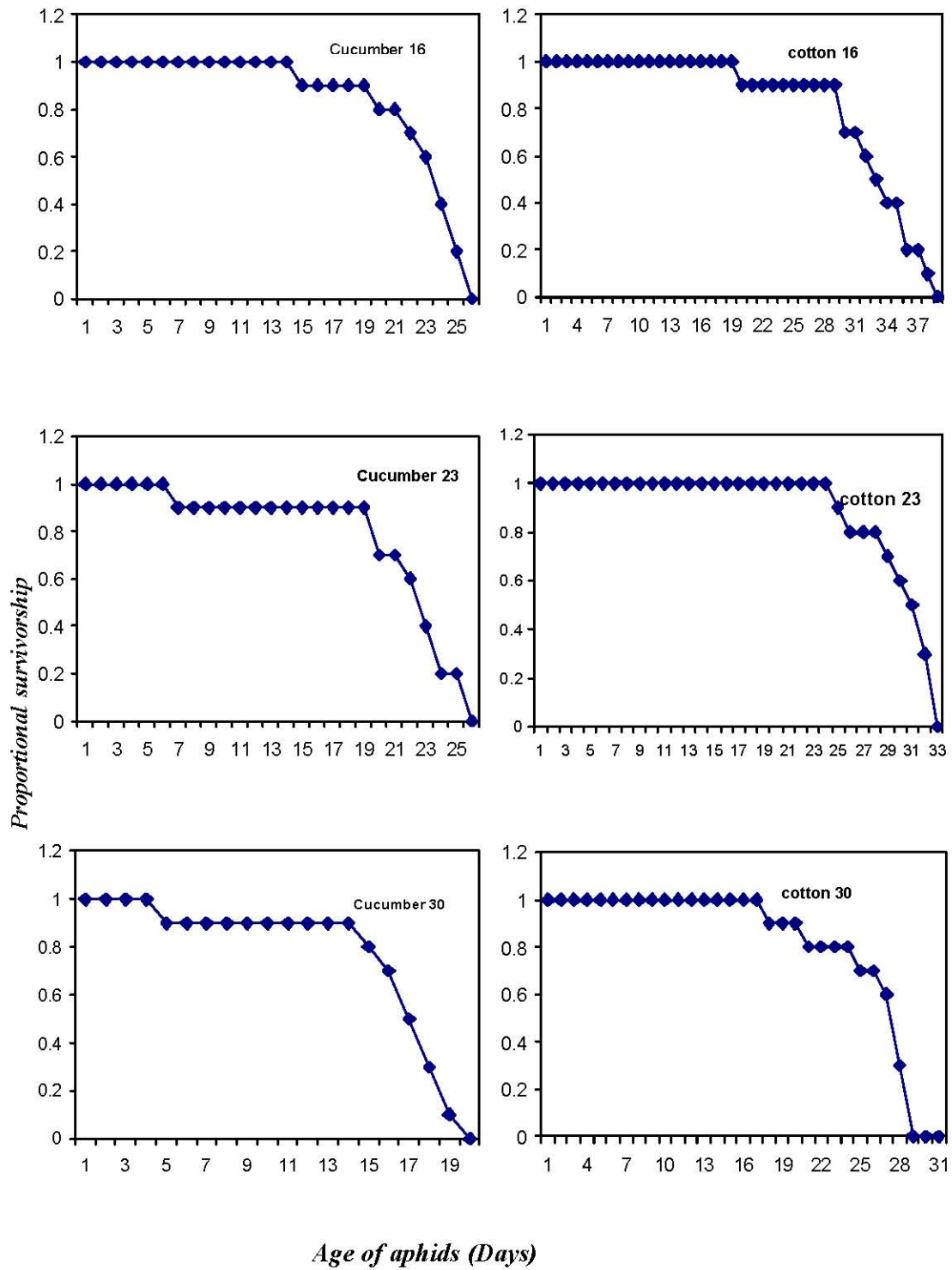


Fig. 2: Proportional survivorship of *Aphis gossypii* on cotton and cucumber raised at three constant temperatures 16, 23 and 30 °C

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