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Different cucumber (*Cucumis sativus*) varieties could affects biological performance of cotton aphid, *Aphis gossypii* Glover (Hemiptera: Aphididae), a case study at laboratory condition

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Abstract

Worldwide, the developing industry of cucumbers (*Cucumis sativus* L.) grown in green houses is threatened by damage from sucking pests, especially aphids. Among these, the cotton aphid, *Aphis gossypii* Glover (Hemiptera: Aphididae), is the most serious. Understanding the biology of a pest is essential to develop an integrated pest management strategy. Biological parameters of *Aphis gossypii* Glover on greenhouse cucumber varieties (Salar, Sepehr, Sina, Homa, Zohel and Zomorod) were investigated at laboratory conditions (25±2°C, 60±10% RH and a photoperiod of 16:8 (L: D) h). In this study, 70 same-age nymphs were used. Each treatment was checked daily and nymphal and adult stages were recorded. According to the results, the highest and lowest development time were obtained 5.20±0.09a days on Sepehr and 4.40±0.06d days on Homa. Also, the highest and lowest life span was determined 27.34±1.46a days on Zohal and 18.18± 0.81c days on Sepehr. The total fecundity was no significantly difference between the cucumber varieties. The highest and lowest total fecundity were obtained on Zohal and Sepehr. The results of this study indicated that cucumber variety is a factor which can significantly affect the biology and reproduction parameters of *Aphis gossypii*. The findings of the present study could be useful to design a comprehensive IPM program for this pest on different cucumber varieties in greenhouse.

Key words: Biology, Cucumber variety, Developmental time, *Aphis gossypii.*

Zusammenfassung

Die Erzeugerindustrie von Gurken (*Cucumis sativus* L.) die in Gewächshäusern aufgezogen werden wird weltweit von Parasiten, insbesondere Aphidae bedroht. Die Art "cotton aphid", *Aphis gossypii* Glover (Hemiptera: Aphididae) ist darunter die bedeutendste. Die Kenntnis der biologischen Zusammenhänge eines solchen Schädlingsbefalls ist zur Entwicklung einer Bekämpfungsstrategie unabdingbar. Die biologischen Parameter von *Aphis gossypii* Glover wurden an verschiedenen Gurken-Arten unter Laborbedingungen erforscht. Als Ergebnis wird festgestellt, dass die Art der Gurke entscheidenden Einfluss auf den Schädlingsbefall hat und somit kann diese Studie einen Beitrag zur Entwicklung eines IPM Programms gegen den Befall der verschiedenen Gurken-Arten in Gewächshäusern liefern.

Introduction

Greenhouse-based cucumber (*Cucumis sativus* L.) production has recently increased worldwide. However, the warm humid conditions and the abundance of hosts in greenhouses and protective structures are ideal for occurrence and development of pests and diseases (Syed 2006). This developing industry is threatened by damage from sucking pests, especially aphids. Among aphids, the cotton aphid, *Aphis gossypii* Glover (Hemiptera: Aphididae), is the most serious pest of cucumbers. This aphid is a major polyphagous pest worldwide attacking cotton (*Gossypium hirsutum* L.) and cucurbits, where it builds up large populations, as well as on citrus (*Citrus* spp.), eggplant (*Solanum melongena* L.) potato (*Solanum tuberosum* L.), okra [*Abelmoschus esculentus* (L.) Moench], and many ornamental plants. In addition, *Aphis gossypii* is a major pest of greenhouse plants in the colder temperate regions (Blackman & Eastop 2000) and creates major problems in greenhouse-grown European cucumber (*Cucumis* spp.) greenhouses (van Steenis & El-Khawass 1995; Stoetzel et al. 1996). It is a cosmopolitan, polyphagous species widely distributed in tropical, subtropical and temperate regions (Kresting et al. 1999; Razmjou et al. 2011, 2012; Torkamand et al. 2013). The cotton aphid colonized over 60 plant species including cucurbits, citrus, vegetable and ornamental plant (Behdad 1982; Slosser and costly (Hardee 1993) research has increasingly been conducted to identify alternative measures to chemical control. Host resistance is one way of controlling insects that is not detrimental to the environment and that also reduces expenses for growers (Li et al. 2004). Relative resistance to *Aphis gossypii* has been found in several cotton cultivars, and, during field experiments, its population increased on certain cultivars, whereas it decreased significantly on other cultivars (Mojeni et al. 1997).

The majority of current management strategies for the cotton aphid rely on applying aphidicides. Not only are these very costly but also increasing resistance to pesticides (Barber et al. 1999, Foster et al. 2002) can escalate applications, which can ultimately threaten human health. A more appropriate approach would be to use all possible options to reduce pesticide use and make resistance plants a component of an integrated pest management (IPM) program.

Many researchers have documented the effects of host plants on developmental rate and fecundity in various pest insects (Kocourek et al. 1994; Morgan et al. 2001; Du et al. 2004;

Li et al. 2004). Understanding these parameters will help the development of comprehensive pest management program for cucumber. In this study, we obtained developmental time, reproduction period, life span, preadult and adult longevity of Aphis gossypii for the use resistance variety cucumber greenhouse. Understanding these parameters will help in the development of a comprehensive pest management program for cotton. In summary, based on our results, a combination of a partially resistant cucumber cultivar and with other types of IPM practices, could play a key role in managing this aphid in cucumber greenhouses.

Slosser et al. (1989); Khanjani 2005. In Iran *Aphis gossypii* is one of the most important pests of greenhouse plants (Baniameri & Nasrollahi 2003).

This pest can cause direct damage resulting from the search for food that may induce plant deformation and indirect damage caused either by honeydew (Perng 2002; Shi et al. 2011; Amini Jam et al. 2014). Honeydew causes black sooty mold fungus cover substantial portions of leaves and inhibiting photosynthesis, reducing plant vigor and inhibiting proper plant growth mold develop on honeydew and as a result, plant leaves may become wilted (Takalloozadeh 2010). It is to be vector of 76 virus diseases in a very large number of plants (Chan et al. 1991). This species has a very high rate of development and is able to increase up to 12 times per week (Roistacher et al. 1984).

Biological parameters of *Aphis gossypii* have been done on five cotton cultivars (Razmjou et al. 2006), colored lint cotton cultivars (Batista Correa et al. 2013), garden cucumber *Cucumis sativus* L. (Kocourek et al., 1994; van Steenis & El-khawass, 1995) and greenhouse cucumber (Mollashahi & Tahmasebi 2009; Zamani et al. 2012) and isabgol (Patil & Patel 2013). The theory and method of biological parameters are discussed in most ecology text books (Price 1997, Ricklefs & Miller 1999). Because aphicidal treatments have become both variable in their effectiveness

Materials and methods

Insect and plant material

A research was conducted in the Department of Plant Protection of Yasouj University, Iran with six varieties of greenhouse cucumber seeds in a trading name of Sina, Sepehr, Salar, Zomorod, Zohal and Homa. After 15 days cucumber plants reached the flowering stage and then the soil was fertilized with a dilution of fertilizer N.P.K: 20:20:20 in all pots. At this stage cucumber leaves were prepared to be used in vitro. Population of *Aphis gossypii* from cucumber greenhouse located around of Yasouj were collected and shelved at the colony rows.

Six pots of a greenhouse cucumber were considered in each colony. *Aphid colonies* were watered on a daily basis and their environmental conditions including temperature, light and humidity was adjusted and entry of pets and pathogens were prevented. In order to help the plants health for aphid and aphid colony be survived for experimental duration, fresh plants were replaced instead of withered ones every two weeks. After removing the adult aphids on cucumber leaves, all Petri dishes were transferred into the growth chamber with a temperature of 25±2°C, relative humidity of 60±10 % and photoperiod of 16:8 (L:D). 12 hours later, Petri dishes were reviewed based on conditions. If nymphogenesis takes place,

we keep one of the nymphs and female and the rest of the nymphs are eliminated by brush and, if not, 2 to 3 hours later, the containers are checked again. Moreover, in each variety 70 nymphs surveyed to study the biological parameters. In order to maintain of the freshness and vitality leaves, all examination containers were replaced every three days. Biological parameters of *Aphis gossypii* took place on leaves of different varieties of greenhouse cucumber. All Petri dishes tested in daily visits and molting time and deaths were recorded. After aphid's maturity, the number of nymphs laid by each aphid per day counted and after recording, all nymphs were removed by brush. This process lasted until last aphid's death. The maternal aphid's mortality was also recorded.

The aphids used in this study had been reared on cucumber for 2 mo. To reduce any inbreeding effects, regular infusion of the wild aphids was made into the colony. The experiment followed a complete randomized design (CRD).

Statistical analysis

In this study, different stages of *Aphis gossypii* including development times for each nymphal instar, duration of adult pre-reproduction, reproduction, and post-reproduction periods, adult longevity and total life span were examined for each aphid. Then for calculating mentioned parameters for six cucumbrer cultivars, variety-treatment cohorts were analyzed by analysis of variance (on way-ANOVA) by Minitab version 16. In this research, the complete randomized design (CRD). Data were checked for normality prior to analysis.

Results

Biological parameter

Developmental time and longevity

The results of biological parameters of *Aphis gossypii* on six cucumber variety are shown in Table 1. The development of instar I and IV *Aphis gossypii* were significantly different on cucumber varieties; whereas this mentioned parameters dosnt show significant difference at instar II & III. The shortest developmental time on Homa was 4.40±0.06 days and the longest developmental time was 5.20±0.09 days on Sepehr. The pre-reproduction period showed significantly difference among different varieties. This parameter ranged from 0.26±0.05 days on Sina to 0.68±0.05 days on Homa. The aphid *Aphis gossypii* was observed to reproduce for a period of 11.65±0.52 on Homa to 13.21±0.71 days on Zohal in laboratory. The post- reproduction period of *Aphis gossypii* was significantly different on cucumber varieties.This parameter was recorded from 1.22±0.24 days on Sepehr to 9.34±1.02 days on Zohal. Adult longevity was significantly different on cucmber varieties, ranging from 11.73±0.85 on Zohal to 21.33±1.26 on Salar. The life span showed significantly difference among different varieties. The

significantly lowest life span was recorded 18.18±0.81 days on Sepehr and the highest life span was recorded 27.34±1.46 days on Zohal.

First and fourth nymphal instar longevity showed significant difference between varieties, while second and third nymphal instar longevity had no significant difference between varieties. Maximum length of fourth instar nymphal was observed in Sepehr variety.

Table. 1: Biological parameters of A. gossypii on six cucumber varieties.

Parameters (days)	Varieties					
	Sepehr	Salar	Sina	Zohal	Zomorod	Homa
Development						
Instar I	1.41± 0.05ab	1.27±0.05bc	1.20±0.04bc	1.12±0.04c	1.51±0.07a	1.20±0.05bc
Instar II	1.19±0.04a	1.08±0.03a	1.13±0.04a	1.10±0.03a	1.22±0.05a	1.08±0.65a
Instar III	1.12±0.04a	1.22±0.05 a	1.06±0.02 a	1.15±0.04 a	1.18±0.04 a	1.14± 0.04 a
Instar IV	1.48± 0.06a	1.16± 0.04bc	1.23± 0.05 b	1.07± 0.03bc	1.09± 0.03bc	1.00± 0.00c
Total development	5.20± 0.09a	4.75±0.05bc	4.58±0.06cd	4.43±0.06 d	4.90±0.08 ab	4.40±0.06d
Pre-reproduction period	0.35±0.06bc	0.51±0.06ab	0.26±0.05c	0.35±0.06bc	0.46±0.06abc	0.68±0.05a
reproduction period	11.74±0.59a	12.60±0.50a	12.43±0.61a	13.21±0.71a	11.93±1.58a	11.65±0.52a
Post-reproduction period	1.22±0.24c	8.21±1.02a	6.47±0.81ab	9.34±1.02 a	4.43±0.65bc	7.21±0.88a
Adult longevity	13.08±0.78 c	21.33±1.26ab	19.17±1.18ab	11.73±0.85a	16.83±1.98bc	19.55±1.21ab
Life span	18.18±0.81c	26.09±1.25 a	23.75±1.18ab	27.34±1.46 a	21.74±0.98bc	23.95±1.21ab

Mean values followed by the same letter in same row are not significantly different (LSD; P< 0.05).

Discussion

The current study provides more information on effect of different variety of cucumber on development *Aphis gossypii*. According to Mollashahi & Tahmasebi (2009), nymphal longevity on the cucumber was 4.98± 0.1 days which is so close to the obtained nymphal longevity of aphid on Zomorod variety (4.90 days). Kersting et al. (1999) reported the value of 4.51±0.09 days for nymphal longevity in cotton plants and based on findings Xia et al. (1999), 4.60±0.09 days for cotton aphid which is close to Sina nymphal longevity (4.90 days) in our study, and also on three varieties of hollyhock, cotton and okra 5.6, 5.5 and 6 days, have been recorded, respectively (Satar et al. 1999, 2008) which are indicating the host effect on biology of *Aphis gossypii*. According to Shirvani & Hosseini nave (2004), nymphal longevity for three plants including cucumber, pumpkins and squash were recorded, 5.6, 5.2, and 4.5 days respectively which all are close to Sepehr nymphal longevity (5.20 days) in our study. Consequently, there is no huge difference between above-mentioned researches and ours.

Life span of *Aphis gossypii* on cucumber in vitro was 26.98 days (Mollashahi & Tahmasebi 2009) which is close to Salar life span (26.06 days) in our research. In temperature of 25°C, life span of Royal cucumber variety was 21.9±0.32 and the Storm variety lasted for 21.6±0.25 days (Haji Ramezani et al. 2012) which is near to Zomord life span in this study (21.74 days). Life span of *Aphis gossypii* was 25.69 days on cucumbers, 14.06 days on the pumpkin, 15.37 days on squash which the minimum life span was on the cucumber and lowest life cycle concerned to the pumpkin (Shirvani & Husseini nave 2004) that the difference of host plants were observed.

These contrasts indicate a possible effect of different variety of host plant species, techniques, and equipment of the experiments on development of *Aphis gossypii.* Life span in different varieties of cotton such as Bakhtegan, Sahel, Silandr, Ciukra and Varamin were obtained 21.6, 20.5, 16.4, 18.2 and 21.2 days, respectively (Razmjou et al. 2006).

Compared with other researches, we can conclude that hosts have a big influence on life span of the aphid. Cucumber plant is more suitable host plant than any other plants and provides favorable conditions for aphid. We can consider much suitable nutritional conditions for aphids in cucumber than any other plants. Eventually, physical barriers such as the secretory and non - secretory trichomes have a negative impact on the biology of insect that feeds on plants and may be the reason for antibiosis (Nuri Qunbolany et al. 1994).

Large number of elements have effects on the biological parameters. In his study, only the effect of resistance was considered and the rest of effective elements on biological parameters were eliminated. Therefore, both resistance and non-resistance variety terms have not satisfied and the varieties in this study are equally sensitive to aphid. But among these varieties in this research, the aphid has the highest effects and damage on Homa variety, however, the minimum effects on Sepehr.

The results of this study may provide some essential information on developmental and longevity of *Aphis gossypii* on cucumber. When this information to be used in association with other ecological data (such as intrinsic rate of increase, fecundity, and mortality) may be useful for predicting growing conditions conducive to *Aphis gossypii* outbreaks on different variety of cucumber and would be valuable in the development and implementation of pest management programs on cucumber. After laboratory studies, more attention should be devoted to semifield and field experiments to obtain more applicable results in agricultural conditions.

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