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Research Article
Biological Responses of *Aphis gossypii* (Glover) to Different Squash (*Cucurbita pepo*) Varieties and Two Acaricides Application

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Abstract

Background: *Aphis gossypii* (Glover) is one of the most important sucking insects causing severe damage for squash plant since their nymphs and adults continuously suck the phloem sap of the leaves and more seriously is the fact that such insects are potential vectors of plant viruses. **Materials and Methods:** The present investigation was an attempt to evaluate the biological responses of *Aphis gossypii* (Glover) to different squash (*Cucurbita pepo*) varieties: Lebanese, Arab marrow, Alma and Caserta. The experiments were performed under controlled greenhouse conditions. Biological and reproductive variables of nymph have been assessed throughout the entire course of the experiment. Furthermore, study of the effect of acaricides on the population density of melon aphid was addressed when two acaricides (Torque L550 Sc and Nerot 25% E.C.) were employed. Data were analyzed using JMP software with analysis of variance (One-way ANOVA). **Results:** The present findings indicated remarkable variations among the varieties studies regarding the *Aphis gossypii* biology, where Lebanese ranked the most preferred varieties to *A. gossypii* and Caserta variety was the least preferred one since the total duration of nymph stage for Caserta was longer in most stages (first, second and third) compared with Lebanese which required less time to conclude this phase. Furthermore, Lebanese showed no reductionin the population rate reflecting the suitability of this cultivar for the growth of *A. gossypii*. On the other hand, aphids showed different response to the different acaricides applied and time to kill the aphids was positively correlated to the concentration of applied acaricides. **Conclusion:** The overall results provided convincing evidence for the effect of plant species on the biology of *Aphis gossypii* which was also partially influenced by acaricides application. Further, experimental study is required to explore the mechanisms behind variation in biological sensitivity of *Aphis gossypii* to different plant species and varieties. The actual action of acaricides on *Aphis gossypii* is still a mystery.

Key words: *Aphis gossypii*, *Cucurbita pepo*, varieties, biology, acaricides, plant viruses, Torque, Nerot

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Competing Interest: The author has declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Vegetables are very important commodity, most vegetables have a high economic value and as a source of nutritive food especially vitamins and minerals[1]. The Cucurbitaceae family has over 800 species of plants, which are grouped into about 80 genotypes, some of which hold great importance to the economical horticulture worldwide[2]. Among these cucurbitaceas, the *Cucurbita pepo* L. specie, popularly called squash is an important vegetable in SA. The most common pests in cucurbitaceous are aphids, thrips and whiteflies causing substantial losses especially, when intense infestations occur on the beginning of the vegetative cycle[3]. *Aphis gossypii* (Glover) is an important agricultural pest that transmits many agriculturally important plant viruses. Productivity reduction and plant death are the direct damage of *Aphis gossypii* feeding and the indirect damage is through contamination with aphid honeydew which lead to economic loss through physical contamination and by vectoring viral pathogens[4-6]. Honeydew causes black sooty mold fungus covers the leaves and inhibit photosynthesis which may lead to leaves wilting[7]. The most commonly used control method in the management of *Aphis gossypii* in squash is still chemical and use of a wide range of insecticides[3]. But, increasing concern about environmental pollution over the use of pesticides is a major issue due to environmental contamination. However, this method for aphids population reduction in cucurbitaceous is not effective beside, the excessive use of the chemical may result in presence of certain resistance species which leads to increased government regulation of chemical use[4,8]. Using of crop varieties that are resistant to insect, pests and diseases is one of the backbones of integrated pest management system. Insect may less prefers the resistant variety since it may affect its survival and normal development[9]. Generally, knowing about pest biology and its interaction with the host may help leading to find suitable way for population reduction of the insect that help in determining the suitable variety for cultivation. Moreover, biology of *A. gossypii* is vary with respect of geographic locations. In Saudi Arabia, upper limit for Aphid survival on squash is 35°C Aldyhim and Khalil[10]. Knowledge of host plant effects on the biological parameters of the melon aphid is essential for population dynamics studies. Consequently, experiments were conducted to examine the effects of four different cultivars of squash plants (Lebanese®, Arab marrow®, Alma®and Caserta®) on the development longevity and reproduction of *A. gossypii* under constant conditions in the greenhouse in Riyadh Saudi Arabia.

MATERIALS AND METHODS

The experimental study was performed in controlled growth chambers (Weiss Technik®) at constant temperature 25±1°C with 12 h photoperiod with light intensity of approximately 54000 Lux. Laboratory colonies of *Aphis gossypii* (Glover) were started with field collected single viviparous female from *Cucurbita pepo* (local cultivar). New born nymphs were propagated on a leaf of four varieties in separated petri dishes for 10 days. Aphis were moved from petridhes to seedling of the same variety. The colony was continued for 1 month before starting the experiment. The seedlings of the four varieties were grown to 4-5 leaf stage in a mixture pot in diameter was 18 cm. The soil was composed of 50% clay, 30% sand and 20% peat-moss. The Irrigation rate was 250 mL twice a week for each pot.

Experiments: Two groups of experiments were undertaken in this study.

First experiment: In this experiment, four squash plant varieties (Lebanese®, Arab marrow®, Alma® and Caserta®) were used to investigate their effect of on the biology of melon aphid. Ten mother aphids were removed from colonies of each plant varieties and placed on the lower surface of the third leaf of the seedling of the same variety. Mothers were allowed to reproduce for 6 h. The nymphs were examined daily. Developmental time of each nymphal stadium, generation time (T), longevity from birth to death and net reproductive rate (Ro) were assessed. The intrinsic rate of increase (rm) was computed using the equation of Wyatt and White[11]:

$$r_m = 0.74 (\log R_o/T)$$

Effect of squash plant varieties on the population of melon aphid: Five adults of melon aphids were placed on each seedling of the four varieties. Aphids of each seedling were collected and were counted after 2 weeks of infestation. Ten replicates per treatment (per variety).

Second experiment: In this experiment, effect of acaricides on the biology and population density of melon aphid was analyzed. Two acaricides (TorqueL550 Sc and Nerot25% E.C.) were employed and only seedlings of Lebanese® variety were used. Thirty seedlings were divided randomly to three groups (Treatments). Seedling of the first, second and third groups were treated with Torque, Nerot and distilled water at

recommended dose, respectively. A new born nymph and adult were treated by the two acaricides was followed by reduction rate calculations in each stage.

Statistical analysis: All results were computed and expressed as Mean±Standard Deviation (SD) from triplicates. Statistical analysis was performed using JMP software (version 18.0) with analysis of variance (One-way ANOVA).

RESULTS AND DISCUSSION

Developmental stages of aphid populations on different squash varieties: The current investigation was undertaken to study the biological behaviour of *Aphis gossypii* in four squash varieties (Lebanese®, Arab marrow®, Alma® and Caserta®). A further goal was to evaluate the response of *A. gossypii* when Lebanese variety was subjected to different acaricides application. Investigation revealed that the squash varieties differed from each other in their effect on the different growth stages of *A. gossypii.* Furthermore, the average duration of the nymphal stadium of *A. gossypii* kept in squash showed no significant variations among the studied varieties in the first stage (Table 1). In the second stage, Caserta variety showed the highest period of duration with the mean value of 1.6 days (approximately 2 days). This value is higher than the value reported by Baldin *et al.*[3] who reported average duration of nymphal stadiums of 1.47 days (approximately 2 days). For the same variety in the second stage. In the third stage, Lebanese and Arab marrow showed a shorter period of duration 1.1 days (approximately 1 day). where Caserta variety showed the highest period of duration with the mean value of 1.4 days (approximately 2 days). In the last stage, Arab marrow and Alma showed higher nympahl duration period than other varieties. Regarding the total duration of nympahl stage, Caserta showed relatively longer period in most stages (first, second and third) compared with others. This observation might lead to speculate that Caserta variety required more time for this this phase to be completely developed. On the other hand, Lebanese variety in contrast required short duration of nympahl stage development and this probably point to the suitability of this variety to the development of nymphs of *A. gossypii.* Similar observation was also recorded by Baldin *et al.*[3] for some squash varieties. The findings obtained in this study regarding Labanese variety with an average duration period of about 4.7 days (approximately 5 days) are in agreement to those reported by Satar *et al.*[12] and Leite *et al.*[13] where the total duration periods of nympahl stage of *A. gossypii* were about 4.6 and 4.7 (approximately 5 days) for *Cucumis sativus* and Casetra, respectively. Long nympahl duration period likely suggest resistance of these varieties to *A. gossypii* due to the fact that non-preference feeding may lead to extend the nympahl stage of an insect[14]. plant resistance or susceptibility to aphid might be a consequence of plant-aphid interaction[15]. Such resistance is normally expressed via different resistance mechanisms such as tolerance, antixenosis and antibiosis that reduce aphid growth in melon[16,17].

Table 1: Average duration of nymphal stadiums of *Aphis gossypii* in four cultivars of *Cucurbita pepo* (T = 25±1°C and photoperiod = 12 h with light intensity of approximately 54000 Lux

	Duration/stadium (days)				
Plant variety	First	Second	Third	Fourth	Total
Lebanese	1.4±0.10^{a}	1.2±0.09^{b}	1.1±0.08^{b}	1.0±0.10^{b}	4.7
Arab marrow	1.4±0.11^{a}	1.3±0.05^{ab}	1.1±0.07^{b}	1.3±0.09^{a}	5.1
Alma	1.5±0.12^{a}	1.3±0.10^{ab}	1.3±0.10^{ab}	1.3±0.10^{a}	5.4
Caserta	1.7±0.10^{a}	1.6±0.08^{a}	1.4±0.09^{a}	1.1±0.10^{b}	5.8

Data are Mean±SD followed by the same letter in the column did not different from each other, Tukey, 5%

Table 2: Reduction rate of the development of *Aphis gossypii* nymphs in relation to different squash *Cucurbita pepo* varieties

	Mean No.			
Plant variety	Nymphs	Adults	Total	Reduction rate (%)
Lebanese	186.40^{a}	306.00^{a}	492.40^{a}	-
Arab marrow	63.20^{b}	102.00^{b}	165.20^{b}	66.4
Alma	49.80^{b}	65.60^{b}	115.40^{b}	76.6
Caserta	29.00^{b}	102.00^{b}	131.00^{b}	73.4

Data are Mean±SD followed by the same letter in the column did not different from each other, Tukey, 5%

Impact of plant varieties on the population density of melon aphid: The data illustrated in Table 2 showed that Alma and Caserta varieties negatively affected the development of nymphs with a mortality rate of 76.6 and 73.4% of the individuals of Alma and Caserta varieties, respectively. High mortality rates obviously suggest high levels of antibiosis in those varieties. Furthermore, Arab marrow variety displayed moderately mortality rate, but for the Lebanese no mortality rate was detected, which might strongly indicate the suitability of this variety for the growth of *A. gossypii.* In addition to the influence of antibiosis in acquiring varieties certain degrees of resistance, the high mortality rates for the varieties mentioned above might also underline the presence of a chemical materials with antibiotic features that may cause a delay in the development of *A. gossypii.* The chemical compounds and its adverse effect on the biology of aphid has been well documented by Cook and Neal[18]. Two different chemical compounds were identified in melon variety by

Table 3: Biological aspects (Mean±SE) of *Aphis gossypii* in four cultivars of *Cucurbita pepo* (Lebanese, Arab marrow, Alma and Caserta)

Plant variety	Generation time, T (days)	Longevity (days)	Reproduction rate	Intrinsic rate of increase (rm)
Lebanese	4.7 1±0.16^{c}	20.30±0.73^{a}	51.07±4.41^{a}	0.27±0.01^{a}
Arab marrow	5.07±0.19^{cb}	19.57±0.71^{a}	31.29±2.59^{b}	0.22±0.01^{b}
Alma	5.43±0.13^{ab}	19.86±0.23^{a}	30.14±3.06^{bc}	0.19±0.01^{bc}
Caserta	5.71±0.13^{a}	17.70±0.41^{b}	21.71±1.93^{c}	0.17±0.01^{c}

Data are Mean±SD followed by the same letter in the column did not differernt from each other, Tukey, 5%

Table 4: Population growth of melon aphid after Nerot and Torque application (Zero time)

	Mean No.			
Acaricide type	Nymphs	Adults	Total	Reduction (%)
Nerot	113.6^{ab}	46.8^{ab}	160.4^{ab}	59.6
Torque	30.4^{b}	11.80^{b}	42.2^{b}	89.4
Control	276.0^{a}	121.6^{a}	397.6^{a}	0.0

Data are mean values, different letter indicate significant variations among different treatments

Table 5: Population growth of melon aphid after 3 days of Nerot and Torque application

	Mean No.			
Acaricide type	Nymphs	Adults	Total	Reduction (%)
Nerot	197.6^{b}	296.8^{b}	377.2^{b}	58.1
Torque	209.6^{b}	141.2^{b}	350.8^{b}	61.1
Control	604.0^{a}	296.8^{a}	900.8^{a}	0.0

Data are mean values, different letter indicate significant variations among different treatments

Table 6: Population growth of melon aphid after 6 days of Nerot and Torque application

	Mean No.			
Acaricide type	Nymphs	Adults	Total	Reduction (%)
Nerot	148.8^{ab}	045.0^{a}	193.8^{ab}	48.1
Torque	098.0^{b}	049.4^{a}	147.4^{b}	58.2
Control	225.8^{a}	127.0^{a}	352.8^{a}	0.0

Data are mean values, different letter indicate significant variations among different treatments

Leite *et al.*[13] which have negative effect on insect biology. This information offer good support to the data presented for the average duration of nymphal stadiums in the first stage. The other varieties tested assumed more resistance to the development of aphid than Lebanese.

Concerning the other biological aspects of *A. gossypii* and Caserta could be assigned as the most resistant variety in the light of biological data presented in Table 3. Caserta variety showed higher generation time, shorter Longevity and reproduction period (17.70 days) besides lower reproduction rate (21.71) relative to all other varieties investigated in this study. The observed low longevity might highlight the negative effect on the biology of *A. gossypii* (Table 3), classifying it as a resistant variety. Similar observation was also recorded by Baldin *et al.*[3] for the reproduction period in the Caserta variety. Regarding the intrinsic rate (rm), a parameter which describes the growth possibility of insects[19] was lower in Caserta (0.17) suggesting slow rate of growth of *A. gossypii* in this variety compared with Lebanese variety which showed (0.27). This information might explain why Caserta variety had the least suitability among other varieties concerning the development and growth of aphid. A better performance of *A. gossypii* when reared on Lebanese variety was detected compared with other varieties. On the other hand, Lebanese variety showed suitability to the development of aphis since the reproduction rate of the insect was the highest compared to others. Squash plant varieties showed different levels of tolerance to melon aphids, under experimental conditions. Caserta was most tolerant and Lebanese was most susceptible. Furthermore, lower development rate of aphid and reduced reproduction rate was reported in the resistant cotton variety[17].

Acaricidal activity of nerot and torque: Chemicals are still the most frequently method used in the management control of *A. gossypii* in squash, but this method is being replaced by other that has less negative impact to the human kind and environment in general[20]. In the current investigation, the effect of acaricides on the population growth of melon aphid was studied. Torque L550Sc Torque® and Nerot 25% E.C. Nerot® were tested against *A. gossypii* and used as acaricides in Lebanese®variety. Mortality rate was detected in different stage of the growth of *A. gossypii* at zerot time, after 3 days and after 6 days. The effect of Nerot and Torque against *A. gossypii* nymphs and adult at zero time is shown in Table 4. Mortality rate caused by application of Nerot and Torque was significantly higher than those of the two controls (0.0%). Significant variations were observed between different acaricide used in this study, Higher reduction rate was observed when Torque was applied (89.4%) when compared with Nerot (59.6%) at zero time.

Furthermore, after three and 6 days of Nerot and Torque application against *A. gossypii*, same trend of observation were noticed. Reduction rates were significantly higher than those of the two controls (0.0%). Higher reduction rate was observed when Torque was applied when compared with Nerot (Table 5, 6).

Generally, tested acaricides had a significant effect on the life parameters of melon aphids which showed had high mortality rate. The adverse effect of the chemical compounds on the biology of aphid has been well recognized[18].

Duration of killing: The time to kill the aphids was positively related to the concentration of applied acaricides (Table 4-6). Results indicated that, higher the concentration of acaricide, higher mortality rate of aphids was observed. It is expected that at zero time the acaricide concentration was higher than after 6 days. Same trend of observation was detected by Mohamad *et al.*[21]. Tested acaricides had a significant effect on the life table parameters of melon aphids and had high mortality rate.

CONCLUSION

Field experiments are required to confirm the current results. The study findings indicated that Caserta expressed high level of antibiosis against *A. gossypii* and Lebanese was most susceptible cultivar to *A. gossypii* attack. Findings needed to be confirmed by studying focusing on the changes in the physiology and metabolism of melon after following aphid attack treatment. Furthermore, Identification of the chemical composition of the different varieties is necessary for the good argumentation for the negative impact in the biology of insects.

SIGNIFICANT STATEMENTS

This study would fit in a broader framework of life science knowledge because it is an invented work in Saudi Arabia. In this investigation the biology of *Aphis gossypii* (Glover) to different squash (*Cucurbita pepo*) cultivars was recorded. Furthermore, application of two different acaricides against *A. gossypii* were studied. Moreover, the study findings highlighted the most cultivar had an ability to resist *Aphis gossypii* without acaricides application. Therefor, this study outcome will be important for scientists and it will help in taking decision in the breeding programs.

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