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The Effect of Nitrogen Fertilizer on the Cotton aphid (*Aphis gosypii)* when grown in the Cucumber (*Cucumis sativus)*

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Abstract. The cotton aphid, *Aphis gossypii* is a known pest in the agricultural industry. Aphid growths are influenced by environmental conditions, such as the species of the plant and soil nutrition. The cucumber, *Cucumis sativus* L var. *Beit Alpha* is the main host of *A. gossypii*. The aim of this research was to study the effect of nitrogen fertilizer on *A. gossypii*, including biological performance, number of alate and apterous individuals, and its life span. Three different doses of nitrogen fertilizer were used, 0, 0.5, and 0.75 g under laboratory conditions. Each treatment was replicated in triplicates. The life span of *A. gossypii* in the cucumber was found to be 27.5 ± 9.52 days, which consisted of 5.1 ± 0.57 days of the nymphal period and 21 ± 1-day in the adult period. The average of number progeny was determined to 74.7 ± 14.58. At the end of the growth period, the populations of *A. gossypii* in each nitrogen treatment were 614.33 ± 579.26 (0.75 g), 602.25 ± 159.63 (0.5 g), and 854.75 ± 453.82 (0 g). These populations indicate that there was no significant difference between the treatment. However, the infestation of *A. gossypii* caused the plant to wilt and suppressed its growth, and this infestation rate increased as the nitrogen level increased. Overall, it was found that nitrogen affected the progeny number, population, and life span of *A. gossypii*.

Keywords: *Aphis gossypii*, *Cucumis sativus*, nitrogen fertilizer.

INTRODUCTION

The cotton aphid, *Aphis gossypii* is a known pest in the agricultural industries worldwide. It's polyphagous insect, that can infect many cultivated plants such as cucumber (*Cucumis sativus*) and other Cucurbits.[1] Morphologically *A. gossypii* is a small, soft-bodied insect that varies in color and size but is mostly yellow, and may be darker in color during spring.[2,3,4] High populations of aphids are known to reduce the lifespan of a plant; however, it also reduces a plant's susceptibility to other destructive pests. When honeydew is infected with *A. gossypii* it shows a reduction in fruit quality and a growth of sooty mold is observed, which can hamper the photosynthetic activity and quality of the leaves.[5] *A. gossypii* has the potential to grow into large populations on a variety of crops under any favorable environmental conditions.[6] The biology of *A. gossypii* is unique in that mostly only females are found in nature. The female live and produce progeny in plants, and grow rapidly depending on the environmental conditions. In cotton plants it was found that a female produced 80 young females who matured within 8 to 10 days, which then have 50 generations per year. In some case, the progeny matured slightly quicker in 5 to 7 days under optimum conditions.[7]

The major factors controlling the population dynamic of an insect are the quantity and quality of the food provided by the host plant. Nitrogen is a crucial component of the plant tissue for phytopaghus insects such as *A. gossypii*.[8] An aphid will take up feed from the phloem rather than other tissues, as it contains a relatively high amount of nitrogen and will help their continual development.[8,9] Fertilizers are being extensively used to produce high-quality crops, but they are also responsible for nitrate and soluble amino acid accumulation in soil, attracting phytophagous insects to the crops. Previous studies have shown that the population growth rate and

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development of phytophagous insects are not only influenced by the plant nutrient level but also the nutrient ratio.[10]

C. sativus L var. Beit alpha (cucumber) is a crop of characteristic short dark-green smooth fruit (15-18 cm), with a parthenocarpic flower and is grown under protective structures in the Middle East.[3] In this study, the aim was to determine the effect of the nitrogen level on the number of individual of *A. gossypii,* including the number progeny in the cucumber under laboratory conditions.

MATERIALS AND METHODS

Plant Preparation

Cucumbers seeds, *(C. sativus)* was grown on petri dish, covered by filter paper. Water was continually sprayed every 2 days to ensure the paper remained wet. After 1-week, the covers were opened, and the seedlings exposed to light for 3 to 4 days. Following on from this, 7-day old seedling were transplanted into 12 cm diameter pots containing soil media, which consisted of clay, sand, and pit moss in a 1: 2: 1. Each pot contained single plant and growth was maintained for 30 days until it was ready for insect infestation. The plants were grown at room temperature inside a growth chamber.

Individual Aphid Biological Assessment

A single young leaf of the cucumber plant was placed in a 9 cm petri dish. Mature *A. gossypii* was transferred onto the leaf using a fine brush and it was kept at room temperature. Observations of the number of progeny per individual were carried out every 12 h. Each progeny born from the adult was killed using a fine needle. Observation carried out until mature or *A. gossypii* death. Ten replicates were performed.

Nitrogen Treatment

Three levels of nitrogen were tested, 0.75 g (A), 0.5 g (B), and 0 g (C), in addition a single control (D) was also used. Nitrogen was applied to the media 3 days before *A. gossypii* treatment. Each plant was infested by five mature *A. gossypii* and they were placed on three young leaves. The plant was then covered using a transparent perforated 14 kg plastic. Once again, ten replicates were performed per treatment. The plants were maintained for 14 days at 22 ± 1 °C. Everyday plants were given 50 mL waters through their pots. After 14 days the plants were harvested precisely by their crown. *A. gossypii* was collected and categorized as either adult or nymph and was later differentiated into alate or apterous individuals.

The quantitative data of adult and nymph individual *A. gossypii* for each treatment were analyzed using an analysis of variance (ANOVA). The mean values were analyzed using the Duncan's test (DMRT) with significance determined at $p < 0.05$. ANOVA and DMRT test were analyzed in the SAS 9.0 program (SAS Institute, USA). Furthermore, correlation and regression data were analyzed if required.

RESULTS AND DISCUSSION

Individual Biological Assessment

The results of ten individual *A. gossypii* assessments are presented in Table 1.

TABLE 1. Longevity of Cotton Aphid, *Aphis gossypii* on Cucumber (n=10)

Nymphal period (Days)	Adult period (Days)			Number progeny/female	Lifespan
	Preovoposition	Oviposition	Postoviposition		
5.1±0.57	0.55±0.16	11.8±0.82	10.05±7.79	74.7±14.58	27.5±9.52

The life span of *A. gossypii* on a cucumber was determined to be 27.5 ± 9.52 days, consisting of 5 days in the nymphal period, and 21-22 adult days. These data show that the aphid has a longer period as an adult, especially in a post-oviposition period. These results are consistent with previous studies, confirming that the longevities of the aphid during this study was relatively similar to normal conditions in nature.[11,12,13] The life span of *A. gossypii* is influence by both environmental conditions and the host plant nutrition. Therefore, fluctuation of environment factors can affect the longevity of *A. gossypii*, either directly or indirectly. There has been several

hosts discovered for *A. gossypii* including beans, peas, crucifers, celery, cowpea, cucurbits, dahlia, lettuce, onion, pawpaw, peppers, soybean, strawberry, sweet potato, tobacco, tulips, as well as many other plants.[14]

Aphid Abundance

In this study it was determined that there is a correlation between nitrogen fertilization and biological performance of *A. gossypii*, including longevity, adult morph, and population density. The aphid abundance under different nitrogen concentrations is shown in Table 2.

TABLE 2. Abundance of Aphid on cucumber under different level of nitrogen and plant size during treatment

Treatment	Nymph		Adults		Total	Plant Height (cm)
	Alate	Apterous	Alate	Apterous		
A	14.33±7.77 [a]	503.67±469.87 [a]	10.33±5.86 [a]	86.00±103.97 [a]	606.33±579.26[a]	6.08±1.70[a]
B	60.25±73.87 [b]	443.25±79.42 [a]	39.00±39.10 [b]	59.75±30.43 [a]	602.25±159.63[a]	5.63±0.85[a]
C	103.67±24.01 [c]	672.75±381.05 [a]	62.00±19.67 [c]	57.75±20.27 [a]	854.75±453.82[a]	5.73±1.66[a]
Control	-	-	-	-	-	5.63±1.15[a]

Note: Numbers in the same column followed by the same letter are not considered statistically significant differences ($p < 0.05$)

It was found that the abundance of *A. gossypii* in the different nitrogen treatments, 0.75 g (A), 0.5 g (B), and 0 g (C) was not significantly different, except in the number of morph alate individuals. In the plants with 0 g of nitrogen fertilizer, the highest number of *A.* gossypii individuals (854.75 ± 453.82) were found, while the 0.75 g had the lowest of number individuals (602.25 ± 159.63). The plants with the highest nitrogen concentration (0.75 g) was observed to have the tallest plants compare to the other treatments.

Nitrogen is an essential nutrient in the growth of a plant, under normal conditions without any disturbance from pest and diseases. Nitrogen fertilizer is given as it can directly affect the growth of the plant.[1] Increasing the nitrogen concentration has a positive effect on the plant growth as summarized in Table 2. However, in this study the plants under all treatments showed similar heights and may be due to the suppression of the growth of *A. gossypii*. In the presence of the *A. gossypii,* all the nutrients used in the growth of the plant are taken by the aphid, and therefore. It was observed in this study that the growth of the plant decreased as an increasing abundance of an aphid emerged.

The phloem tissue of the plant is rich in nutrition, including nitrogen, which is due to the leaf being the organ responsible for photosynthesis. Most aphids take their food from the phloem tissue due to this. Fertilizers are responsible for the high abundance of nitrogen in the soil.[15.] Therefore, increasing nitrogen concentration in the soil, increases the abundance of nutrients in the phloem of the plant.

These results illustrate that the level of nitrogen affect the morph variation of adult and immature aphids. The variations in the morph observed in this study are presented in Table 2. These variations of aphid morph may be caused by three main factors, development time, fecundity, and longevity.[8] The number of alate was found to be significantly different between the treatments. The nitrogen caused the plant to be rich in nutrients, increasing the growth of the aphid. Also, this caused a low competition between the aphid individuals and therefore there was a reduction in the alate morph. The aphid variations, including, weight, size, color, morph, and fecundity are known to be enhanced by the nitrogen level.[1,10,15] In this study it was found that without nitrogen showed the highest total aphid abundance, and this relatively decreased as nitrogen increased, indicating that competition is a major factor affecting aphid abundance.

SUMMARY

The nitrogen concentration in soil is an important factor to both plant growth and aphid abundance. These result show that that nitrogen has a positive effect on plant growth. In addition, treatment with no nitrogen fertilizer showed the total highest number of aphid individuals (854.75 ± 453.82), compared to the other treatments 0.5 g and 0.75 g. The level of nitrogen fertilizer seemingly has a relationship with *A. gossypii* abundance and morph variations. However, further investigations into this relationship between plant nitrogen composition, aphid densities, and plant yields are required.

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