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EFFICIENCY OF PREDATION *Exochomus nigromaculatus* (COLEOPTERA: COCCINELLIDAE) ON DIFFERENT DENSITIES OF CITRUS MEALYBUG NYMPHAS *Nipaecoccus viridis* (HEMIPTERA: PSEUDOCOCCIDAE)

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ABSTRACT

This study was conducted at the biological control laboratories of the Department of Plant Protection /College of Agricultural Engineering Sciences/ University of Baghdad to evaluate the effect of three numerical densities, 25, 50, and 100 of the first instar nymphs of the mealybug *Nipaecoccus viridis*, on the predatory efficiency and development and growth rates of *Exochomus nigromaculatus*. The results of the study showed that there was an inverse relationship between the increase of numerical densities of the prey provided and the development and growth rates of the predator. Also, in this result it was recorded that the shortest growth time of the larval stage was at 10.9 days, as well as a daily consumption range was between 24-45 nymphs/day. in addition, the four larval stage recorded the shortest growth period and was at a rate of 2, 1.8, 3.1, and 4 days respectively for each instar at a density of 100 mealybug nymphs. The longest growth time was during the larval stage which was 17.78 days, with a daily consumption range between 4-19 nymphs/day in treatment of density of 25 mealybug nymph, at this density, the longest developmental rates of the four larval stages also were recorded, which were 3.38, 2.9, 5.13, and 6.37 days respectively for each stage, a direct relationship was found between the increase the numerical densities of the preys provided and the consumption rates of the predator, the consumption rate were 217.09 and 391.41 nymphs At densities of 25 and 100 nymphs, respectively, in addition to this , Lowest dead rate was recorded at the larval stage of predator, and reached to 0.00% at densities of 100, while the value was highest at the density of 25 nymph which was 30% . Adult female predators recorded an increase in predation efficiency at a higher rate compared with males at the three mealybug nymph densities, as the daily predation range reached (15-21), (18-38), and (51-63) at densities of 25, 50, and 100, respectively, this was higher than the daily rates of predation recorded by predatory males. Adult females of predator consumed the highest number of nymphs during Within a period of ten days a higher rate than males at the same densities of prey.

Keywords: Predatory efficiency, Mealybug, Nutrition, Biological control, Nymphs.

[*]The article is taken from the master's thesis of the first researcher.

الكفاءة الافتراسية للمفترس *Exochomus nigromaculatus* (Coleoptera: Coccinellidae) على كثافات مختلفة من حوريات حشرة البق الدقيقي للحمضيات *Nipaecoccus viridis* (Hemiptera: Pseudococcidae)

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الخلاصة

أجريت هذه الدراسة في مختبرات المكافحة البيولوجية التابعة لقسم وقاية النبات/ كلية علوم الهندسة الزراعية/ جامعة بغداد لتقييم تأثير ثلاث كثافات عددية 25 و 50 و 100 من حوريات الطور الأول لحشرة البق الدقيقي *Nipaecoccus viridis* في الكفاءة الافتراسية ومعدلات تطور ونمو *Exochomus nigromaculatus* . وأظهرت نتائج الدراسة وجود علاقة عكسية بين زيادة الكثافات العددية للفرائس المقدمة ومعدلات تطور ونمو المفترس. كما أظهرت النتائج أن أقصر فترة نمو لمرحلة اليرقات كانت 10.9 يوم، كما تراوح معدل الاستهلاك اليومي ما بين 24-45 حورية/يوم. بالإضافة إلى ذلك، سجلت مرحلة اليرقات الأربعة أقصر فترة نمو وكانت بمعدل 2، 1.8، 3.1، 4 يوم على التوالي لكل طور وبكثافة 100 حورية بق دقيقي. أطول فترة نمو كانت خلال مرحلة اليرقات والتي بلغت 17.78 يوماً، إذ تراوح الاستهلاك اليومي ما بين 4-19 حورية/يوم في معاملة كثافة 25 حورية بق دقيقي، وعند هذه الكثافة كانت أيضاً أطول معدلات النمو في المراحل اليرقية الأربعة. والتي بلغت 3.38، 2.9، 5.13، 6.37 يوم على التوالي لكل مرحلة، وقد وجِدَ وجود علاقة طردية بين زيادة الكثافات العددية للفرائس المقدمة ومعدلات استهلاك المفترس، إذ بلغ معدل الاستهلاك 217.09 و391.41 حورية خلال عمر الطور عند كثافات 25 و 100 حورية على التوالي، بالإضافة إلى ذلك تم تسجيل أقل معدل موت في الطور اليرقي للمفترس، إذ وصل إلى 0.00% عند كثافة 100 حورية ، بينما كانت أعلى قيمة عند كثافة 25 حورية والتي كانت 30%. سجلت إناث المفترسات البالغة زيادة في كفاءة الافتراس بمعدل أعلى مقارنة بالذكور عند الكثافات الثلاث لحورية البق الدقيقي، إذ بلغ مدى الافتراس اليومي (15-21)، (18-38)، و(51-63) عند كثافات 25، 50، و100 على التوالي، وكان هذا أعلى من المعدلات اليومية للافتراس التي سجلتها الذكور المفترسة. استهلكت الإناث البالغة من الحيوانات المفترسة أكبر عدد من الحوريات خلال فترة عشرة أيام بمعدل أعلى من الذكور بنفس كثافات الفرائس.

الكلمات المفتاحية : الكفاءة الافتراسية، البق الدقيقي، تغذية، المكافحة الاحيائية، يرقات.

INTRODUCTION

The order Coleoptera is the second largest order in the insect group, and animal nutrition is the predominant one of the most of its predators. The feeding habits of these types of predators are not similar during their different life stages, as they have been showed a difference between the larval and adult stages **(Augul *et al.*, 2015)**. The Coccinellidae family, often referred to as "True ladybirds," includes up to 90 genera and more than 1,000 different species distributed throughout the world **(Escalona *et al.*, 2017)**. The family Coccinellidae is one of the largest families of insects, and it includes up to 6,000 species spread all over the world. It also includes the most important families of predatory insects that have a role in the biological control of different insect pests, they are specialized in feeding on scale insects, whiteflies, and mealybugs **(Kaydan *et al.*, 2012)**. There are different genera of predators within the Coccinellidae family that are considered as the effective and good natural enemies on the citrus mealybug, as it was found that the predator *Nephus jaderiensis* (Coleoptera: Coccinellidae) has a high ability to consume incomplete stages of the mealybug **(Awad & Al-Zubadiy, 2014)**. This species of predator belonging to this family has an effective role in regulating the population density of mealybugs **(Chrysantus, 2012)**. **Al-Rubaie & Al-Khafaji, (2015)** found that the species *C. undecimipunctata* and *C. Septempunctata*, which belongs to the Coccinellidae family, has an important role as a natural biological control agent, as it works to reduce population of mealybugs in some regions of Iraq. **Hermize *et al.*, (2022)** also they found the species *C. undecimipunctata* and *C. Septempunctata*, feeds on aphids in leaves of apricot. As well as the predator *Chilocorus bipustulatus* which is an example of a predator belonging to the Coccinellidae family, has been recorded to be an effective and very successful biological control agent on the scale insect *Parlatoria blanchardi* **(Shaimaa & AL-Rubeae, 2018)**. The predator *Cryptolaemus montrouzieri* Mulsant from the Coccinellidae family was also effective In biological control of mealybugs type of *Nipaecoccus viridis*, as it was recorded a mean of 82.37% reduction in the population of this insect, recorded 60 days after *C. montrouzieri* release **(Mani & Krishnamoorthy, 2008)**. Also, the eggs of *Nipaecoccus viridis* mealybug were preferred more than any other stages by most stages of *Hyperaspis polita* that belongs to Coccinellidae family **(Farhadi *et al.*, 2018)**. The use of natural enemies in biological control is more effective than other biological control methods, as the use of entomopathogenic fungi, including *Metarhizium anisopiliae* and the *Beauvaria bassiana* fungus, has shown a Ineffectiveness on high temperatures when the are used to control *Maladerrainsanabilis* (brenske) **(Al-Jassani & Al-Jubouri, 2019)**. As for chemical control methods, using pesticides that have a negative impact on the environment, as well as on various types of predatory insects that act as natural enemies and are useful in biological control **,** the use of pesticides on crops and different varieties of plants will indirectly lead to a population explosion of insects populations, and its effects will also include the spread of diseases and the emergence of resistance in many species of insect pests, as well as the occurrence of side effect on non-target species of insects exposed to pesticides **,** biological control agents could be an alternative approach to chemical pesticides for controlling insect pest in both green house and field **(Johari *et al.*, 2019)**. The predator *E. nigromaculatus* is effective species which could be used in biological control programs to reduce the population of mealybugs and aphids, as well as the egg stage of other types of insect pests **(Mohamed *et al.*, 2008)**. Various studies have indicated that the predator *E. nigromaculatus* was suitable for use in biological control program. This predator can be artificially reared under laboratory conditions and released into the fields for controlling insect pests because its ability to consume high amount of insets and it has high and active searching aptness **(Atlihan & Kaydan, 2002; Mohamed *et al.*, 2008)**. This type of predator can also be an effective agent in biological control in order to reduce the spread of the mealybug pest in some regions in Baghdad Iraq, as this type of pest has been recorded on 4 different fruit trees, in addition to two vegetable crops and more of 19 plant species belonging to 14 plant families. **(Abdul Rassoul & Hermize, 2018)**. Coccidian insects in general are among the insects that cause significant losses in agricultural production and various crops in different regions of the world due to their ability to feed on different types of agricultural crops and cause big damage to plants and crops , either directly or when fed on the stems and leaves of the plant, or indirectly, represented by their ability to transmit dangerous viruses and diseases to the plant **(Adhab ,2021; Adhab *et al.* ,2021; Adhab *et al.* ,2019)**.

MATERIALS AND METHODS

Rearing the Predator

The experiments were carried out in the laboratories of the Plant Protection Department/College of Agricultural Engineering Sciences/University of Baghdad , Adult male and female predators were collected from okra crop fields grown in the Bismayah province, northeast of Baghdad , by collecting leaves by hand , after bringing them to the laboratory, they were identified and placed into plastic cages (50 x 50 x 75 cm) for development and rearing , which was opened from the top and covered by a piece of cloth. This piece was tightly secured using a rubber band in order to prevent escaping of the adults. These specimens were take placed in the laboratory for establishing a colony and providing the adequate numbers of predators to conduct the experimentsof this study they mealybug was reared using potato tubers , mealybug *Nipaecoccus viridis* was collected from citrus fruits, .To increase female fertility, an artificial food consisting of water, sugar, and yeast was given, and the food was provided using pieces of cotton saturated with the solution and placed inside 10 cm dishes **(Tassan *et al.*, 1979)**. To provide appropriate humidity, small pieces of cotton moistened with water were placed inside plastic dishes **(Grafton-Cardwell & Gu, 2003)**. For the purpose of creating a suitable place for predatory females to lay eggs, a layer of multicell sandwich cardboard with dimensions (15 x 20 cm) was added to the rearing cages for the purpose of providing a suitable place for predatory females to lay eggs **(Hilal, 1983)**. An incubator type BINDER was used for laboratory experiments at a temperature 20C°, 30C°, and the relative humidity was 60±5%, and the photoperiod (16-8) hours. The eggs were collected daily to prevent self-predation by the adults inside the rearing cages. After that, the eggs were transferred to special rearing rooms when with temperature of 29±1C° and a relative humidity of 60±5%, an air conditioner was used to provide suitable conditions, with a photoperiod (8-16) hours **(Morrison *et al.*, 1975)**. The eggs laid by the females were in the form of masses in most cases and were located on the inner surface of the proboscis, on the walls and corners of the plastic cage, or on or on the layer of multi-celled cardboard (Multi Celled Sandwich) , the eggs were isolated inside plastic boxes of size (10 × 5 cm), covered with white milling cloth And it was installed with a rubber band, one egg individually inside each plastic box to prevent self-predation (Canniblism) , it is monitored daily until the larvae emerge after the eggs hatch and are fed on mealybug nymphs until they reach After the emergence of adults, the pupae are distributed among the breeding boxes in the form of male and female pairs, if the sexes are differentiated based on the size of the body and the shape of the abdomen, if the females are larger in size than the males **(Finney, 1948)**. It was provided with the necessary food from mealybug nymphs, breeding continued for several months and it took on all the roles of the predator during the study after controlling the temperature and humidity inside the incubator.

Mass-rearing of Mealybugs

Citrus mealybug *Nipaecoccus viridis* were collected from the infected leaves and fruits of citrus trees from several orchards in the Suwayra District (Eastern Jumaysa region , Near Essaouira Grand Bridge) , these samples were transferred to the laboratories of the Plant Protection Department/College of Agricultural Engineering Sciences/University of Baghdad for identification , some samples were sent to the Natural History Museum at the University of Baghdad to confirm the diagnosis, and insects were reared and developed on potato tubers to prepare the colony required to conduct laboratory experiments. The tubers were washed with water before using to remove dirt and dust and then were sterilized using 5% sodium hypochlorate solution to control pathogenic bacteria and fungi on the surface of the tubers. The potato tubers were placed inside plastic boxes with dimensions (9 x 32 x 50 cm) and placed infected specimens **(Martinez & Suris, 1987)**. After that, they were transferred to a controlled rearing, the colony was monitored constantly, The old tubers were replaced with new ones for continued growth and development of insects, the boxes were also kept in completed darkness condition during the first days, to ensure that the first instar nymphs are not attracted to the light and to ensure that they settle on the sprouting buds of the tubers.

Evaluation of predation Efficiency of Larvae and Adults of *E. Nigromaculatus* on different density of Nymphs

The larvae and one-day-old adults of predator were transferred from the rearing cages for bioassay as previously mentioned, and each was placed inside a plastic dishes (5× 10 cm), each larva was prepared daily at a density of 25, 50, and 100 second-instar nymphs. mealybug, 5 replicates per treatment, with 10 larvae per replicate. The experiments are carried out inside petri dishes that were opened at the top and covered with a piece of mesh cloth and closed tightly with a rubber band, after that, the dishes were placed inside the incubator at a temperature of 30 ºC±1 and the relative humidity was 65±5% and the photoperiod was 14 hours (10 light and 4 darkness), and the number of nymphs consumed by the predator larvae was recorded daily for each larval stage, and the consumed food was replaced with new food, also, in each treatment, the duration of the larval stages and their duration ratios were recorded,. The following equation was used to extract predatory efficiency values **(Al-Hajiya, 2011)**.

$$Daily\ predatory\ efficiency = \frac{Number\ of\ mealybug\ nymphs\ consumed\ by\ each\ larval\ stage}{Duration\ of\ the\ larval\ stage/day}$$

$$Percentage\ of\ death = \frac{Number\ of\ dead\ larvae}{Total\ number\ of\ larvae} \times 100\%$$

The predatory efficiency of female and male adults was also recorded using the same numerical densities of citrus mealybug nymphs, under the same conditions of temperature, humidity, and photoperiod, as well as the same number of replicates for ten days.

Statistical Analysis

The results of the laboratory experiments were analyzed through a completely randomized design (CRD), and the least significant difference (LSD) test was adopted under the 0.05 level to ensure the least significant difference between the rates of the different coefficients **(Alrawi & Abdul Aziz, 1980)**. The (GenStat.7) program was used to analyze the results of the functional response to the predator *E. nigromaculatus* **(Payne *et al.*, 2003)**.

RESULTS AND DISCUSSION

The results of (Table,1) shows Daily predation rates of first instar larvae of predator were increased by increasing the density of mealybug nymph. The daily predation rates for the first instar were 6.67, 14.69, and 28.376 nymphs/day at densities of 25, 50, and 100 of citrus mealybug nymphs, respectively, with clear significant differences between the densities provided to the first instar larvae of the predator , it was also found that the average duration of the development of the first instar larvae of the predator differed with an increase in the numerical densities provided to the mealybug nymphs, as it reached, 3.38, 2.89, and 2 days at densities, 25 50 and 100, respectively, with clear significant differences between the provided densities. As **Abdul Rahman (2020)** recorded that the lowest mortality rate was in the first instar of the predator *E. nigromaculatus,* which reached to 18.28 nymphs when reared on mealybugs.

Table (1): Predation efficiency of the first larval instar of *E.nigromaculatus* on the first instar nymphs of citrus mealybug.

First instar nymphs of citrus mealybugs	Range of nymphs consumed(day)	Duration time of first nymphal instar(day)	Mean of nymphs consumed/day	Duration time instar/day
25	4-9	3-4	6.67	3.38
50	11-18	2-3	14.7	2.89
100	24-32	1-2	27.97	2.2
L.S.D			0.81	0.59

The results in (Table,2) shows that the rates of development duration for the second instar larvae of the predator decreased with increasing numerical densities provided which reached to 2.8, 2.48, and 1.8 days at densities of 25, 50, and 100, respectively. Also, it was observed that there were significant differences in the duration of development of the second instar larvae, it was found out that the daily predation rates for second-instar larvae increased with increasing numerical densities provided and reaching to 9.79, 17.64, and 35.45 nymphs/day when feeding at densities of 25, 50, and 100 nymphs, respectively. The results of the statistical analysis showed that there were significant differences in daily predation rates, for the second instar larvae. **Abdul Rahman (2020)** reported that the lowest mortality rate in the second larval instar of the predator, as the mortality rate reached 11.88 larvae when raised on mealybugs.

Table (2): Predation efficiency of the second instat larvae stage of instar *E.nigromaculatus* on the first instar nymphs of citrus mealybug.

First instar nymphs of citrus mealybugs	Range of nymphs consumed(day)	Duration time of first nymphal instar(day)	Mean of nymphs consumed / day	Duration time instar/day
25	7-13	2.5-3.5	9.61	2.90
50	14-20	2-3	17.65	2.48
100	31-39	1-2	35.45	1.80
L.S.D			1.85	0.54

Also the results in (Table,3) indicates that the daily predation rates of the third instar larvae of the predator were increased by increasing the numerical densities of the citrus mealybugs provided daily, the highest daily predation rates was 38.11 nymphs/day, and the minimum development period was 3.1 days at a density of 100 prey of mealybug nymphs. in the density of 25 prey, the highest development period reached to 5.13 days, and the lowest daily predation rates were recorded,reached to 15.19 nymphs/day, and daily consumption rates reached 20.99 nymphs/day, and the larval development period was also 4.6 days at a density of 50 mealybug nymphs . **Abdul Rahman (2020)** illustrated that the highest mortality rate in the third instar larvae of the predator *E. nigromaculatus*, as the mortality rate in this instar reached the highest rate of all four larval instars, reaching 25.39 larvae when feeding on mealybugs.

Table (3): Pradation efficiency of the third instar larvae stage of instar *E.nigromaculatus* on the first instar nymphs of the citrus mealybug.

First instar nymphs of citrus mealybugs	Range of nymphs consumed(day)	Duration time of first nymphal instar(day)	Mean of nymphs consumed / day	Duration time instar/day
25	13-17	5-6	15.20	5.13
50	18-23	4-5	20.22	4.60
100	36-42	3-4	38.10	3.10
L.S.D			1.12	0.55

The results in (Table,4) indicates that the daily predation rate increases as predator larvae age, as well as with increasing population densities of nymphs provided for feeding, as it reached 41.73 nymphs/day at population densities of 100 mealybug prey, and the shortest development period was recorded, reaching 4 days, when the predator feeds in the density of 25 prey, predation rates decrease and the duration of larval development increases, reaching

17.19 nymphs/day and 6.37 days, respectively , while daily predation rates and the duration of development of fourth-instar larvae of the predator at a prey density of 50 nymphs reached to 26.06. nymph/day and development period of 5.1 days, respectively, it was noted that there were clear significant differences between the different densities of nymphs on which the fourth instar predator larvae feed. Also, **Abdul Rahman (2020**) illustrated that the high mortality rate for this stage, as the mortality rate reached 21.27 larvae when raised on mealybugs.

Table (4): Pradation efficiency of the fourth instar larvae stage of instar *E.nigromaculatus* on the first instar nymphs of the citrus mealybug.

First instar nymphs of citrus mealybugs	**Range of nymphs consumed(day)**	**Duration time of first nymphal instar(day)**	**Mean of nymphs consumed / day**	**Duration time instar/day**
25	14-19	6-7	15.29	6.37
50	20-29	5-6	25.97	5.10
100	37-45	4-5	41.73	4
L.S.D			3.97	0.68

The results of (Table, 5) indicates that the final rates of preation efficiency for the four instar larvae of predator *E. nigromaculatus*, it was recorded that the daily predation rates for the entire larval stage reached to 12. nymphs/day, while the development rate reached to 17.78 days at a density of 25 nymphs of mealybugs, and the total consumption was the total instar was 217.09 nymphs, while the at population density of 50 nymphs were different, as daily consumption rates reached to 19.72 nymphs/day, while it was found that the duration of development of the predator’s larval stage amounted to 15.07 days at a density of 50 nymphs, and the total consumption amounted to 297.57 nymphs, We notice There are clear significant differences between the daily predation rates and the total number of predation at the densities of 25 and 50 nymphs, however, at the population density of 100 nymphs, the daily consumption rates reached 35.91 nymphs/day, and the period of development of the larval stage of the predator reached 10.9 days, and the total amount of consumption over a period of the duration of the larval stage reached to 391.41 nymphs.

Table (5): Pradation efficiency of the larvae instar of *E.nigromaculatus* on the first instar nymphs of citrus mealybug.

Density of first nymphal instar of citrus mealybugs	Range of nymphs consumed(day)	Total number of nymphs consumed in the larval stage/day	Mean of nymphs consumed / day	Duration of the larval stage/day
25	4-19	229.36	12.9	17.78
50	11-29	257.74	19.72	13.07
100	24-45	391.31	35.9	10.9
L.S.D			8.07	2.11

The results were obtained in this study and showed in each of the tables (1-2-3-4-5), it was found that the rates of larval development duration and daily predation rates, as well as the total number of pry, differ according to the densities provided to the predator larval stage, as the predation efficiency increases with an increase the number of prey also reduces the length of the larval stage, the reason for this is that increasing the numerical density of the prey increases the efficiency of daily predation of the predator, to increase has activity and its size, which increases its need for larger quantities of food necessary to provide the energy necessary for it to perform its vital activities, the difference in densities had the Significant impact an impact on the duration of larval development of the predator *E. nigromaculatus*, as the shortest duration of development of the larval stage was at a density of 100 nymphs and the longest duration of development of the larval stage was at a density of 25 nymphs. Likewise, **Mougi & Iwasa (2011)** found out that in a similar study on predators that predators had ability to increase their predation efficiency by increasing the population densities of host. They also found that increasing the prey provided to the predator increased consumption rates, and reduced the period required for growth, and increased the size of the predator, and the opposite was true if the numbers of prey offered to the predator decrease.

The results presented in (table,6) indicate that when feeding predatory adults, males and females, at different population densities of citrus mealybug nymphs, for a period, there was a difference in their predatory efficiency, when feeding the density of 25 nymphs per day to predatory adults, females and males, there was a difference, the numbers of nymphs consumed amounted to 185 and 152 nymphs, respectively, with a daily predation rate of 18.5 and 15.2 nymphs, respectively , the daily consumption range for females and males was estimated at (15-21) nymphs and (13-18) nymphs, respectively, and when numerical densities increased. For adult female predators, daily predation increases until it reaches its highest rate at a population density of 100 nymphs, reaching 570 and 363 nymphs for females and males, respectively, over a period of ten days, with a daily rate of predation of 57 and 36.39 nymphs, respectively , the daily limit for consumption by females and Males are (51-63) nymphs and (33-39) nymphs, respectively , through the values obtained, it is noted that there are differences between the daily predation rates of adult females and males at densities of 25 and 100 nymphs, the reason for this is due to an increase in Preparing the prepared prey and thus increasing the predatory efficiency. When the density was prepared at an average number of 50 nymphs, the predation rates for females and males at the prepared density for feeding were 343 and 240 nymphs, respectively, for a period of ten days, with a daily consumption rate of 34.3

and 24 nymphs per day, respectively. The daily range of what was consumed by females and males was (18-38) nymphs and (20-27) nymphs, respectively, with clear significant differences from the rest of the population prepared from citrus mealybug nymphs. **Abdul Rahman (2020)** also indicated in a study they conducted that the entire female and male predator *E. nigromaculatus* did not record any deaths when the predator was raised on mealybugs during their rearing period. **Mohamed *et al.*, (2008)** stated that the differences in Survival and fertility rates of the predator *E. nigromaculatus* indicate that there are effects related to the efficiency of the predator and the numerical density of the targeted prey.

Table (6): Pradation efficiency of female and male predator *E. nigromaculatus* on first instar nymphs of citrus mealybug.

Density of first nymphal instar of citrus mealybugs	Daily range of predation for each female	Daily range of predation for each male	Number of nymphs consumed over a period of ten days per adult female predator	Number of nymphs consumed over a period of ten days per adult male predator
25	15-21	13-18	187	148.6
50	18-38	20-27	342.6	243.6
100	51-63	33-39	575.2	364.0
L.S.D			11.39	10.25

CONCLUSION

This study showed that the duration of the larval stages of the predator *E. nigromaculatus* and the death rates were increased to the increase in the numerical densities of the prey provided, as it was shown that the development rates of the insect differ according to the numerical densities of the prey provided to it, as the larval stage took 10.9 days, which is the shortest period of time. At the population density of 100 nymphs, the death rate of larvae was 0.00%, while the average duration of the larval stages increased to 17.78 days at the population density of 25 nymphs, an increase in the death rate of nymphs was recorded, reaching 30%. The results also showed that the predator and during the four larval stages the recorded the best and fastest indicators of growth and development at high numerical densities of prey , It is also clear that the results showed that the older adults, their predation efficiency increases, and female predators were more voracious towards mealybug nymphs than male predators, at the three numerical densities tested , the reason of this was that females need to provide amounts of energy for the process of laying eggs, as they required more food than what males needed , it is becomes clear that differences in the numerical densities of prey have a significant impact on the longevity of the larvae and their daily consumption rates.

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