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Functional Response of Common Green Lacewing *Chrysoperla carnea* (Stephens) on black bean aphid *Aphis fabae* (Scopoli)

*Shaymaa Abdulkhaliq Alhamawandy
Plant Protection Department. college of Agriculture. Baghdad University
Corresponding Author: Shaymaa Abdulkhaliq Alhamawandy

Abstract: *The functional response of common green lacewing Chrysoperla carnea (Stephens) on black bean aphid (Aphis fabae Scopoli) was studied in the biology unit at 25 C⁰. Functional response curves showed that common green lacewing larvae followed the second type (cyclic) of functional response patterns. The functional response of the predator common green lacewing increased with the increase in population density, i. e. the opportunities of the common green lacewing for facing the prey increased at high density and then increased in the number of consumed prey in comparison with low density. When calculating the attack coefficient (a) and handling time (T_h), increase in (a) and decrease in (T_h) were found during the development of the predator common green lacewing C. carnea. The highest attack coefficient (a) was 0.976 at the third phase of the predator C. carnea, whereas, the lowest attack coefficient (a) was 0.635 at the first phase of predator C. carnea, and it was 0.654 at the second phase. In contrary, handling time (T_h) decreased to 5.328 min., the shortest period of handling time (T_h), at the third phase of the predator C. carnea, whereas the longest period of handling time (T_h) was 21.6 at the first phase of predator C. carnea, and at the second phase the handling time (T_h) of predator C. carnea was12.6. Also attack coefficient (a) increased and handling time (T_h) decreased during the development of the common green lacewing C. carnea larvae.*

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I. Introduction

Biological control is one of the oldest and most progressive methods that was used for controlling pest, especially the delicatessen insects because of the number more of bio enemies (1,6). The adoption of bio enemies is essential part of integrated pest management methods.

The predation process consists of two major:- the predators density and the pry density, and Predator consumption rate of change relative to the prey density leads to a change predation process components which affect results of these process, especially the population density for each of prey and predator which represent the basic part of predation process. Prey density increase leads to functional and numerical responses in the predator which can be confirmed by testing their main components to clarify the predation process And rely on predators that goes back to the Mantis Mantidae family in the study of how can be confirmed by testing their main components to clarify the predation process (11) . Prey and predator density represent the basic part of predatory process. Densities of each of prey and predator represent the basic part of predation process. Functional response has been described as the changes in numbers of preys attacked by one predator during a specific time, when the prey population density changes. Numerical response is the increase in predator numbers as a result of prey population increase (18).

The predator **common green lacewing** *Chrysoperla carnea* (Stephens), which is characterized by high predation efficiently for many insects (3,5,17) But the strong correlation between predator and the insect *Aphis fabae* Scopoli, since this pest is very widespread on many of Agricultural crops. (4). as. For this importance, this research aims to evaluate the functional response of *Chrysoperla carnea* (Stephens) larvae when they are fed on different population densities of black bean aphid nymphs.

II. Materials And Methods

Raising the predator Chrysoperla carnea (Stephens)

1- Raising the predator *Chrysoperla carnea* (Stephens)

Males and females of *C. carnea* (Stephens) were collected from a citrus grove. The trees were varied in height and infected by Different insects ,for preparing the laboratory colony to be used later in supplying enough number of predators to be tested after their classification . Adult predators were placed in breeding glass cages dimensioned 40 x 80 x 40 cm. Upper slot was blocked with a piece of cloth and fixed by a rubber bond. They were provided food consisted of yeast, sugar, and distilled water in rate of 4: 7: 10 respectively (10) . The insect adults laid their eggs on the cloth lid of the slots. The cloth lid was lifted daily from breeding boxes to isolate the eggs by cutting the cloth into small pieces each of them contained one egg and putting them lonely in glass tubes sized 1.5 x 5. 5 cm. Then, the tubes were blocked by cloth pieces and fixed by rubber bonds. They were watched daily till the eggs hatching and larvae got out (2). The larvae were fed every day on individuals of black bean aphid until they became pupas. Different instar of predator were taken for investigation.

Preparing colonies of black bean aphid Aphis fabae* (Scopoli*)

For getting numbers of black bean aphid (*Aphis fabae* Scopoli) individuals, broad bean seeds (Cyprus variety) were planted in pottery pots (10 x 20 cm) placed in the canopy, for testing. When the plans reached 10 cm height, they were infested by bean aphid black. After their population of aphid increased. Taking Enough numbers for testing in experiment in the study (2) .

Determine the form of the functional response and calculating the attack coefficient and handling time of Chrysoperla carnea (Stephens) larvae toward the prey.

Larvae in an age of one day were taken from studying breeding cages and each of them was placed in a 5 x 12 cm size plastic container. Each larva was supplied daily by one of the treatments of population densities, 15, 30, and 45 nymphs of black bean aphid. Each treatment included 10 larvae and replicated five times. Number of nymphs consumed by each larva phase was calculated daily till the pupal phase. In order to determine the general form for a functional response of predator larvae accurately and analyze the functional response curve, the relation between consumed prey number (H_a) and prey density (H) was drawn. To distinguish between the second and third types of patterns of functional response, relation curve between prey killing ratio (consumed prey number (H_a)/ prey density (H)) and prey density (H) was drawn. Increase in killing ratio as a result of the prey density increase represented the third pattern appearance of functional response, whereas the decrease killing ratio to gradually increase of prey density represented a second pattern of functional response (22,15). Attack coefficient (a) and Handling time (H_h) for three larva phases were calculated depending on the model (12). These activities are dependent on total time available for predator. Amount of predator consumption, according to that model is limited even with the existence of enough number of prey, and the predator does not need more time to look for a prey, instead, it needs time for handling (Handling time). So Total time (T) is the time that spends on looking for the predator which is called searching time (T_s) and Handling time (H_h), as the following equation:-

$T = T_s + H_h$

T = Total time to research , Ts = Find time , Th = processing time

Supposing that the predator consumes a number of prey (H_a) during the total available time, so the handling time should (H_h) be relative to the number of prey consumed by the predator, therefore:

$T_h = H_a.\ H_h$

The predator continues passing time in looking for the prey found in region and consuming them according to available density.

Then:

$$H_a = a \cdot H \cdot T_{search} \qquad \boxed{T_{search} = \frac{H_a}{a \cdot H}}$$

Since the

$$\boxed{T = T_{search} + T_{handling} = H_a \cdot T_h + \frac{H_a}{a \cdot H}}$$

Equal to (Ha), the number of prey consumed

$$\boxed{H_a = \frac{a \cdot H \cdot T}{1 + a \cdot H \cdot T_h}}$$

This equation was called "disc equation" by (12). It was applied in the current study to calculate attack coefficient (a) and handling time (H_h) after converting the disc equation into linear equation, as follows:

$$H_a = \frac{a \cdot H \cdot T}{1 + a \cdot H \cdot T_h} \Rightarrow \underbrace{\frac{1}{H_a}}_{y} = \underbrace{\frac{1}{a}}_{\alpha} \cdot \underbrace{\frac{1}{H \cdot T}}_{x} + \underbrace{\frac{T_h}{T}}_{\beta}$$

$$y = \alpha x + \beta$$

H_a: number of prey consumed by one predator
a: attack rate
H: prey density
T: total time
T_h: handling time
α: cross point of the straight line
β: slope of line X

III. Results And Discussion

Evaluating of the functional response of *Chrysoperla carnea* (Stephens) larvae through rearing them on different population densities of black bean aphid (*Aphis fabae* Scopoli)Results, in (figure 1), showed that the increase in the number of *Aphis fabae* insects consumed by predator *Chrysoperla carnea* at low population densities led to a deviation from a straight line, because the increase in the number of consumed prey were decreased in rate. Thus, the functional response of *Chrysoperla carnea* larva pattern corresponded, to the different densities of *Aphis fabae* nymphs, with the cyclic pattern which considered the most common pattern among insect predators (15,22,24). It was noticed also there was a response from *Chrysoperla carnea* to the prey population density increase. In other words, increasing the chances of *Chrysoperla carnea* confrontation with the prey at high prey density (figure 2). What would confirm the results, the functional response of predator was inversely density-dependant that demonstrated possession of *Chrysoperla carnea* to a good characteristic, looking for prey at high and low density. So it would be able to reduce prey population. Results referred to high appropriateness and correspondence to the functional response curve according to Rogers equation (1972), which describes the actual data except some cases in which the evaluation of attack number is slightly less than at low density or slightly higher than at high density. This pattern of response was referred (18), regarding to *C. carnea* during its feeding on the eggs of *Heliothis virscens* F), and it was also found in many Arthropod predators like ladybirds (13,14,23) .

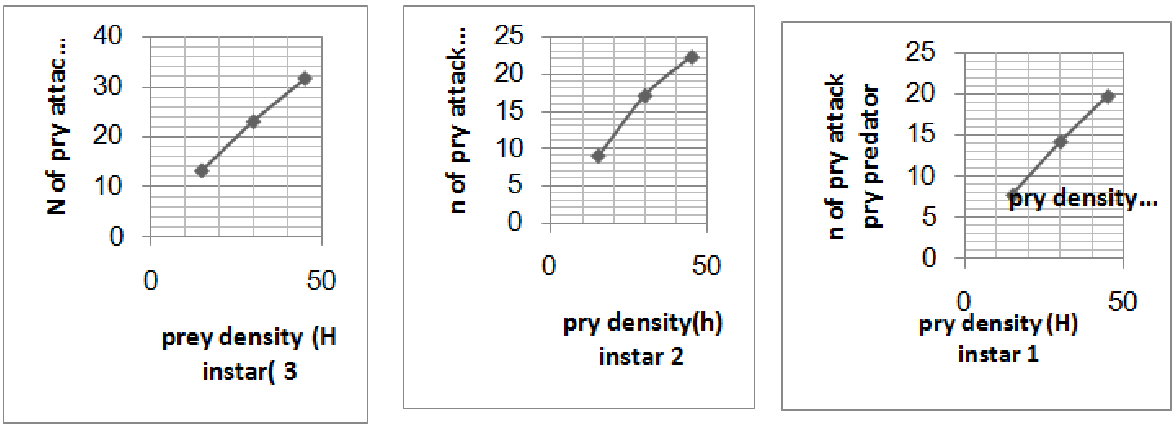

Figure (1): The patterns of functional response for every instar of *C. carnea* to *A. fabae* nymphs

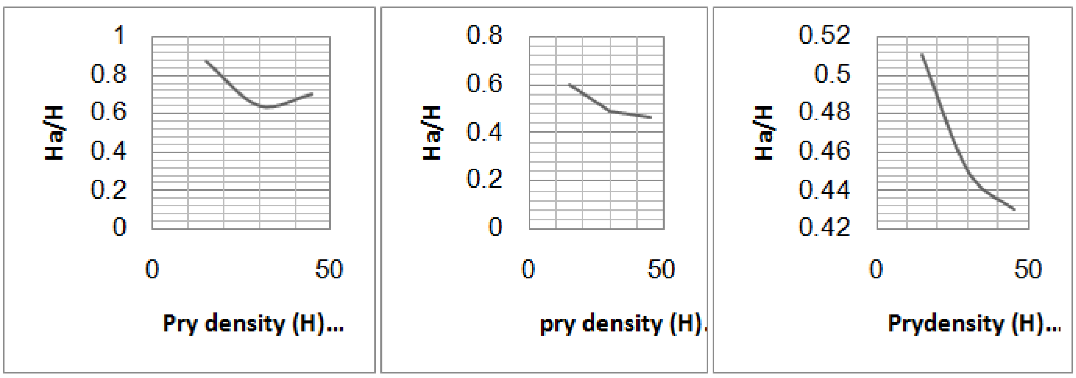

Figure (2) the relationship between The rate of prey that was consumed by *C. carnea* {H/ H_a} and the number of prey provided by *A. fabae* Scopoli nymphs

The results of attack coefficient (a) and Handling time (T_h) (figure 3) explained an increase in (a) and decrease in (T_h) with the development of *C. carnea* larvae. The highest attack coefficient (a) was 0.976 recorded at the third instar of *C. carnea* larvae whereas the lowest value 0.635 was recorded at the first phase, and at the second instar, it was 0.654. On the contrary, the shortest period of attack time (T_h) was 5.328 min. at third phase of the predator larvae *C. carnea*, the longest period of attack time (T_h) was 21.6 min. at the first phase, and at the second instar, it was 12.24 min. The results of this study were similar to the interaction study between predator and prey for various species. In some of them, fixed size of prey was used against varied phases of predator, and in the others, there were variation in phases of prey and predators (14, ,20,21, 23).Changes in (a) and (b) values at diversity prey and predator size are correlated to the changes that occur in the secondary components of two criteria as the small prey is easy to be stalked, preyed and digested in comparison with large prey (8). Similarly, the large predator usually looking faster and achieve greater success in hunting in comparison with the small predators that face the same size of the prey (7,9). It should be noted that the values of the attack coefficient and handling time which were calculated from functional response curves represented the average values of these criteria for(22) preceded by subjecting the predator to starvation making the hunger levels decreasing throughout the experiment at rates differ with the difference of prey density. This change in hunger level affects the second components which affect the values of attack coefficient and handling time(12). It has been observed in similar studies that increase in the speed of hungry individual movement, in comparison with less hunger individuals, increase the opportunity to meet with the prey (9).

Digestion point, which is considered one of the secondary components of handling time that follow a successful attack, increases harmonically with the increase in the consumed prey and the interaction distance which comes from leaving the hungry individuals to hunting locations and pursuit the prey.

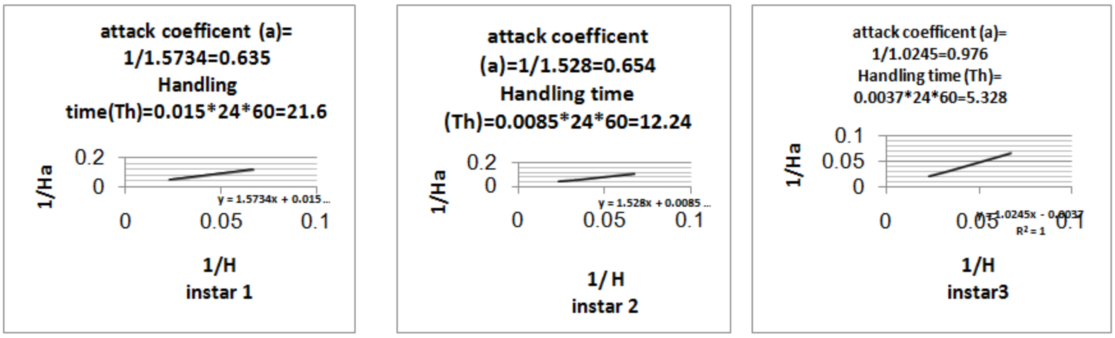

Figure 3. It explains attack coefficient (a) and Handling time (Th) Each stage of *C.*carnea

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