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Original Research Article

FUNCTIONAL RESPONSE OF LARVAL INSTARS OF *CHRYSOPERLA CARNEA* (NEUROPTERA: CHRYSOPIDAE) FED ON *MACROSIPHUM ROSAE* (HEMIPTERA: APHIDIDAE) UNDER LABORATORY CONDITIONS

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Abstract: *The functional response of larval instar of Chrysoperla carnea (Neuroptera: Chrysopidae) fed on rose aphids (Macrosiphum rosae) was investigated to check their predatory potential as biological control agent. This study examined the predation patterns of first, second and third larval instars of C. carnea when exposed to varying densities of rose aphids under controlled laboratory conditions at Department of Entomology, University of Agriculture, Faisalabad. The results showed that all larval stages of C. carnea significantly consumed rose aphids M. rosae. The density of rose aphids (Macrosiphum rosae) had no impact on the functional response of larval instars of green lacewing. Among larval stages, 3rd instar larvae of green lacewing exhibited the highest predation rates on all densities of rose aphids, followed by 2nd and 1st instars. However, aphid consumption rate of larval instars of C. carnea increased with increase in larval stages. Overall, these findings emphasize the significance of larval stages in the predatory performance of green lacewing and highlight the importance of 3rd instar larvae in biological control applications.*

Keywords: Biological Control, Chrysoperla Canea, Functional Response, Larval Instars, Rose Aphid (*Macrosiphum Rosae*)

Introduction

The adverse effects of chemicals insecticides on environment and human health, have led to perceive the need of alternative approaches of pest management, which are sustainable, eco-friendly and economically viable (Rana et al., 2017). It can be achieved through the development of alternative methods for insect pests' control such as IPM approaches, botanicals and biological control (predators and parasites) (Akter et al., 2015). Over the past few decades, biological control has been a crucial approach in managing the insect pests (mostly aphids) (Farhan et al., 2019). The biological control agents related to families such as Himeptera, Diptera, Hymenoptera, Coleoptera and Neuropteran, potentially used for control of many insect pests. These natural enemies commercially reared and released to the agro-ecosystem as an ecofriendly approach for pest management. The biological control agent, green lacewing (*Chrysoperla carnea* S.) (Helaly, 2021) is a common, polyphagous and an important predator of many soft body insect pests (Memon et al., 2015). The larval instars of green lacewing actively feed on soft body insects like whitefly, thrips, Jassid, caterpillar, leaf hoppers, mites, aphids and insect eggs (Halder et al., 2021), the adults of lacewing only feed on honeydew secreted by aphids, nectar and pollens, and lived independently (Luquet et al., 2021). However, aphids are considered as the most preferred host of green lacewing (Lerault et al., 2021). The predatory *Chrysoperla carnea* is now frequently cultured in laboratories and extensively used world wise for control of soft body insects (Ismail et al., 2023). It has greater potential for commercialization and used against various pests in combination with different IPM strategies (Mazza et al., 2021). The application of these insect predators and parasites decreases the use of pesticides and save money (Ghongade et al., 2023). Thus, exploring the biotic potential of predator is an important approach for the effective management of insect pest's agroecosystem and it helps us to measure the numbers of natural enemies to be released in the farmer's field. The Rose aphids (*Macrosiphum rosae*) is the insect pest of rose or causes significant loses to ornamental plants (Quratulain et al., 2015) and considered as an important host of green lace wing. Therefore, knowing the significance of *C. carnea* in agriculture, their role in development of effective and ecofriendly management approach against aphids, the present study was conducted with the objective to check the functional response of larval instars of *Chrysoperla carnea* (Neuroptera: Chrysopidae) fed on *Macrosiphum rosae* (Hemiptera: Aphididae) (Yousuf et al., 2020).

Methodology

The present study was conducted to check the functional response of larval instars of *Chrysoperla* carnea

(Neuroptera: Chrysopidae) fed on *Macrosiphum rosae* (Hemiptera: Aphididae) during 2016 under laboratory conditions at 26±2℃ temperature and 70% Relative humidity in national agriculture research center Islamabad.
The rose aphids (*Macrosiphum rosae*) were collected from different flowering and fodder crops at the national agriculture research center Islamabad. The collected aphids were then identified using microscope for sorting of rose aphid. After sorting the rose aphids were kept at room temperature 26±2℃ and 70% R.H for feeding trial. The fresh aphids were used for trial.
The rearing of green lacewing has been done by follow the procedure described by Farhan et al. (2019). The *C. carnea* (larvae and adults) were collected from nearby cotton fields in plastic vials. The larvae of green lacewing provided with eggs of *Sitotroga cerealella* (already established cultured in biocontrol lab). C carnea adults were reared in a rectangular cage, made of 6cm thick, transparent plastic sheet. The cage is 35cm long, 35 cm high and 20 cm wide. Two circular windows, each of 13 cm diameters, covered with lids of the same material, situated diagonally near opposite comers of a front wall of the cage, are made for handling adults, as well as for cleaning sanitation and provision of water in petri dish etc. Artificial standard foods containing yeast + sugar + honey + water (2: 1:1:4) were provided in small food bowls, of 0.5 cm diameter, engraved in the upper side of two plastic rods each of 4 mm thick and 22 cm long, running width wise at the opposite ends inside the cage. A sieve of circular holes (2 mm diameter) is drilled into the sidewalls to ensure proper ventilation in the cage, for better survival and fecundity of adults. A black paper underside the removable top of the new cage is a real substitute for oviposition. On daily basis the eggs were collected with help of camel hairbrush and razer and placed into plastic petri plates for hatching.
The experiment was performed according the describe method by Iesa (2021). To check the functional response of green lacewing on rose aphids the newly hatched larvae were transferred to plastic containers with a fine camel brush. The containers were provided the fine muslin cloth at the top for ventilation. The counted numbers of rose aphids released in container. The experiment was laid out in such a way that the 1st instar larvae of green lacewing were provided with rose aphids (considered as treatments T_1, T_2, T_3, T_4 and T_5) having densities (10, 20, 30, 40 and 50 aphids) each with three replications. Similarly, the 2nd instar provided with (15, 30, 45, 60 and 75 aphids) and 3rd instar were provided with 25, 50, 75, 100 and 125 aphids. All the larvae provided with aphids until they pupate. Feeding and functional response of *Chrysoperla carnea* on rose aphid were recorded after 24 hours of experimental period (Farhan et al. 2019).
The collected data were arranged in MS Excel and subjected to one way ANOVA to check the functional response of green lacewing on *Macrosiphum rosae*. The average feeding potential and standard error were calculated. The significance among treatments were further analyzed using Tukey HSD test.

Results

The one-way ANOVA analysis showed that all the treatments was not significantly different from each other's (F=0.78, p<0.5648), indicate that the density of rose aphids (*Macrosiphum rosae*) had no effect on the functional response (feeding behavior) of 1st instar larvae of green lacewing. The mean predatory potential was recorded as 9.667±2.18a, 9.334±0.88a, 9.333±0.33a, 8.667±2.90a and 6.000±0.57a after the treatments T_3, T_4, T_5, T_2 and T_1, respectively. The results indicated that with increase in aphid density the predatory potential increases linearly and then become static, this condition is called asymptotic (Figure 1).

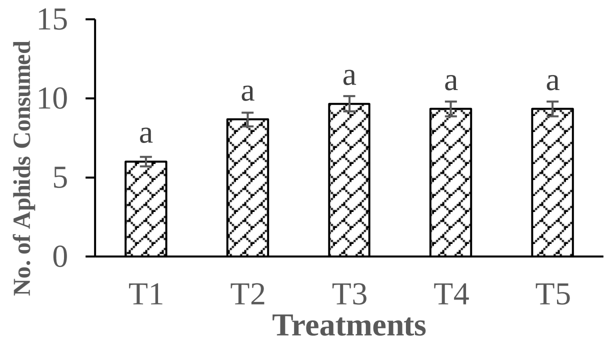

Figure 1: Functional response of 1st instar larvae of green lacewing Chrysoperla carnea on rose aphids *Macrosiphum rosae*. Bars with lower case letters was not significantly different from each other's (Tukey HSD, p<0.05).

The one-way ANOVA analysis exhibited that density of aphid had some positive impact on feeding behavior of 2nd instar larvae of green lacewing (F=53.17, p<0.000). The higher functional response of green lacewing was recorded in treatments with high aphid density. The maximum numbers of aphids consumed (32.333±1.45a) by green lacewing at the treatment T_5 (75 no. of aphids) which was not significantly different from the treatment T4 and T3, respectively and the numbers of aphids fed by *C. carnea* were recorded as 29.000±0.57a and 28.667±0.88a. The lower numbers of aphid's consumption were noticed (21.333±1.2b and 14.667±0.33c aphids) after the treatment T_2 and T_1, respectively (Figure 2).

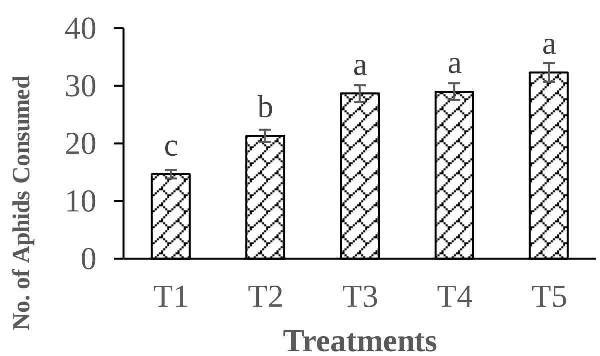

Figure 2: Functional response of 2nd instar larvae of green lacewing Chrysoperla carnea on rose aphids *Macrosiphum rosae*. Bars with lowercase letters was not significantly different from each other's (Tukey HSD, p<0.05).

The one-way ANOVA analysis presented that all the treatments was not significantly different from each other's

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(F=118.63, p<0.000), indicate that the density of rose aphids (*Macrosiphum rosae*) was not affect the functional response (feeding behavior) of 3rd instar larvae of green lacewing. The mean predatory potential was recorded as 44.333±0.667a, 42.000±1.00ab, 41.333±0.57ab, and 41.000±0.88ab after the treatments T_5, T_2, T_4 and T_3 respectively. The lower predatory potential was noticed as (25.000±0.00b) @ the treatment T_1, however, total numbers of consumed is equal to provided numbers of aphid. The results further showed that with increase in aphid density the predatory potential increases linearly and then become static, this condition is called asymptotic (Figure 3.3).

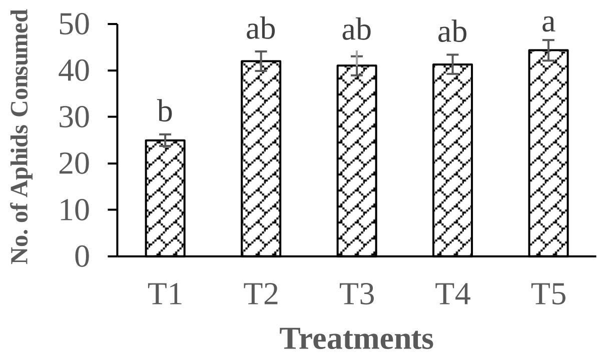

Figure 3: Functional response of 3rds instar larvae of green lacewing *Chrysoperla carnea* on rose aphids *Macrosiphum rosae*. Bars with lowercase letters was not significantly different from each other's (Tukey HSD, p<0.05).

Discussion

Biological control of insect pests gains more importance around the world, because of the environmental hazards associated with the use of insecticides. The green lacewing (*Chrysoperla carnea*) has gained more importance as predator of many soft body insects like aphids, mealybugs, thrips, jassids and whiteflies etc. (Hassanpour et al., 2021). The study conducted by Satapathy, (2022) to check the predatory potential and life cycle of green lacewing on tobacco aphid (*Myzus nicotianae*) reported that *C. carnea* is considered an excellent predator of aphids (Rana et al., 2020). As, the predatory potential of green lacewing proved by different research studies the green lacewing has been used as biological control agent in biological control programs (IPM) (Gutierrz-Cardenas et al., 2020). The *C. carnea* known as aphid lion, as it consumed all types of aphids. It is considered as major predator (Koutsoula et al., 2023). The results exhibited that the density of rose aphids (*Macrosiphum rosae*) had no effect on the functional response (feeding behavior) of 1st instar larvae of green lacewing. The 1st first instar larvae of green lacewing follow the Type II functional response models "eaten pray is not density dependent" (Holling 1959). The current agreement with Iesa, (2021) who stated that *Chrysoperlla nipponensis* exhibited Type II function response to all given prey species, when provided with different densities of prey such as aphids, whiteflies, papaya mealybug and artificial diet. The results showed that 2nd instar larvae of green lacewing consumed 32.333±1.45a aphids at T_5 (75 no. of aphids provided) which was not significantly different from other treatment except T_2 and T_1 (where 30 and 15 aphids were provided). similarly, the 3rd instar larvae of *C. carnea* consumed 44.333±0.667a aphids at T_5 (125 no. of aphids provided) which was not significantly different from other treatment except T2 and T_1 (where 50 and 25 aphids were provided). This exhibited that predation rate of green lacewing was independent of prey density. The current study agreement with Elango et al. (2017) who checked predatory potential of *Chrysoperla zastrowi* (Sillemi) against *Aphis punicae* stated that 2nd and 1st instar larvae consumed total 68.1 and 30.7 aphids during their progressive period, respectively. However, aphid and predatory species different from current study. The predation rate of *C. carnea* larvae increased with each developmental stage (Liu et al., 2020). The similar results have been recorded by other researchers the functional response of green lacewing *Chrysoperla carnea* may varies depending on temperature and humidity (Fang et al., 2022).

Conclusion

It was concluded that the green lacewing had a great potential to consume rose aphids and it's all stages, significantly consume large numbers of aphids. The results indicated that with increase in aphid density the predatory potential increases linearly and then become static, means that the prying density had no impact on feeding behavior of green lacewing. Thus, it was suggested form the current study that the *C. carnea* are effective biological control agents, mainly at low to moderate aphid population, making them a valuable tool in integrated pest management strategies targeting rose aphid.

Declarations

Data Availability statement
All data generated or analyzed during the study are included in the manuscript.
Ethics approval and consent to participate
Approved by the department Concerned.
Consent for publication
Approved
Funding
Not applicable

Conflict of interest

The authors declared absence of conflict of interest.

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