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BIOLOGICAL PARAMETERS AND PREDATORY POTENTIAL OF *CHRYSOPERLA CARNEA* (NEUROPTERA: CHRYSOPIDAE) FEEDING ON WHEAT APHID *SCHIZAPHIS GRAMINUM* (HEMIPTERA: APHIDIDAE) UNDER LABORATORY CONDITIONS

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ABSTRACT:- Studies on biological parameters of *Chrysoperla carnea* (Stephens) on *Schizaphis graminum* (Rondani) aphid were carried out in Insecatry- Bio control Laboratories, Insect Pest Management Programme, Department of Plant and Environmental Protection, National Agricultural Research Centre, Islamabad, Pakistan. The results indicate that incubation period was 3.8±0.08 days with 87.0% hatchability. The developmental duration of first, second and third instar larvae were 3.2 ± 0.13, 4.0±0.21 and 4.8±0.25 days, respectively. The total larval developmental duration was 12.0 ±0.67 days with 85.05% survival rate of larvae. The larval predatory potential was 414.6±0.05 aphid per larvae. The total duration and survival rate from egg to adult emergence was 24.6± 0.06 days with 73% survival rate. The pre oviposition, oviposition and post oviposition periods were 9.2±1.25, 34.6±1.72 and 7.4±1.02 days, respectively. The female and male longevity was 51.2 ± 2.18 and 32.4±2.04 days respectively. The female fecundity was 384.2±21.20 eggs per female with 11.16±1.31 eggs per day per female.

Key Words: Chrysoperla carnea; Biological Parameters; Schizaphis graminum; Aphid; Predatory Potential; Survival Rate; Pakistan.

INTRODUCTION

Green lacewing, *Chrysoperla carnea* (Stephens) generally known as aphid-lion is generalist predator of a wide range of pest species such as mealybugs, aphids, thrips, whiteflies mites and eggs of insect pests (Carrillo and Elanov, 2004). *C. carnea* is the most intensively studied species of Chrysopids because of its wide geographical distribution, broad habitats with high relative frequency of occurrence, good searching ability and easy rearing in the laboratory. The larvae of lacewing feed on a wide range of pest species while adults are free living and feed only on nectar, pollen and honey dew (El-Serafi et al., 2000)

Chrysopids feed on various aphid species, including *Aphis glycines* Matsumura (Ragsdale et al., 2011), *Myzus persicae* Sulzer (Pappas et al., 2007).

Among aphid pests green bug, *Shizaphis graminum* (Rondani) has been recognized as a major pest of

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small grains. In Pakistan, wheat was considered to be a pest free crop in the past. Since the introduction of high yielding and fertilizer responsive wheat varieties, aphid became a serious pest to wheat. Wheat aphid was one of dangerous emerging problems and causing serious threat to Pakistan's economy (Munawar, 2011).

Biological control of insect pests is an important component of integrated pest management (IPM) and can be used in combination with other control methods in pest management programmes. Different bio control agents are available for the management of insect pests. Among these, *C. carnea* is one of the important generalist predator and can be mass reared easily in the laboratory and released in the field for the management of particular insect pests (Huag and Enkegaard, 2009). *C. carnea* can be easily mass reared on *Sitotroga cerealella* (Oliver) eggs under laboratory conditions widely in the world. In Pakistan, there are many studies on the biological parameters of *C. carnea* feeding on different host insects but there is no information on the biological parameters and larval predatory potential of *C. carnea* feeding on *S. graminum* aphid under laboratory conditions.

Present study was conducted on the biological parameters and predatory potential of *C. carnea*, feeding on green bug, *S. graminum* aphid. This information can be utilized for quality mass rearing of the predator and its utilization is an important component of IPM programmes for the management of *S. graminum* aphids in wheat crop under field conditions

MATERIALS AND METHOD

The experiments were conducted on the biological parameters and predatory potential of *C. carnea* feeding on *S. graminum* aphids at Insectary-Bio control Laboratories. Integrated Pest Management Programme, Department of Plant and Environmental Protection, National Agricultural Research Center, Islamabad, Pakistan during winter 2011, under controlled conditions of 24±1 °C and 50 ± 5% relative humidity.

Culture Maintenance of *Schizaphis graminum* aphid

The green bug, *S. graminum* culture was maintained on wheat plants under glass house conditions. The seed of wheat variety Inqilab-91 were sown in beds, under glass houses in Insectary. To establish the culture, aphids were initially collected from wheat fields. The aphids were released on plants inside the glasshouse and leave for establishment of colony. The aphids multiplied freely and the colony was established on all plants in the glasshouse during the experiment for feeding to *C. carnea* larvae. To collect different nymphal instars of aphids of known age single female was separated and kept for breeding. The progeny was observed daily and individuals collected for feeding to *C. carnea* larvae under controlled conditions.

Rearing of *Chrysoperla carnea*

C. carnea adults were reared in a rectangular cage, made of 6cm thick, transparent plastic sheet. Artificial foods containing yeast + sugar + honey + distilled water in ratio of 8:4: 2:1 were provided in 0.5 cm dia food

bowls engraved in the upper side of 2 mm thick and 22 cm long plastic rods running width wise at the opposite ends inside the cage. A black granulated paper underside the removable top of the cage was provided as an oviposition substrate. The eggs were collected from the sheath with razor every morning during the study. The eggs were kept in plastic jars for hatching and further propagations.

Experiments were conducted on the developmental duration, survival rate and predatory potential of immature stages of *C. carnea* feeding on *S. graminum* aphid under controlled condition of 24 ±1 °C, 50 ±5 % relative humidity and 16hL: 8hD. at Insectary-Biological Control Laboratories, National Agricultural Research Centre, Islamabad, Pakistan.

Developmental Duration and Survival Rate of Immature Stages of *C. carnea*

To study immature developmental duration and survival rate of *C. carnea* two hours fresh eggs were collected from stock culture at Insectary. A total of 100 eggs were counted under microscope and kept for hatching in plastic vials separately. The eggs were observed daily for incubation period and percent hatchability. Upon hatching the newly emerged first instar larvae were kept in the same vials separately. Second and third nymphal instars of *S. graminum* were provided inside the vials on fresh leaves of wheat plants. The vials were covered with muslin cloth at the top, tightened with rubber band. Initially 15 nymphal instar were provided in each vials and then the number of host insects were gradually increased with the passage of time every day and the third larval instars of *C. carnea* were provided up to 120 aphids per day. The insect passes through three larval instars and exuva after molting in vials indicates that the insect entered in to the next instar. The process was continued till all larvae entered in pupal stage and the pupae were kept for adult emergence. The parameters recorded daily were: (i) incubation period and percent hatchability of eggs, (ii) developmental duration, survival and predatory potential of larval instars, (iii) pre pupal and pupal duration and their viability (iv) total duration and survival rate of immature stages from egg to adult emergence.

Adult Developmental Duration and Reproductive Potential of *C. carnea*

Study was conducted on the developmental duration of adult male and female *C. carnea* and reproductive potential of female. A total of 20 newly emerged one day old male and female *C. carnea* whose larvae were reared on *S. graminum* aphids were paired and kept in chimney glasses rearing cages. The cages were covered at the top with black granulated paper as oviposition substrate. Artificial diets (including yeast: sugar: honey: distilled water in ratio of 8:4: 2:1) was provided in small petridishes at the bottom of the chimney glasses daily. The insect were observed for developmental duration and eggs laying daily. The eggs were collected with razor from black paper after 24h. The process continued till all male and female died inside the rearing cages and the data were recorded daily on: pre oviposition, oviposition and post oviposition periods, female and male longevity as

well as number of eggs per female and number of eggs per female per day.

The mean data were statistically analyzed using one way ANOVA and standard error tests.

RESULTS AND DISCUSSION

The results regarding the immature developmental duration, survival rate and predatory potential of *C. carnea* feeding on *S. graminum* under controlled conditions revealed that the mean duration of the egg stage was 3.8 ± 0.047 days with 87 % hatchability (Table 1). Previous authors have reported durations for egg stage and their hatchability. Qadeer (2012) indicated that the duration of egg stage was 4.0±0.00 days at 26±1 °C which confirms the result of the present study.

The insect passes through three larval instars before transforming in to pre pupa.The average durations of first, second and third instars were 3.2 ± 0.033, 4.0 ± 0.045 and 4.8 ± 0.029 days with 88.5, 96.1 and 100 percent survival rate, respectively (Table 1). Afzal and Khan (1978) reported that the average duration of first, second and third instars were 3.20 ±0.09, 3.4 ±0.05 and 4.7±0.08 days, respectively. Lenardo et al. (2002) reported the viability for first, second and third instars was 93.3%, 100% and 89.5% respectively for *C. everes* when feeding on *S. cerealella* eggs.

The larval developmental duration and survival rate was 12.0 ± 0.092 days with 85.05 survival rate (Table 1). Naila (2012) indicated that the larval developmental dura-tion was 12.7 ± 0.67, 11.7 ± 0.69 and 10.6 ± 0.66 days at 20, 24 and 28 ± 1 °C, respectively when feeding on *Brevicoryne brassicae* aphids. These divergent values found by different workers should be due to differences in environmental conditions under which the experiments were carried out and due to different host insect used for feeding *C. carnea* larvae. The larvae completed two moults during the active feeding period and passed the last moult within the cocoon. This period has been designated as the pre pupal period. The pre pupal skin was cast off after 1.2±0.018 days with

Table 1. Biological parameters of immature stages of *Chrysoperla carnea* feeding on *Schizaphis graminum* aphid under controlled conditions of 24 ±1 °C, with 50 ± 5 % relative humidity

Developmental stages	No. of Insects	Mean developmental durations (days)	Range (days)	Survival (%)
Incubation period	100	3.8 ± 0.047	3.0 - 4.5	87.0
First instar larvae	87	3.2 ± 0.033	2.4 - 3.6	88.5
Second instar larvae	77	4.0 ± 0.045	3.4 - 4.5	96.1
Third instar larvae	74	4.8 ± 0.029	4.0 - 5.0	100.0
Larvae	74	12.0 ± 0.092	11.0 - 13.6	85.5
Pre pupa	74	1.2 ± 0.018	1.0 - 1.5	98.6
Pupa	73	7.6 ± 0.041	7.0 - 8.0	100.0
Egg to adult emergence	73	24.6 ± 0.116	22.0 - 25.5	73.0

98.6% survival, which was packed into one end of the harbouring cocoon. This skin was seen through the thin cocoon wall as a dark disc like structure and its presence was used as an indication that the pupation had occurred. Mean duration of pupal stage was 7.6 ± 0.041 days with 100% viability. Total duration and survival rate from egg to adult emergence was 24.6 ± 0.116 days with 73 % survival rate (Table 1).

Predatory Potential of Larvae

The result indicates that the predatory potential of first, second and third instar was 61.8 ± 1.973, 113.6 ± 2.426 and 239.2 ± 6.870 aphids, respectively (Figure 1). The results showed that all three larval instars of *C. carnea* are voracious predator of *S. graminum* aphid and maximum aphid was consumed by the third instar larvae. The larvae consumed 414.6 ± 7.845 aphids. Previous authors also indicated different values when feeding on different host insects. Renu and Pathak (2010) evaluated the effect of temperature on the consumption capacity of *C. carnea* reared on four aphid species i.e., *Aphis craccivora* Koch, *A. gossypii* Glov., *Myzus persicae* Sulz and *Lipaphis erysimi* Kalt as a prey, at five constant temperature i.e. 10 °C, 15 °C, 20 °C, 25 °C and 30 °C in growth chamber. The data revealed that the consumption capacity of *C. carnea* differ significantly, when its larvae was reared separately on the four aphid species at various temperatures. Predatory potential was maximum (320.5 ± 22.79 aphids) at 15°C on *A. craccivora* and minimum (143.3 ± 1.25 aphids) at 30°C when fed on *L. erysimi*.

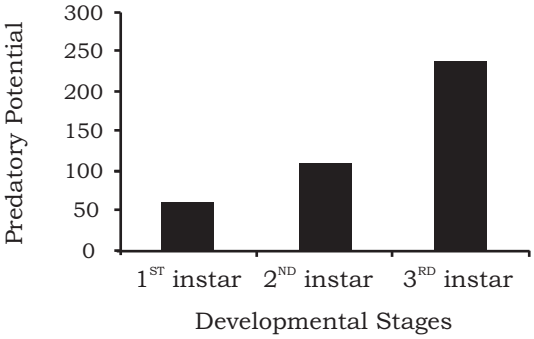

Figure 1. Predatory potential of *C. carnea* larval instars feeding on *S. graminum*

Rabinder et al. (2008) conducted research work on the developmental duration and predatory potential of *C. carnea* on *Corcyra cephalonica* eggs and *P. solenopsis* under laboratory conditions. The results indicated that larval duration was 8.25 and 22.15 days, respectively on two different host insects. The total developmental period was significantly longer on *P. solenopsis* compared to that on *C. cephalonica* eggs. *C. carnea* larvae consumed significantly higher number of crawlers of *P. solenopsis* (671.45) than *C. cephalonica* eggs (211.70).

The differences in predatory potential of *C. carnea* larvae was due to different environmental conditions of the experiments by different authors and also different host insects which they used for feeding the larvae. Larval prey quality has considerable influence on the biology and behavior of Chrysopids.

Biological Parameters of Adult *C. carnea*

The study was conducted on the biological parameters of adult *C. carnea* when the larvae were reared on *S. graminum* aphids and the adults

Table 2. Biological parameters of adult *Chrysoperla carnea* under controlled conditions of 24 ± °C, with 50 ±5 % relative humidity

Developmental stages	Developmental durations in (days)	Range (days)
Pre oviposition period	9.20 ± 0.074	8.5 - 9.5
Oviposition period	34.60 ± 0.282	32.0 - 36.0
Post oviposition	7.40 ± 0.152	6.0 - 8.0
Male longevity	32.40 ± 0.296	31.0 - 35.0
Female longevity	51.20 ± 0.723	48.0 - 56.0
No of eggs per female	384.20 ± 8.045	300.0 - 415.0
No of eggs per female per day	11.16 ± 0.342	6.0 - 12.0

were provided artificial diets. The result indicated that the pre oviposition, oviposition and post oviposition periods were 9.20 ± 0.074, 34.60 ± 0.282 and 7.40 ± 0.152 days, respectively (Table 2). The total longevity of male and female was 32.40 ± 0.296 and 51.20 ± 0.723 days, respectively. The result indicated that female lived longer than male. The female fecundity rate was 384.20±8.045 eggs per female and the number of eggs per female was 11.16 ± 0.342 eggs per day. Tesfaye and Gautam (2002) indicated that longevity, reproductive age, fecundity and other reproductive features of *Chrysoperla carnea* adult signi-ficantly influenced oviposition, post oviposition periods and fecundity, while it has no significant effects on pre-oviposition and longevity of *C. carnea*. The highest number of eggs per female was 1245.2 eggs per female.

The result of the present study and some past workers showed that there is high variation in biological parameters of *C. carnea*. These variations may be due to different environmental condition and different host under which the experiments were conducted. The present results and that of past workers indicate that *C. carnea* are voracious generalist predator and can be successfully reared under laboratory conditions. The predator may be utilized for the management of different host insects in field condition. On the basis of the present study it was concluded that *C. carnea* can successfully be reared under controlled conditions and their larvae can be utilized for the management of *S. graminum* aphid in wheat fields.

LITERATURE CITED

Afzal, M., and M. R. Khan. 1978. Life history and feeding behavior of green lacewing, *C. carnea* (Stephens) (Neuroptera: Chrysopidae). Pakistan J. Zool.10 (1): 83-90

Carrillo, M., and P. Elanov. 2004. The potential of *C. carnea* as a biological control agent of *Myzus persicae* in glass houses. Annl.

Appl. Biol. 32: 433-439.

El Serafi H.A.K., A. Salam, and N.F. Bakey. 2000. Effect of four aphid species on certain biological characteristics and life table parameters of *C. carnea* (Stephens) and *Chrysoperla septempunctata* Wesmael (Neuroptera: Chrysopidae) under laboratory conditions. Pakistan J. Biol. Sci. 3: 239-245.

Huang, N., and A. Enkegaard. 2009. Predation capacity and prey preference of *Chrysoperla carnea* on *Pieris brassicae*. J. Biol. Control, 55: 379-385.

Lenorado, R.B., S.D. Freitas, and A.M. Auad. 2002. Biological aspects of the immature stages of the immature stages of *Ceraeochrysa everes*. J. Agric. Sci (Piracicaba) Braz. 59: 423-429.

Munawar, H. 2011. Wheat crop under pest attack in Punjab. Food and Agriculture Organization of the United Nation. http://faostat.fao.org/site/567//default.aspx.

Naila, A. 2012. Biological parameters of *Chrysoperla carnea* feeding on cabbage aphid, *Brevicoryne brassicae* aphid. MSc thesis, KPK Agri. Uni. Peshawar, p. 1-78.

Pappas, M.L., G.D. Broufas, and D.S. Koveos . 2007. Effects of various prey species on development, survival and reproduction of the predatory lacewing *Dichochrysa prasina* (Neuroptera: Chrysopidae). J. Biol. Control 43: 163-170

Qadeer, A., R. Muhammad, N. Ahmad, J. Ahmed, and N. Suleman. 2012. Effect of different photoperiods on the biological parameters of *Chrysoperla carnea* under laboratory conditions, J. Basic and Appl. Sci. 136 (8) :638-640.

Rabinder, K., R. Kaur, K. S. Brar. 2008. Development and predation efficacy of *Chrysoperla carnea* (Stephens) on mealy bug, *Phenacoccus splenopsis* (Tinsley) under laboratory conditions. J. Insect. Sci. Ludiana. 21(1): 93-95.

Ragsdale, D.W., D.A. Landis., B. Jacques., G.E. Heimpel and N, Desneux. 2011. Ecology and management of the soybean aphid in North America. Ann. Rev. Entomol. 56: 375-379.

Renu, Y. and P. H. Pathak. 2010. Effect of temperature on the consumption capacity of *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) reared on four aphid species. Intern. J. Life Sci. 5(2): 271-274.

Tesfaye, A., and R. D. Gautam 2002. Effect of adult food supplements on reproductive attributes and longevity of *Chrysoperla carnea* Stephens (Neuroptera: Chrysopidae). Annal. Pl. Prot. Sci. 10: 198-201.