



Comparative study on Biology and Life Table Parameters of the Predator, *Chrysoperla carnea* (Stephens, 1836) (Neuroptera: Chrysopidae) on Sugarcane Whitefly

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Abstract- *Chrysoperla carnea* is a general predator of worldwide insect pests like whiteflies, thrips, mealy bugs, aphids, mites as well as eggs of different arthropods. Studies on the biology of *C. carnea* are important because they attack a wide range of hosts which generally difficult to control. The incubation period of *C. carnea* ranged from 2-4 days with 2.73 ± 0.24 days was recorded on sugarcane whitefly. The 1st Instar larval period was 2.97 ± 0.23 with 2-4 day ranges, followed by 2nd Instar and 3rd Instar period with 3.80 ± 0.38 ranging from 3-7 days and 3.37 ± 0.16 with 3-4 (days) ranges. However, *C. carnea* complete their larval period with in 10.13 ± 0.45 days, ranged from 8-14 and pupal period takes 8.17 ± 0.29 days with 6-9 (days) ranges. The average larval survival rate was $83.33 \pm 12.22\%$, adult survival rate $80.00 \pm 12.87\%$, male longevity 22.27 ± 0.96 days and female longevity 26.43 ± 0.89 days were recorded. The pre oviposition, oviposition and Post oviposition days was recorded 2.60 ± 0.22 , 17.43 ± 0.64 and 6.00 ± 0.3 . The results further revealed that the *C. carnea* female lay eggs 12.53 ± 0.46 / day with $83.31 \pm 1.87\%$ fertility.

Keywords: *Chrysoperla carnea*, Biology, Predator, Sugarcane whitefly, *Aleurolobus barodensis*.

1. INTRODUCTION

Green lacewing (*Chrysoperla carnea*) cosmopolitan polyphagous predator, commonly familiar as a aphid-lion are also regarded as a generalist predator of broad range of hosts like whiteflies, thrips, mealy bugs, aphids, mites as well as eggs of different arthropods (Saminathan *et al.*, 1999; Carrillo and Elanov, 2004; Liu and Chen, 2001; Yadav and Pathak, 2010). It has been observed as a most successful generalist predator in agro-eco system. (Yuksel and Goemen, 1992; Singh and Manoj, 2000; Zaki and Gesraha, 2001). Green lacewings are a most successful predator in its family due to effective foraging, abundant occurrence, and easy rearing, good searching ability and habitat parameters. Larvae feed on different arthropods hosts and adult feed on different plant material such as honey dew, nectar and pollen (El-Serafi *et al.*, 2000). The predator *C. carnea*, with a soft body, biting mouth parts along with two pair of membranous wings, at the time of rest they are keeping on abdomen which look like a roof (Tjeder, 1960). It is proved effective predator for better management of several insect pests, lepidopteran eggs, small larvae and a variety of different soft-bodied arthropods (Zaki *et al.*, 1999; Singh *et al.*, 2003). The all larval stage of *C. carnea* is stable and successful biological control agents for the control different plant eating insect pests (McEwen, *et al.*, 2001). A larva may eat greedily several aphids more or less five thousands in their

life period and they play an important role as a natural enemy to control small insect pests (Michaud, 2001). Predators required for reaching their maturity a number of prey individuals, predacious larvae kill its prey by sucking the body content leaving the hard chitinized parts. Daane *et al.*, 1996 reported that application of *C. carnea* predators in Field resulted average leafhopper density reduction 29.5%.

The adults of *C. carnea* are non predator and feed on pollens and honeydew (Dean and Satasook, 1983). They are usually 2 cm long with membranous wings and light green body and Larvae are "alligator" shaped with long forceps-like curved tubular mandibles with which they suck the insect fluid (Batool *et al.*, 2014). The larval stage of *C. carnea* was completed in 13.9 days with 15% mortality on *S. cerealella* eggs. The pre-oviposition period was observed 3.4 days, with as high as 713 eggs laid per female. However, the eggs hatching period can vary from 2-3 days (Syed *et al.*, 2008). *C. carnea* is a generally feeding on different soft bodied insects, so that it is considered key part of IPM program (Rashid *et al.*, 2012).

Integrated pest management is combination of different control methods; from which Biological control method is an important part of (IPM) and can be used for suppress the insect pest population along with different control methods. Huang and

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Enkegaard (2009) reported that many predators and parasitoids are available to control insect pests. Among the predator list, the *C. carnea* are most efficient predator which can be easily reared in control condition and easily applied for the management of targeted insect pests in the field. (Huang and Enkegaard, 2009). The insect pests control through natural enemies is comparatively secure, cheap and eco-friendly. It easily understands as “the action of parasites, parasitoids, predators and pathogens to keep the pest populations at a lower average than the economic injury level”. From the environmental point of view biological control is excellent as various predators and parasitoids are host-specific. Therefore they control target species and not effect on non target insect. The perfect natural enemies often keep the prey under suppressing (DeBach, 1964). Since very little is known about the development of this species on sugarcane whitefly, it is necessary, laboratory study were conducted to study its developmental biology on sugarcane whitefly.

C. carnea generally mass reared under laboratory condition in different countries of the world on *Sitotroga cerealella* eggs. In Pakistan, nearby several experiments were conducted on the life cycle study of *C. carnea* on different insect hosts but there is minute knowledge available on the biological study and predatory effectiveness of *C. carnea* rearing on *Aleurolobus barodensis* under laboratory condition. Present work was conducted on the biological study and reproductive measures of *C. carnea*, on sugarcane whitefly, *Aleurolobus barodensis*. The result of these studies can be used as a biological control of sugarcane whitefly.

2. MATERIALS AND METHODS

The experiments were conducted to study “biology and life time parameters of *C. carnea* on sugarcane whitefly under laboratory conditions, during 2017, in Insect Systematic Laboratory, Department of Entomology, Sindh Agriculture University Tandojam.

2.1 Rearing of *Chrysoperla carnea*:

The life cycle study of the *C. carnea* was conducted on sugarcane whitefly. The preliminary culture of *C. carnea* was collected from sugarcane fields and additional multiplication was carried out in the laboratory. Adults were kept in plastic bottles; the head of rearing bottles were closed with black muslin cloth. Adults were feed on synthetic diet, using 10:2:1 ml ratio of warm water, yeast and honey. The mixture of artificial diet was supplied on hard paper and also on the sides of the bottles. After two days, eggs were harvested, from the black covers, with the help of a blade. Water were supplied to adults with a soaked

cotton, after hatching larvae were reared on different nymphal instars of sugarcane whitefly in small plastic bottles, and rearing conditions were maintained at 26±2 °C, 65±5% R.H.

2.2 Life cycle study of *Chrysoperla carnea*:

On the daily basis nymphal stages of *Aleurolobus barodensis* were collected directly from infested sugarcane fields of Tandojam locality. Freshly hatched larva of *C. carnea* were kept singly in small plastic bottles (15X10X15 cm), covered with muslin cloth. The 100 nymph of different nymphal instars of sugarcane whitefly were provided daily for feeding larvae of the predator until pupation. The Incubation period, complete larval period, pupal period, larval survival %, adult survival %, longevity of female and male, pre oviposition, oviposition and post oviposition periods, fecundity/ female/ day and fertility % were determined on the daily basis. For the record of hatchability %, the eggs of *C. carnea* were kept for hatching in petri dish. For male and female longevity, two days old a pair of male and female adult were kept in 2-liter plastic bottles, the head of bottles was closed with muslin cloth. The water was supplied with as soaked cotton and adult diet was supplied two times a day regularly using a hard paper. Female and male longevities were observed on daily basis and eggs were laid by each female was also counted during the oviposition phase.

3. RESULT AND DISCUSSION

The predator *C. carnea* completed their larval period successfully on the sugarcane whitefly nymphal instars. The larva of *C. carnea* is very active, alligator shaped, with elongated body and with a pair of large tubercles.

Egg: singly eggs were laid by female of *C. carnea* with long silken stalks on the lower surface of black cloth of the plastic jar. Newly hatched eggs were light green in color with oval shaped, which is changed light whitish just before hatching. The result showed (Table-1) that the fecundity/ female/ day were 12.53±0.46 eggs with an average range from 10-6 per day. These observations agreed with the conclusion of Patel and Vyas (1985), Gadhia (1988) and Tanwar *et al.* (2005). Further result of fertility % indicates that, the fertility % of *C. carnea* eggs was recorded 83.31±1.87 with a ranged from 75.00-92.86 %. However, hatching % of *C. scelerates* eggs with an average 93.02 and 93.83 % respectively has been recorded by Patel and Vyas (1985) and Gadhia (1988).

Oviposition period: The data showed in table-2, reveals that the *C. carnea* adult takes 2.60±0.22 days ranging from 2-4 days for pre-oviposition, however,

oviposition days of *C. carnea* was observed 17.43 ± 0.64 with a ranged from 14-20 days. Furthermore, the data revealed that the post oviposition period 6.00 ± 0.31 days was recorded with an average ranged from 4-7 days.

Incubation period: The data revealed that (Table-1) the average incubation period of *C. carnea* was recorded 2.73 ± 0.24 days ranging from 2-4 days. Patel and Vyas (1985) reported that *C. carnea* takes 2 to 4 days for incubation period. These reports are conformation the present results. While, Shaukat (2018) reported that the incubation period of *C. carnea* on different insect hosts were recorded as (2.25) on *A. gossypii*, (2.28) on *P. solenopsis*, (2.36) on *S. cerealella*, (3.85) *H. armigera*, (2.25) *P. gossypiella* and (2.80) days on mixed host diet, these results conform the present study. Furthermore, Verma and Shenhmar (1983) reported that incubation period takes 3 days at 27 °C. Whereas, Afzal and Khan (1978) reported that the eggs hatching period of *C. carnea* eggs was 4.8 ± 0.4 days under laboratory conditions. However, Sultan *et al.*, (2017) observed incubation period on different hosts with an average was 2.25, 2.75 and 3.50 days on Angoumois grain moth, the stem borer and on the sugarcane whitefly, respectively.

Larval period: The *C. carnea* passed through three larval instars before transforming in to pupa. The freshly hatched young larvae were small, look like as alligator, yellow-brown with greenish-yellow head with the dark lines. The 2nd instar larva did not show changes in coloration and other morphological characters except the size. However, the 3rd instar larva was elongated, spindle shape or flatted with large tubercles with light yellow color. These findings are in conformity with the result of Jalali *et al.*, (2003). The results (Table-1) indicated that the duration of 1st instar larva of *C. carnea* feeding on sugarcane whitefly 2.97 ± 0.24 days with ranged from 2-4 days, while duration of 2nd larval instar was observed as 3.80 ± 0.38 with ranged from 3-7 days and the larval duration of 3rd instar 3.37 ± 0.16 with ranged from 3-4 days were recorded. Afzal and Khan (1978) reported that the average duration of first instar was 3.20 ± 0.09 days, followed by second instar 3.4 ± 0.05 and third instar 4.7 ± 0.08 days, respectively. While Mari *et al.*, (2006) reported that developmental period of first (2.46 ± 0.05), second (4.36 ± 0.10) and a third instar (5.91 ± 0.19) day was observed when feeding on aphid. However the complete larval developmental period takes 10.13 ± 0.45 with ranged from 8-14 days. Sultan *et al.*, (2017) reported that average period of larval stages of *C. carnea* were 12.00 days on sugarcane whitefly, which conform the result of present study. While, Verma and Shenhmar (1983) reported the larval period was 8.3 day at 27 °C. Furthermore, the result of larval

survival % was observed 83.33 ± 12.22 with ranged from 80-90%. Sultan *et al.*, (2017) reported that the highest larval survival rate (80.00%) was recorded on Sugarcane whitefly, which conform the result of present study.

Pupal period: After the compellation of larval period, the full grown larvae of *C. carnea* pupated inside the spherical cocoon with white colored, which covered with silken threads. The color of cocoon changed in light green before adult emergence. Gadia (1988) were recorded similar observations. Furthermore, the result showed that the pupal period (Table-1) of *C. carnea* was recorded 8.17 ± 0.29 with a ranged from 6-9 days. El-Dakroury *et al.*, (1979) and Patel and Vyas (1985) reported that pupal period complete with an average 5.80 ± 0.11 days with ranged from 5 to 8 days, which is the result agreed with the present study.

Adult: The adults were soft bodied, with light green in color, along with a pair of translucent wings, with metallic luster in its eyes. The antennae were delicate, filiform and larger than the body. The female were usually larger than male with swollen abdomen and a creamy-yellow lining on 2-5 abdominal sternites. This is in conformity with the statement of Tanwar *et al.*, (2005). The data revealed (Table-1) that male longevity takes 22.27 ± 0.96 days with a ranged from 19-27 days, however female longevity was observed 26.43 ± 0.89 days with a ranged from 24-32 days. Furthermore, the adult survival % was recorded 80.00 ± 12.87 with a ranged from 70-90%. Sultan *et al.*, (2017) reported the adult maximum survival rate was 95.50% for *S. cerealella*, followed by (80.75%) for the whitefly and (70%) for the stem borer, which conform result of the present study.

Table (1): Mean developmental parameters of *Chrysoperla carnea* on sugarcane whitefly (Mean±SE)

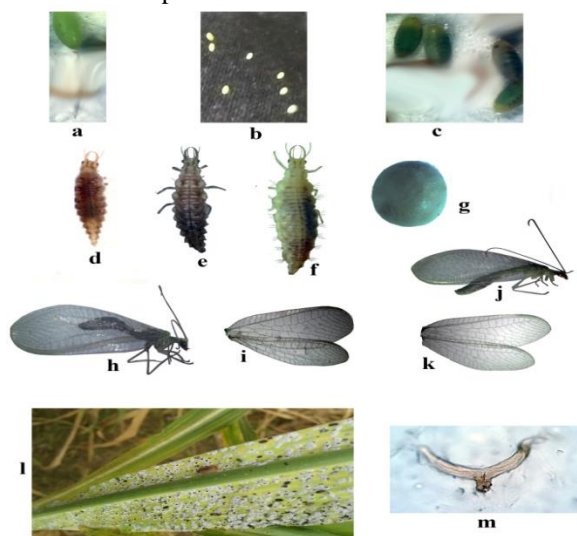
Stages of Developments	Duration period	
	Mean±SE	Range
Incubation period (Days)	2.73 ± 0.24	2-4 (days)
Instar-I	2.97 ± 0.23	2-4 (days)
Instar-II	3.80 ± 0.38	3-7 (days)
Instar-III	3.37 ± 0.16	3-4 (days)
Larval period (days)	10.13 ± 0.45	8-14 (days)
Pupal period (days)	8.17 ± 0.29	6-9 (days)
Larval Survival (%)	83.33 ± 12.22	80-90 (%)
Adult Survival (%)	80.00 ± 12.87	70-90 (%)
Male longevity (day)	22.27 ± 0.96	19-27 (days)
Female longevity (day)	26.43 ± 0.89	24-32 (days)

Table (2): Mean reproductive measures of *Chrysoperla carnea* on sugarcane whitefly (Mean±SE)

Stages of Developments	Duration period	
	Mean±SE	Range
Pre oviposition (days)	2.60±0.22	2-4(days)
Oviposition (days)	17.43±0.64	14-20(days)
Post oviposition (days)	6.00±0.31	4-7(days)
Fecundity/ female/ day	12.53±0.46	10-16(days)
Fertility (%)	83.31±1.87	75-92.86 %)

4. CONCLUSIONS AND RECOMMENDATIONS

This sugarcane is a major crop which is generally attacked by number of insect pests throughout the year. From the result of this study it was observed that *C. carnea* is a very important predator of sugarcane whitefly. It is safest and comprehensible method to control the insect pests from the crops. The usage of *C. carnea* is economically beneficial to growers. However, it is essential, to conduct further study on its developmental biology on sugarcane whitefly. The *C. carnea* is a general predator of sugarcane pests like, whitefly, thrips, mealy bugs, mites as well as eggs of sugarcane borer complex. However, *C. carnea* predator cards can be applied along with other control methods for better IPM practices.



***Chrysoperla carnea* (a-m):**

a) Fresh egg b) Group of eggs on muslin cloth c) mature eggs
 d) First instar larva e) Second instar larva f) Third instar larva
 g) pupa h) Female lateral view i) Forewings and hind wings
 j) Male lateral view k) Forewings and hind wings l) Feeding on sugarcane whitefly m) Aedeagus

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