



## CORRELATIVE EFFECT OF TEMPERATURE AND PHOTOPERIOD ON THE OVIPOSITION AND ADULT LONGEVITY OF *CHRYSOPERLA CARNEA* STEPHENS (NEUROPTERA: CHRYSOPIDAE)

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### ABSTRACT

Among the natural enemies, the larval stage of green lacewing, *Chrysoperla carnea* Stephens (Neuroptera: Chrysopidae) is the most commercialized and prominent predator on many soft-bodied insects like juveniles of aphids, whiteflies, thrips, mealybugs and eggs of lepidopterans, where adults feed only nectar, pollen, and honeydew. Despite, many factors influencing insect endurance, abiotic factors such as temperature and photoperiod are the main components when insects grew under a controlled atmosphere. The observation taken on oviposition revealed that rearing adult insects at temperature 24 °C with a photoperiod of 18:6 hours (Dark: Light) conditions produced the highest quantity at an average of 620.9 ± 0.85 eggs/day/100 insects respectively. Data on adult longevity showed that adult life extended up to 43.4 ± 0.22 days when reared at temperature 22 °C with a photoperiod of 18:6 hours (Dark: Light).

**Key words:** Natural enemies, aphids, whiteflies, thrips, mealybugs, temperature, photoperiod, *Chrysoperla carnea*, oviposition, adult longevity

From the past few decades, a tremendous revolutionary change has occurred in agriculture as several farmers have started to follow organic agriculture because it sustainably supports safe and healthy food and undoubtedly it retains a pollution-free environment (Das et al., 2020). The management of insect pests in organic agriculture is highly dependent on the cultural, physical, mechanical, and biological method where the biocontrol approach is more compatible with the natural interconnection (food web) that maintains a balanced natural enemy population in agro-ecosystem (Dara, 2019).

Commercialization of natural enemies for the biological pest management by the bio-factories is popularized in present scenario. Among the insect predators, the larval stage of aphid lion or green lacewing, *Chrysoperla carnea* Stephens (Neuroptera: Chrysopidae) is the most prominent predator on many soft-bodied insects like juveniles of aphids, whiteflies, thrips, mealybugs and eggs of lepidopterans where adults feed only nectar, pollen, and honeydew (Alghamdi et al., 2018).

Khaliq et al. (2014) described that the living (habitat, diet/host, and competition) and non-living factors (temperature, light, and humidity) are the main components that directly or indirectly consequence

the growth and development of the insect population. Abiotic factors such as temperature and photoperiods are the predominant phenomenon for the growth and development of insects (Fisher et al., 2015; Chen et al., 2017). Nadeem et al. (2014) narrated that rearing of adult females of *C. carnea* at a temperature of 10 °C for ten days has produced an average of 19 eggs/ day/ female. The survival and reproductive ability of green lacewing were drastically declined when temperature increased (Fonseca et al., 2001).

Data proposed by Bezerra et al. (2012) shown that the culturing of *Chrysoperla genanigra* at 21 °C incubation temperature with 12 h:12 h (Light: Dark) photoperiod manifested the maximum adult survivability (76.70%) and the highest number of egg-laying about 992.7 eggs/ female was at 25 °C temperature. Arroyo et al. (2000) revealed that the preservation of *C. carnea* eggs under low temperature had displayed prolonged shelf life. Fujiwara and Nomura (1999) elucidated that the egg to pupal stage of *C. carnea* is highly receptive to both short and long day.

There is a necessity to standardize the suitable laboratory conditions to do such a production of a large quantity of bio-control agents (Abd-Elgawad, 2019). Even though numerous reports have been publishing on the influence of abiotic factors against different

life stages of insects, there is a need to examine the correlative effect of temperature and photoperiod to ascertain the potential egg production and adult survivability of green lacewing. Hence, this experiment has focused on the most favourable conditions (temperature and photoperiod) for the mass rearing of *C. carnea* under laboratory condition.

#### MATERIALS AND METHODS

The laboratory experiment was performed at CREED KVK ICAR, Chozhamadevi, Ariyalur district, Tamilnadu during 2019-2020 under a room-size of 25ft length × 15ft width with Air-conditioning facility. Besides, windows were alternately flipped up or down with brown sheets to maintain natural light/dark whereas LED light also uphold whenever needed in the study.

The egg cards of *C. carnea* holds 1500 to 2000 eggs/card (sized 30cm x 12cm) were purchased from Tamilnadu Agricultural University (TNAU), Coimbatore. The egg cards were cut down into small pieces (50 eggs/piece) and kept individually inside a round plastic basin (28 cm dia) covered by khada cloth. Fresh *Corcyra* eggs were provided as a larval diet. After the second instar stage, the grubs were transferred individually into a small plastic container to avoid cannibalism. Pupation takes in containers itself are collected and transferred into adult rearing cages. The adult cage was made by an iron G.I. round troughs (30 cm x 12 cm) whereas the bottom was built by a wired nylon net. The round trough sized black sheet was placed inside for egg-laying. Adult insects in 100 numbers (60% female and 40% males) were maintained and covered with white georgette cloth secured by an elastic band. On the cloth surface, an artificial diet (Yeast, Honey, Proteinex, and Water at 1:1:1:1 ratio + Zincovit 0.2% + Vitamin E tablet 2 Nos.) has pasted by two streaks along with two bits of water holding foam sponge. The egg cards were collected daily, and adults were transferred to new cages (TNAU Agri Portal, 2016; Mudassar et al., 2013).

For studying temperature and photoperiods, the newly emerged adults were caged and shifted to controlled room condition. In each treatment 100 adults (60% female and 40% males) incorporated in each cage and 10 cages maintained per treatment. The correlation of temperature and photoperiod on the adult stage of *C. carnea* were examined for their egg-laying ability and survivability under constant temperature at 20, 22, and 24 °C and Photoperiod at 0:24, 6:18, 12:12, 18:6,

and 24:0 with dark:light hours respectively. Adult survivability were observed from 1<sup>st</sup> to 20<sup>th</sup> day after release (DAR) irrespective to either male or female.

The data obtained on the effect of abiotic factors against reproduction and adult longevity were statistically analyzed by one factor analysis (ANOVA) using completely randomized design (CRD) in OPISTAT Statistical Software Package for Agricultural Research (Sheoran et al., 1998).

#### RESULTS AND DISCUSSION

The outcome of the correlative effect of three altered temperature (20, 22, and 24 °C) and five different photoperiod (0:24, 6:18, 12:12, 18:6, and 24:0 dark:light hours) on oviposition revealed that when adult insects of *C. carnea* reared at the temperature of 20 °C with 18:06 hours (dark:light) of photoperiod had encouraged highest egg production at average  $502.2 \pm 0.96$  eggs/day/100 adults compare to all other photoperiods. Whereas the lowest egg-laying ( $219.4 \pm 0.98$  eggs/day/100 adults) was observed at the same temperature but with varied photoperiod hours (24D:00L) respectively (Table 1).

Despite, the same photoperiod hours (18D:06L) with changed temperature at 22 °C exhibited that the highest oviposition ( $516.2 \pm 0.96$  eggs/day/100 adults) followed by 12D:12L photoperiods at similar temperature displayed ( $327.2 \pm 0.93$  eggs/day/100 adults) while the least eggs ( $219.4 \pm 0.98$  eggs/day/100 adults) were received at same temperature with 24D:00L Photoperiod hours respectively (Table 1).

The adult insects grown in the controlled atmosphere with temperature at 24 °C along with the photoperiod of 18D:06L hours were highly favoured by insects where they averagely produced highest number of eggs at  $620.9 \pm 0.85$  eggs/day/100 adults compared to all other photoperiods viz., 12:12, 06:18, 24:00, and 00:24 D:L hours with average egg production of  $414.3 \pm 0.88$ ,  $414.3 \pm 0.88$ ,  $315.9 \pm 1.00$ , and  $312.2 \pm 0.90$  eggs/day/100 adults were listed descending order respectively (Table 1).

This experiment on par with an earlier report by Bezerra et al. (2012) published that the 25 °C temperature was highly suitable for *C. genanigra* egg production under laboratory conditions. Eventually, laboratory-reared *C. carnea* was highly responsive to various degrees of temperature between 20 to 24 °C, and in both dark and light photoperiod, they can adjust their egg-producing strategy. Leather et al. (1992)

Table 1. Correlative effect of different temperature and different photoperiod hours on the oviposition of *C. carnea*

Photoperiod time (Dark:Light) in hours	No. of eggs laid/day @ 20 °C	No. of eggs laid/day @ 22 °C	No. of eggs laid/day @ 24 °C
00:24	280.2± 0.61	289.9± 0.67	312.2± 0.90
06:18	319.4± 0.87	326.4± 0.90	355.3± 0.89
12:12	327.2± 0.93	346.2± 0.92	414.3± 0.88
18:06	502.2± 0.96	516.2± 0.96	620.9± 0.85
24:00	219.4± 0.98	228.1± 0.81	315.9± 1.00

Mean is calculated from 10 replications; Mean values are square root transformed; SE: Standard Error of the statistic mean

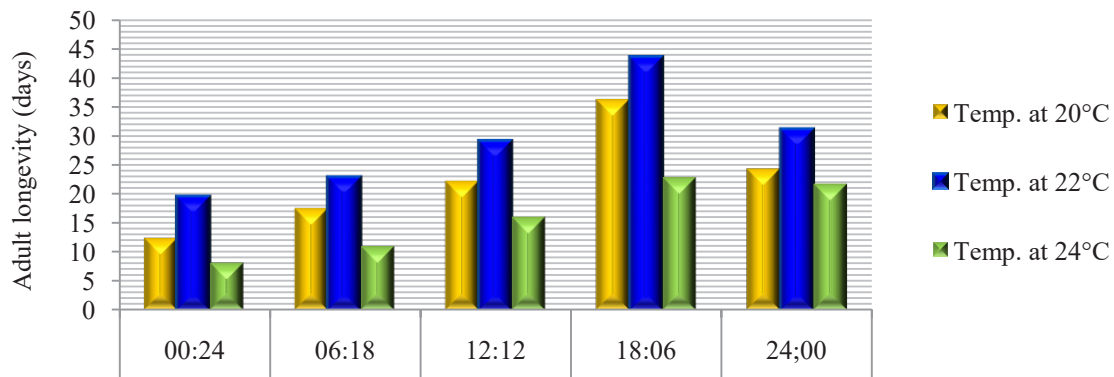


Fig. 1. Effect of co-factors (temperature and photoperiod) on the adult longevity of *C. carnea*

illustrated that the highest number of eggs were received from *C. carnea* between 20 to 25 °C temperatures. The finding of the present result is contrary to previous publication by Ahmed et al. (2012) where they revealed that at a constant temperature 26±2 °C with 00D:24L photoperiod hours were evidenced the maximum egg production of *C. carnea* but in this evaluation, *C. carnea* preferred 24 °C temperature with 18D:06L hours for highest egg production. Moreover, at constant temperature 24 °C is very comfortable compared to two other temperatures range testified in this study and the long day time might impair the egg productivity by which adults can exhaust their energy in light hours for flying compared to dark hours. Therefore, rearing adult *C. carnea* under laboratory conditions for better egg production the best suitable temperature and photoperiod is 24 °C and 18D:06L respectively.

The study on adult longevity was conducted to ascertain how the co-factor such as temperature (20, 22, and 24 °C) and photoperiod (0:24, 6:18, 12:12, 18:6, and 24:00 D: L hours) influences the adult life potency. The result exhibited that among the different temperatures exposed to adult insects at temperature 22 °C with 18D: 6L hours, insects were allowed to survive up to 43.4 days. Meanwhile, when the

temperature decreases (20 °C) or increases (24 °C) with the similar photoperiod, hours were displayed with significant variation in the adult longevity as 36.2 and 22.6days respectively. Saljoqi et al. (2015) observed that the highest adult longevity of female (31.9 days) and male (64.2 days) when grown at 20±1 °C temperature. Similarly, *Chrysoperla cubana* extended their lives maximum up to 43.9 days when reared at 20 °C compared to other temperature ranges of 25 and 30 °C (28.5 and 19.2 days) respectively (Venzon and Carvalho, 1993). Rearing of adult *C. carnea* at 40 °C temperature leads to detrimental effect (Albuquerque et al., 1994). Moreover, the long day (00D:24L hours) at 24 °C temperature drastically reduced the adult survival whereas comparatively the long night (24D:00L hours) allowed more days to thrive well at all the temperatures.

The reason behind the longest adult survival (43.4 days) at temperature 22 °C was that the adults were preferred 24 °C to lay maximum eggs (620.9 ± 0.85/day/100 adults) so it may utilize their energy for reproduction rather than survival. In other cases, if the adults utilise their energy for longevity which produces the lowest eggs. Hence, it is clear that if the mass culturing technique intended for egg production, then it is better to rear the adults at 24 °C temperature

with 18D:6L hours but if the intention is to enhance the longevity of adults, then rear the insects at 22 °C with the same photoperiod hours.

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