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COMPARATIVE STUDY OF DEVELOPMENTAL AND REPRODUCTIVE CHARACTERISTICS OF *CHRYSOPERLA CARNEA* (STEPHENS) (NEUROPTERA: CHRYSOPIDAE) AT DIFFERENT REARING TEMPERATURES

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ABSTRACT

Role of temperature is very critical for the development and reproduction of insects like predator, *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae). Present study was ascertained under laboratory conditions in a completely randomized design to sort out the comparatively effective rearing temperature by studying developmental and reproductive parameters at different temperatures conditions. Results showed that rearing at the different tested temperatures 20, 25, 28, 31, 35 and 40°C, the developmental and reproductive characteristics of *C. carnea* observed quite suitable at 28°C which proved to be the best among the other tested rearing temperatures. Rearing at 31 and 35°C had little effect on both the parameters of insect under study. It was inferred from present findings that rapid development of *C. carnea* observed at 31°C, which can gave useful rearing when quick development desired in laboratories. At 25°C, the reproduction rate of adult was the highest, as females tends to oviposit 10 days after emergence with 9 eggs per day and a total of 179.3 eggs per female. While over all better developmental and reproductive traits were recorded at 28°C. Slow and prolonged development was observed at 20°C, while no development recorded at high temperature of 40°C. Hence, it is demonstrate from the present study that the developmental and reproductive traits of *C. carnea* are directly dependent upon prevailing temperature of the environment.

Key words: Low temperature, rearing, *Chrysoperla carnea*.

INTRODUCTION

Predator, *Chrysoperla carnea* (Stephens) (Neuroptera; Chrysopidae), is recognized as a voracious feeder of whiteflies aphids and other soft bodied insects (Hashami, 2001). This predator has a tremendous potential to consume pests of crops and considered as an important constituent of biological control in integrated pest management of crops. Its mass rearing is being in practice in Pakistan for releases into crops (Sattar and Abro, 2011). This predator can consume many species of insect pests, such as whiteflies, aphids, thrips and eggs of bollworms (Atlihan *et al*. 2004). Its single larva, consumed 487.2 aphids and 510.8 whitefly pupae in its entire life span (Afzal and Khan, 1978). Gurbanov (1984) used *Chrysoperla carnea* against the thrips and aphids, the population of thrips fell down to 95.6% and those of aphids 98.5%. Jin (1998) has evaluated the effectiveness of *Chrysoperla carnea* against the *Heliothis armigera* (Hübner) and observed that pest infestation was reduced from 1.6 to 0.1%.

Study of biology of insect on its developmental and reproductive parameters are very essential and vital for its survival into a set of environmental conditions. *Chrysoperla* present in nature in many crop habitats and predate its target pests in areas where humidity is high like in green houses and irrigated crops etc. It is active in larval and adult forms present on leaves of crops, vegetables, fruit plants and weeds. Its adult has green colour with delicate soft wings. So, due to its appearance it is commonly called as green lace wing. Adults feed only on nectar of plants, pollen and aphids honey dew. Adult size measures 12-20 mm long with long antennae and bright golden eyes. Adults have a body size of 6-8 mm with large transparent pale green wings and a delicate cylindrical body, grey brownish and alligator like with well developed legs and large pincers with which they suck the fluids from the body of prey. Its life cycle is completes in 4-6 weeks, depending upon the temperature of the prevailing environment. Female lays oval shaped eggs singly at the end of a long stalk of silken nature and are pale green in colour. Usually 200 to 400 eggs are laid by a single female during its entire life span. Eggs turn into grey after 3 days and hatch within 3-6 days depending upon the temperature. The larvae are very active predator and larval stage has three instars completes in 2-3 weeks. Mature third instar larvae spin around a parchment like silken cocoon, usually in hidden places on plants. Pupal period prevails for about 7-10 days. Emergence of the adults occurs from silken cocoons after the completion of pupal period. There may be two to several generations per year in nature in favorable conditions and adults may survive for one to many months (Pedigo and Rice, 2005).

Silva *et al.* (2007) have evaluated from their research trial on the life history of a widespread Neotrapical predator, Chrysopodes at constant temperatures between 18 and 28.5°C. The life cycle ranged from 64 to 27 days, respectively at a temperature slightly below 15°C prevented development to show that the developmental rate is directly dependent upon temperature. At 25°C, the reproduction rate was the highest as females tends to oviposit 10 days after emergence, with 9 eggs per day and a total of 200 eggs per female. At low temperature regimes, the shelf life of *C. carnea* eggs can be prolonged (Arroyo *et al*., 2000) and the environment effects upon the viability of green lacewing eggs (Gardner and Giles, 1996). So the efforts were made in the present study to sort out an optimum temperature where both the developmental and reproductive stages of *C. carnea* gave effective rearing.

MATERIALS AND METHODS

Experiment under study was conducted to sort out optimum temperature for effective rearing of predator, *C. carnea* by the study of developmental and reproductive characteristics in mass rearing laboratories of beneficial insects at Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad. Rearing of the predator was carried out at six constant temperature regimes *viz*., 20, 25, 28, 31, 35 and 40°C in incubators in a completely randomized design. Six treatments were made for both the developmental and reproductive stages of *C. carnea*. A batch of 50 eggs was kept at each temperature regimes for hatching of eggs to study the developmental parameters of *C. carnea*. Egg hatching, larval duration (days), larval survival, pre-pupation period (days), pupation period (days) total developmental period (days, from egg hatching to adult formation) and total survival was recorded on daily basis and compared at each temperature condition. For the study of reproductive traits of *C. carnea*, 10 adults maintained at each temperature regime under study. Pre-oviposition period (days), oviposition period (days), total eggs laid per female, life span of female and male (days) recorded and compared. All the data were statistically analyzed accordingly, Steel *et al*. (1997) by using MSTAT-C software programme, where mean values compared with the help of Duncan's multiple range test. Standard error was calculated by using micro soft excel programme.

RESULTS AND DISCUSSION

Developmental parameters of *C. carnea* from eggs: Results of the comparative study to sort out effective rearing temperature for *C. carnea* on the developmental parameters at stages of eggs, larvae and pupae as shown in table 1, revealed significant differences among the tested rearing temperatures, at 20, 25, 28, 31 and 35°C. Maximum eggs were hatched (100%) within 4.5, 4.0 and 4.0 days at 28, 31 and 35°C, respectively. Hatching period was observed significantly ($F = 9.521$, df = 4, $P = 0.0019$), at all tested temperatures. Rearing temperature of 20 and 25°C, gave 92 and 96% egg hatching with prolonged period of hatching (10.3 and 5.9 days respectively) observed as compared to those at other rearing temperatures. Cumulative larval duration of all 3 instars was observed significantly ($F = 13.948$, df = 4, $P = 0.0004$) which prolonged (20.4 days) at 20°C and reduced to 12.9, 11.0, 10.2 and 10.0 days, at 25, 28, 31 and 35°C, respectively. Highest larval survival (100%) was recorded at 28°C, followed by 95.8, 91.3, 72.0 and 28.0% at 25, 20, 31 and 35°C, respectively. Pre pupation significantly differ ($F = 8.424$, df = 3, $P = 0.0074$) at tested temperatures, where, the highest pre pupation (7.4 days) was recorded at 20°C followed by that of 5.9 days at 25°C and it was observed 3 days at 28, 31 and 35°C, respectively. Pupation period (days), showed at par trend ($F = 17.937$, df = 3, $P = 0.0006$), observed at all the tested rearing temperatures. Pupal recovery (%) was observed the highest (95.2) at 20°C and the lowest (42.8%) at 35°C, whereas reduced to 91.3, 92.0 and 77.7% at 25, 28 and 31°C respectively. Total highest survival (92%) was recorded at 28°C followed by 84% at 25°C, 80% at 20°C, 56% at 31°C and no survival observed at 35°C. So, from these results, it is accomplished that rearing at 28°C gave a good results of parameters under study. Rearing at 25°C was also closer which also favored factors under study with high number of eggs production. Temperature of 20°C did not reflect any bad effect upon the developmental parameters except to that of prolonged development. However, whenever prolonged development desired, this temperature can be an effective one. Rearing at 31 and 35°C did not favored positively upon the developmental traits, however when rapid development desired, 31°C may serve the purpose.

Our results agreed to the work carried by Albuquerque *et al*. (1994), who have reported that rearing at 40°C was highly lethal towards developmental traits of the adult predator, *C. carnea.* The developmental traits of *C. carnea*, in our findings, gradually decreased with the increase in rearing temperature and it supports the work reported by Silva *et al*. (2007) who have observed the developmental time of *C. carnea* tends to be faster and at 25°C (31.1 days) and 30°C (26.5 days) but slow (46.2 days) at 21.5°C.

Reproductive parameters of adult of *C. carnea*: Reproductive parameters of the adults of *C. carnea* indicated as in table 2, showed significant variations that were observed at different tested temperatures. Pre oviposition period (Days) were observed in significant range ($F = 12.431$, df = 3, $P = 0.0022$) among tested temperatures. The highest pre-oviposition period (15.2)

of *C. carnea* was recorded at rearing condition of 20°C and it gradually decreased as the temperature increased up to 25, 28 and 31°C and with 10.5, 10.0 and 7.0 days, respectively. Almost similar trend of oviposition period (F = 100.698, df = 3, P = 0.0000) was observed to that of pre-oviposition period and it decreased as the rearing temperature increased from 20 to 31, having 18.3 and 6.3 days of ovi-position, which were the highest and the lowest, respectively. Egg laying trend were observed significantly at various temperatures (F = 83.932, df = 3, P = 0.0000). The highest egg laying (179.3) was observed at 25°C, followed by 113.0, 62.6 and 33.0 eggs at 28, 20 and 31°C, respectively. Here, it is obvious from the results that 25°C temperature favored egg lying as compared to other rearing temperatures. Statistically significant total life span of female (F = 18.908, df = 3, P = 0.0005) and of male (F = 31.341, df = 3, P = 0.0001) were observed, with the longest (51.6 and 18.2 days) at 20°C and shortest (13.3 and 7.0 days) at 31°C, respectively, which was not lead to increase the potential of egg laying. Almost a similar trend of life span of female and male was recorded at 25 and 28°C, respectively. Our findings suggest that rearing of *C. carnea* could be carried out in a range of temperatures from 20 to 31°C whereas, 25°C proved to be the best for egg laying and 28 proved to be overall suited one where, reproductive parameters were observed comparatively better to those at other temperature conditions. Results of our present findings are agreed to the work carried by Albuquerque *et al*. (1994) who have reported that rearing at 35°C proved lethal for the development parameters of *C. carnea.*

Table 1: Effect of different rearing temperatures on the development of adults of *C. carnea*.

Developmental parameters	Rearing temperatures °C				
	20	**25**	**28**	**31**	**35**
Egg hatching (Total 25)	23	24	25	25	25 NS
Hatching duration (Days)	10.3±0.31^{a}	5.9±0.39^{b}	4.5±0.57^{b}	4.0±0.00^{b}	4.0±0.01^{b}
Larval duration (Days)	20.4±0.12^{a}	12.9±0.21^{b}	11.0±0.14^{b}	10.2±0.11^{b}	10.0±0.10^{b}
Survival to larvae (nos.)	21±0.23^{a}	23±0.11^{a}	25±0.12^{a}	18±0.13^{ab}	02±0.57^{b}
Pre-pupation (Days)	7.4±0.13^{a}	5.9±0.11^{a}	3.1±0.30^{b}	3.0±0.10^{b}	-
Pupation (Days)	16.3±0.11^{a}	9.0±0.12^{b}	8.1±0.10^{bc}	8.0±0.11^{c}	-
Pupal recovery (Nos.)	20.0±0.17^{a}	21.0±0.58^{a}	23.0±0.17^{a}	14.0±0.07^{b}	-
Total developmental period (Days)	44.1±0.14^{a}	28.1±0.13^{b}	22.2±0.11^{b}	21.2±0.10^{b}	-
Total survival (Nos.)	20 ±0.23^{a}	21±0.11^{a}	23±0.13^{a}	14±0.33^{b}	-

Means sharing similar alphabets in a row are statistically non significant at 5% level; ±SE= Standard Error.

Table 2: Effect of different rearing temperatures on the reproductive parameters of adults of *C. carnea*.

Reproductive parameters	Rearing temperatures °C				
	20 (n)	**25 (n)**	**28 (n)**	**31 (n)**	**35 (n)**
Pre-oviposition period (Days)	15.2±0.13^{a} (10)	10.5±0.11^{b} (10)	10.0±0.18^{bc} (9)	7.0±0.11^{c} (8)	-
Oviposition period (Days)	18.3±0.23^{a} (7)	27.2±0.17^{a} (9)	25.4±0.20^{b} (9)	6.3±0.14^{c} (8)	-
Total eggs laid per female	62.6±0.09^{a} (7)	179.3±0.13^{b}(8)	113.0±0.16^{c} (8)	33.0±0.18^{d} (7)	-
Life span (Female)	51.6±0.18^{a} (5)	45.2±0.11^{a} (5)	42.7±0.13^{a} (5)	13.3±0.15^{b} (5)	-
Life span (Male)	18.2±0.22^{a} (5)	16.4±0.08^{a} (5)	15.5±0.17^{a} (5)	7.0±0.12^{b} (4)	-

Means sharing similar alphabets in a row are statistically non significant at 5% level; ±SE= Standard Error; n= Number of individuals.

Conclusions: Findings of the present research concludes, that among the tested temperatures, 28°C gave effective rearing for the developmental and reproductive characteristics of *C. carnea* where, shorter period of larval development and more number of egg laid by female adult. The highest number of eggs was received at 25°C, whereas, other parameters under study also closer to that of observed at 28°C rearing condition.

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