

# EFFECT OF TEMPERATURE ON THE CONSUMPTION CAPACITY OF *CHRYSOPERLA CARNEA* (STEPHENS) (NEUROPTERA: CHRYSOPIDAE) REARED ON FOUR APHID SPECIES

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## ABSTRACT

Effects of prey kinds on consumption capacity was studied in the common lacewing, *Chrysoperla carnea* using four aphid species i.e. *Aphis craccivora*, *Aphis gossypii*, *Myzus persicae* and *Lipaphis erysimi*, as a prey, at five constant temperature regimes that is 10°C, 15°C, 20°C, 25°C and 30°C under laboratory conditions. The failures of aphid's chemical control compel us to switch over other methods of integrated pest management (IPM), particularly biological control programme through larvae of *C. carnea*, a predator of several arthropod pest. The data revealed that the consumption capacity of *C. carnea* differ significantly, when its larvae were reared separately on the four aphid species at different temperatures. Consumption was maximum ( $320.5 \pm 22.79$  aphids) at 15°C when *A. craccivora* was given as prey to the larvae of this predator and minimum ( $143.3 \pm 1.25$  aphids) at 30°C when reared on *L. erysimi*.

## INTRODUCTION

Aphids are cosmopolitan, polyphagous species, widely distributed in North Eastern Uttar Pradesh and other parts of India. Most vegetables and cereal crops are attacked by a number of aphid species (Blackman and Eastop, 1984; El-Khawas, 2005), causing quality deterioration and yield loss (Kennedy and Abou-Ghadir, 1979). These losses reduces income drastically and farmers resort to using insecticides (Ronald and Jayma, 2007), which not only increases the cost of production but also pollute the environment.

Green lacewing, *Chrysoperla carnea* (Stephens) is one of the most beneficial and prolific predator, belongs to the family Chrysopidae, order Neuroptera, also known as aphid lion. It is found in different agricultural habitats with high relative frequency of occurrence. Larvae feed on variety of insects, while adults feed only on nectar, pollen and honey dew. Chrysopids shows high resistance towards many widely used pesticides (Bigler, 1984).

The predator efficiency is affected by diet and temperature (Canard and Principi, 1984; Frazer, 1988; Venzon and Carvalho, 1993). Thus, it was thought desirable to understand the effect of temperature and diet (aphid species as a prey) on the consumption capacity of this predator, which can be utilized during field release of this chrysopid for the management of aphid population.

## MATERIALS AND METHODS

A rich laboratory culture of *Coryca cephalonica* (Stainton) was maintained in the laboratory, on diet composed of coarsely ground 'Jowar' (*Sorghum bicolor* (L.) Moench) containing 5% powdered yeast (Mishra and Krishna, 1979), serves as a source for obtaining fresh eggs. These eggs were treated with U.V. rays (30 Watt U.V. bulb at 2 ft distance for 45 minutes) and were utilized as alternative prey for rearing *Chrysoperla carnea* larvae (Viji and Gautam, 2005) in the laboratory. For the culture of *Chrysoperla carnea*, pupa of this insect was collected from Vegetable Research Centre, Adalpur, Varanasi. After the identification of sexes, one male and one female was paired in a 250 mL beaker for mating and to lay eggs. Breeding pairs were provided with mixture of honey, protinex, yeast and water on a piece of sponge (Singh *et al.*, 2005). Culture of both prey and predator were maintained at  $27 \pm 2^\circ\text{C}$  and R.H.  $75 \pm 5\%$  (Mishra, 2008). Counted number (one in each glass vials) of one day old eggs were kept in 20 glass vials (57 mm length, 20 mm diameter) for hatching.

To study the consumption capacity, newly hatched larvae of *C. carnea* were transferred with the help of soft and moist camel hair brush, singly, in 10 glass vials having 50 prey aphids, *A. gossypii* (collected from cucurbit plant: *Luffa aegyptiaca*) as a feed for the larva. The vials were covered at the top by a piece of black muslin cloth, fastened by rubber string. The same type of experiment was repeated with other aphid species that is *A. craccivora* (collected from beans: *Lablab purpureus*), *M. persicae* (collected from cabbage:

*Brassica oleracea capitata*) and *L. erysimi* (collected from mustard: *Brassica campestris*). All the vials having selected aphid species were kept in BOD incubator, maintained at 10°C, 15°C, 20°C, 25°C and 30°C separately as per requirement. The consumed number of aphids was counted after every 24 hrs. and the prey food (the selected prey aphid) of each glass vial was changed daily, so that there was always plenty of food available, until the predator completed their larval development. The consumption capacity for each larval instars of *C. carnea* was recorded under the selected five temperature regimes.

Each experiment was adequately replicated and data analyzed by the Least Significant Difference (LSD) analysis (Paterson, 1939).

### RESULTS AND DISCUSSION

The total consumption of different aphid species by the larvae of *C. carnea* decreased with increase of the temperature. There was significant reduction ( $p < 0.01$ ) in total consumption from 15°C to 30°C (Table 1). At 10°C, eggs were unable to hatch. A reduction of varying degree in total consumption occurred, by each instars of this predator from 15°C to 30°C. The total consumption rate, for selected aphid species, by the larval

stages of *C. carnea* showed significant difference ( $p < 0.01$ ). In relation to the food preference of the predator larvae, among all the aphid species tested, *A. craccivora* stands first, followed by *A. gossypii*, *M. persicae* and *L. erysimi*. The average number of aphids consumed per larva per day also differed significantly at selected temperatures. The regression curve clearly indicates the mean total number of aphids consumed by the larvae, to complete their development, at selected temperatures (Fig. 1).

The consumption increases from the first to last instars at different temperatures with selected prey species (Table 1). It's apparent that on average 10-17% food was consumed by the first instars larvae, 20-24% by the second instars and 60-67% food was consumed by the third instars larvae. The quantity of prey consumed by *C. carnea* depends on the prey species size and the stage offered for feeding. Information in the literature cannot be easily compared because the aphid species, their stages and host plant on which it occurred, was different. Total consumption rate for different larval stages differed significantly ( $p < 0.01$ ), when larvae of this predator was reared on four different aphid species. The maximum consumption rate was recorded with *A. craccivora* and minimum with *L. erysimi*. The same type of results were observed by Balasubramani and Swamiappan (1998), while working with *C. carnea* developed on *A. craccivora* as prey.

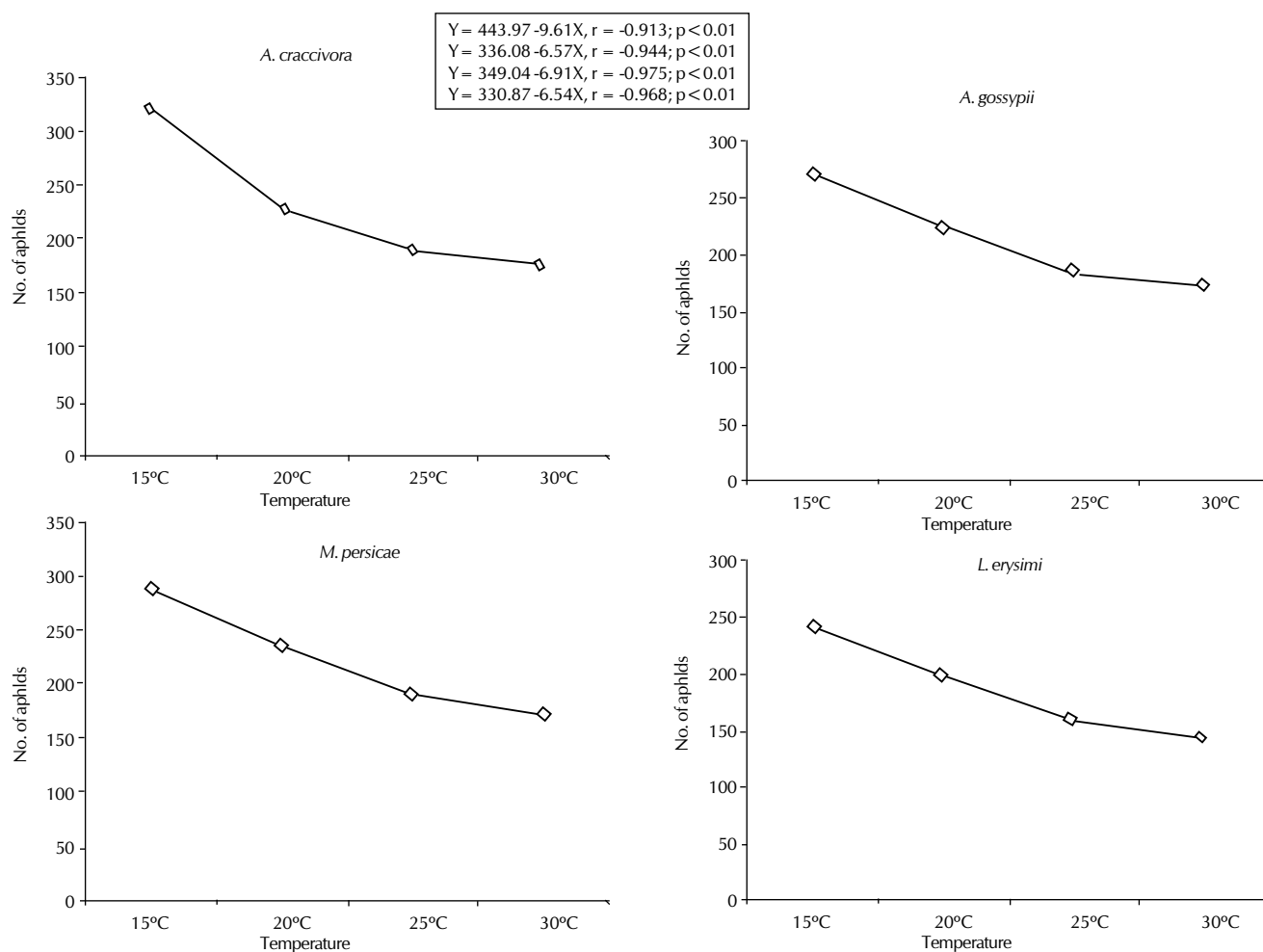


Figure 1: Total consumption capacity of *C. carnea* at different temperatures reared on different prey aphid species

**Table 1: Consumption capacity of *C. carnea* fed with different aphid species at different constant temperatures. All values are expressed as mean  $\pm$  S.D.**

| Regimens                                                                | Aphid Species                     | Temperature                 |                                        |                                        |                                       |                                       |
|-------------------------------------------------------------------------|-----------------------------------|-----------------------------|----------------------------------------|----------------------------------------|---------------------------------------|---------------------------------------|
|                                                                         |                                   | 15°C<br>Number<br>Percent % | 20°C<br>Number<br>Percent %            | 25°C<br>Number<br>Percent %            | 30°C<br>Number<br>Percent %           |                                       |
| Mean number of aphids consumed and its percent to the total consumption | 1 <sup>st</sup> instars           | <i>A. craccivora</i>        | 51.1 <sup>a</sup> $\pm$ 1.10<br>15.9   | 39.7 <sup>b</sup> $\pm$ 1.49<br>17.3   | 19.6 <sup>c</sup> $\pm$ 1.17<br>10.4  | 19.2 <sup>d</sup> $\pm$ 1.87<br>11.0  |
|                                                                         |                                   | <i>A. gossypii</i>          | 44.6 <sup>a</sup> $\pm$ 1.78<br>16.5   | 39.1 <sup>b</sup> $\pm$ 1.19<br>17.5   | 20.1 <sup>c</sup> $\pm$ 1.85<br>10.8  | 18.1 <sup>d</sup> $\pm$ 0.99<br>10.4  |
|                                                                         |                                   | <i>M. persicae</i>          | 39.1 <sup>a</sup> $\pm$ 1.10<br>15.4   | 34.3 <sup>b</sup> $\pm$ 0.82<br>16.6   | 16.7 <sup>c</sup> $\pm$ 0.82<br>10.0  | 15.4 <sup>d</sup> $\pm$ 0.52<br>10.2  |
|                                                                         |                                   | <i>L. erysimi</i>           | 36.0 <sup>a</sup> $\pm$ 2.45<br>15.0   | 30.8 <sup>b</sup> $\pm$ 0.79<br>15.7   | 15.3 <sup>c</sup> $\pm$ 0.67<br>9.7   | 14.6 <sup>d</sup> $\pm$ 0.52<br>10.1  |
|                                                                         | 2 <sup>nd</sup> instars           | <i>A. craccivora</i>        | 76.5 <sup>a</sup> $\pm$ 1.08<br>23.8   | 56.8 <sup>b</sup> $\pm$ 1.23<br>24.8   | 43.1 <sup>c</sup> $\pm$ 3.93<br>22.9  | 42.6 <sup>d</sup> $\pm$ 3.24<br>24.5  |
|                                                                         |                                   | <i>A. gossypii</i>          | 63.3 <sup>a</sup> $\pm$ 1.95<br>23.4   | 53.6 <sup>b</sup> $\pm$ 1.51<br>23.9   | 41.6 <sup>c</sup> $\pm$ 2.70<br>22.3  | 41.5 <sup>d</sup> $\pm$ 5.82<br>24.0  |
|                                                                         |                                   | <i>M. persicae</i>          | 59.5 <sup>a</sup> $\pm$ 0.71<br>23.5   | 49.6 <sup>b</sup> $\pm$ 1.84<br>24.1   | 40.5 <sup>c</sup> $\pm$ 0.53<br>24.3  | 34.2 <sup>d</sup> $\pm$ 1.87<br>22.7  |
|                                                                         |                                   | <i>L. erysimi</i>           | 55.2 <sup>a</sup> $\pm$ 1.39<br>23.0   | 45.2 <sup>b</sup> $\pm$ 1.93<br>23.0   | 35.8 <sup>c</sup> $\pm$ 1.48<br>23.0  | 33.8 <sup>d</sup> $\pm$ 1.03<br>23.5  |
|                                                                         | 3 <sup>rd</sup> instars           | <i>A. craccivora</i>        | 192.9 <sup>a</sup> $\pm$ 22.40<br>60.1 | 132.0 <sup>b</sup> $\pm$ 13.69<br>57.7 | 125.3 <sup>c</sup> $\pm$ 7.35<br>66.6 | 112.0 <sup>d</sup> $\pm$ 4.60<br>64.4 |
|                                                                         |                                   | <i>A. gossypii</i>          | 162.2 <sup>a</sup> $\pm$ 13.99<br>60.0 | 130.7 <sup>b</sup> $\pm$ 7.90<br>58.5  | 124.1 <sup>c</sup> $\pm$ 8.02<br>66.7 | 113.2 <sup>d</sup> $\pm$ 3.97<br>65.5 |
|                                                                         |                                   | <i>M. persicae</i>          | 153.7 <sup>a</sup> $\pm$ 4.90<br>60.9  | 121.5 <sup>b</sup> $\pm$ 3.47<br>59.1  | 108.8 <sup>c</sup> $\pm$ 1.32<br>65.5 | 100.6 <sup>d</sup> $\pm$ 3.72<br>66.9 |
|                                                                         |                                   | <i>L. erysimi</i>           | 148.0 <sup>a</sup> $\pm$ 1.25<br>61.8  | 119.8 <sup>b</sup> $\pm$ 1.69<br>61.1  | 105.3 <sup>c</sup> $\pm$ 0.82<br>67.3 | 94.9 <sup>d</sup> $\pm$ 0.99<br>66.2  |
|                                                                         | Means total no of aphids consumed | <i>A. craccivora</i>        | 320.5 <sup>a</sup> $\pm$ 22.79         | 228.5 <sup>b</sup> $\pm$ 14.13         | 188.0 <sup>c</sup> $\pm$ 8.08         | 173.8 <sup>d</sup> $\pm$ 8.04         |
|                                                                         |                                   | <i>A. gossypii</i>          | 270.1 <sup>a</sup> $\pm$ 14.91         | 223.4 <sup>b</sup> $\pm$ 9.25          | 185.8 <sup>c</sup> $\pm$ 7.86         | 172.8 <sup>d</sup> $\pm$ 5.41         |
|                                                                         |                                   | <i>M. persicae</i>          | 252.3 <sup>a</sup> $\pm$ 4.59          | 205.4 <sup>b</sup> $\pm$ 3.95          | 166.0 <sup>c</sup> $\pm$ 1.25         | 150.2 <sup>d</sup> $\pm$ 4.76         |
|                                                                         |                                   | <i>L. erysimi</i>           | 239.2 <sup>a</sup> $\pm$ 3.19          | 195.8 <sup>b</sup> $\pm$ 2.89          | 156.4 <sup>c</sup> $\pm$ 1.96         | 143.3 <sup>d</sup> $\pm$ 1.25         |

Note: Mean values superscripted by different letter vary significantly at 1% or 5% level by the Least Significant Difference (LSD) test, in each row.

Total consumption of aphid species by the larvae of *C. carnea* increased with decrease in temperature, and consumption increased from first to the third instars under the selected temperature regimes. It was observed that 60-67% of total food was consumed by 3<sup>rd</sup> instars, where as Canard and Principi (1984) mentioned that chrysopids in general, consume 80% of total food intake during the third instars, thereby, increasing their consumption with the decrease in temperature. Same type of result was also reported by Fonseca *et al.*, (2000), Vidya *et al.*, (2007), Mishra, (2008), whereas Liu and Chen (2001) reported that *C. carnea* has greater potential as a predator of *A. gossypii* and *M. persicae* and has lower potential for *L. erysimi*, *Chrysoperla carnea* fed on as few as 208 *A. gossypii* (Burke and Martin, 1956), *Chrysoperla plorabunda* (Fitch) feeds on as many as 419 aphids (Balasubramani and Swamiappan, (1994) and 487 aphids (Afzal and Khan, 1978) and as few as 128 female apterous *M. persicae* to as many as 386 nymphs (Hafez and Abd-el-Hamid, 1965). The availability of a favorable larval prey also affects consumption (Syed *et al.*, 2005; Pappas *et al.*, 2007). Some sort of detrimental effect of *L. erysimi* on *C. carnea* may be a cause in their very limited consumption.

In North Eastern Uttar Pradesh, temperature variation occurs between 10 °C to 35 °C. It has been observed that natural predator and parasitoids of agricultural pest decline with different range of temperatures. For this, periodic inundative and inoculative release is required. Aphid's infestation was

observed from September to March. Heavy infestation was observed during October to November and January to February, during period of investigation. In the month of December, when temperature was very low, aphid population was almost nil. It was observed that this predator is adapted to a wide range of temperature from 15°C to 30°C. Based on the developmental period, percent mortality and consumption capacity, *C. carnea* was evaluated as a good agent for the bio-control of this insect pest in the field. However, *C. carnea* consumed significantly more aphids at 15°C, because the developmental period was longer at lower temperature regimes. As far as, its field release is concerned, it is suggested to release the species in cooler months with temperature ranging from 15°C to 25°C.

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