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Comparative biology and predatory potential of green lace wing on different aphid species

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ABSTRACT

Investigation on comparative biology of green lace wing, *Chrysoperla zastrowi arabica* Henry *et al*. (Neuroptera : Chrysopidae) was carried out in the Bio-control Laboratory, Navsari Agricultural University, Navsari, Gujarat during 2007 to 2009. The results on comparative biology of *C. zastrowi arabica* on two aphid species *viz*., *Aphis gossypii* Glower and *Myzus persicae* (Sulzer) revealed that average duration of total developmental period was 18.70 ± 0.64 and 18.93 ± 0.55 days when reared on *A. gossypii*, and *M. persicae*, respectively. The egg laying capacity of *C. zastrowi arabica* was recorded 754.25 ± 143.47 and 601.75 ± 89.43 eggs when reared on *A. gossypii* and *M. persicae*, respectively. Study on predatory potential of *C. zastrowi arabica* revealed that single larva consumed an average of 627.60 ± 42.39 and 587.5 ± 55.59 numbers (nymphs and adults) of *A. gossypii* and *M. persicae*, respectively.

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INTRODUCTION

The chrysopids, a neuropteran insect popularly known as Green lacewings or Golden eyes or Common lacewing or Aphid lions are of considerable importance because of their role in natural control of many pest in different crops. These lacewings are one of the important biological control agents that are used effectively to manage various insect pests especially sucking pests in different agro–ecosystems (Canard *et al.*, 1984; Carvalho *et al.*, 2002; Symondron *et al.*, 2002; Balakrishnan *et al*., 2004; Venkatesan *et al.*, 2009 and Henry *et al.*, 2010). It has long been considered as a promising candidate for pest management worldwide due to its wide prey range and geographical distribution, resistant to insecticides, voracious larval feeding capability as well as ensured commercial availability (New, 1975; Tauber *et al.*, 2000; Mc Ewen *et al.*, 2001; Medina *et al.*, 2003; Pathan *et al.*, 2008 and Sayyed *et al.*, 2010). Adult lacewings feed solely on nectar, pollen and plant secretions containing sugar (Hagen, 1950 and Hassan, 1974) although a few are predatory (Coppel and Mertins, 1977). It has long been considered as an important natural predator, which can be manipulated for improved pest control. In recent years, use of green lacewing is being recommended in biointensive Integrated pest management. In India, 67 species belonging to 21 genera have been recorded from various crop ecosystem.

The green lacewing, *Chrysoperla zastrowi arabica* Henry *et al.* (2006) is recognized as an insect predator in many crop ecosystems. Its predatory potential is well established in a variety of insect pests and it is also considered to be an important component in the ecologically sound pest

management packages of crops like cotton, sunflower, tobacco, ornamentals, etc. *C. zastrowi arabica* is a general predator on soft-bodied insescts, *viz*., aphid, leafhoppers, whiteflies etc. The larvae of green lace wing are important predators of aphids, eggs and early instar larvae of boll worms in the cotton ecosystem and also on a number of other pests (Gautam and Paul, 1987). Green lace wing are important natural enemies of several insect pests and constitute a prominent group of predators due to their amenability to mass production and use in different ecosystems (Ingole *et al*., 2005).

According to Patel and Vyas (1985) *C. carnea* is one of the most important and valuable predators of economic crop pests like *Helicoverpa armigera* Hubner, *Spodoptera litura* Fabricious, different species of aphids and other sucking pest-complex. The important characteristics of this species include its wide geographical distribution and host range, broad habitats, resistance to certain pesticides and voracious larval feeding capacity. Further, from a commercial point of view, *C. zastrowi arabica* is ideal biological control agent because they can be effective against such a wide variety of pests in so many different cropping systems.

These lacewing larvae are considered generalist beneficially but are best known as aphid predator and have been reported to eat 100 to 600 aphids. The *C. zastrowi arabica* has long been considered an important natural predator and one, which can be manipulated for improved pest control. In India, *C. zastrowi arabica* is mass reared on the eggs of rice moth, *Corcyra cephalonica* (stainton). Considering importance of predators, to generate information regarding mass multiplication of predator on natural host of this insect, the present investigation was undertaken.

MATERIAL AND METHODS

The comparative biology of *C. zastrowi arabica* was studied on two different aphid species *viz.*, *A. gossypii* on cotton and *M. persicae* on maize was carried out during 2007-08 and 2008-09 at Navsari Agricultural University, Navsari, Gujarat, India. For the multiplication of aphids, host plants were potted in Bio-control Laboratory, Department of Agricultural Entomology, Navsari Agricultural University, Navsari. Thirty newly hatched larvae of *C. zastrowi arabica* were taken and kept in plastic vial (4×3 cm) individually in each set. They were provided with known number of second - third instar nymphs and adults of aphid with leaf bit regularly at 24 hour interval. The vial was checked regularly for the presence of exuvie, to calculate the duration of each larval instar. The prepupal and pupal period was recorded during an experiment. Adults were paired and kept in plastic vial (7×6 cm), which was covered with black cloth with the help of rubber band. Adults were provided with standard diet and eggs were harvested with the help of sponge pad regularly. The eggs were placed in individual vial (4×3 cm) for recording egg period. Observations of 10 pairs were taken regularly to count number of eggs laid by the female in each pair during its total life span. Male and female longevity, pre-oviposition, oviposition and post-oviposition period was recorded.

Predatory potential of *C. zastrowi arabica* on different aphid species :

The predatory potential of *C. zastrowi arabica* was studied on different two aphid species, *A. gossypii* and *M. persicae*. Thirty newly hatched larvae of *C. zastrowi arabica* were taken and kept in plastic vial (4×3 cm) individually in each set. They were provided with known number of second - third instar nymphs and adults of aphid (laboratory culture) with leaf bit regularly at 24 hour interval. Aphids and nymphs which were not eaten by the larvae of *C. zastrowi arabica* was counted on next day, thereby exact number of aphids eaten were easily counted, thereby predatory potential was worked out.

RESULTS AND DISCUSSION

The larvae of *C. zastrowi arabica* were fed with different two aphid species to compare biology and to study predatory potential. The study on biology was carried out in two trials, first trial was conducted during November-2007 to January-2008 at 23.37±1.59°C temperature and 58.73±2.97 per cent relative humidity and second trial was conducted during November-2008 to January-2009 at 25.59±1.94°C temperature and 57.13±5.29 per cent relative humidity.

Biology of *C. zastrowi arabica* on different aphid species :

Eggs :

The average incubation period of *C. zastrowi arabica* was 3.60 ± 0.33 and 3.48±0.38 days when *C. zastrowi arabica* reared on *A. gossypii* and *M. persicae*, respectively (Table 1). Earlier, Patro and Behera (2002) recorded that the incubation period of *C. carnea* was 4.01±0.05 days on *A. gossypii*. The present findings are more or less in conformation with above workers.

Larva :

The average duration of first instar larvae of *C. zastrowi arabica* was 2.60±0.33 and 2.85±0.27 days when reared on *A. gossypii* and *M. persicae*, respectively (Table 1).

The average duration of second instar larvae of *C. zastrowi arabica* was 2.55±0.36 and 2.15±0.23 days when reared on *A. gossypii* and *M. persicae*, respectively (Table 1).

Average duration of third instar larvae of *C. zastrowi arabica* on the basis of pooled data was 3.52±0.36 and 3.13±0.35 days, when *C. zastrowi arabica* reared on *A. gossypii* and *M. persicae*, respectively (Table 1). The number of aphids consumed by the third instar larva was incredibly high compared to the first two instars during its developmental

period.

The pooled analysis revealed that the total larval duration of *C. zastrowi arabica* was 8.68 ± 0.50 and 8.13 ± 0.45 days, when reared on *A. gossypii* and *M. persicae*, respectively.

Similar types of observations were also taken by Kapadia and Puri (1992) who recorded the mean larval period of first, second and third instars of *C. carnea* was 2.34 ± 0.44, 4.16 ± 0.40 and 3.11 ± 0.35 days, respectively when reared on *A. gossypii*. According to Thite and Shivpuje (1999), the mean larval period of first, second and third instar was 2.50, 2.60 and 2.50 days, respectively on *A. gossypii* whereas it was 2.77 ± 0.20, 1.87 ± 0.26 and 3.77 ± 0.51 days, respectively on *A. gossypii* with total larval period of 8.40 ± 0.72 days (Patro and Behera, 2002). Thus, results obtained in the current investigations have revealed almost the same trend as reported by the earlier workers, thus, it is line with that of earlier workers.

Prepupa and pupa :

The duration of prepupa was ranged between 6 to 8 hours. There was no sharp change in the duration of prepupa

Table 1 : Incubation period, duration of first, second, third instar larva and total larval period of *C. zastrowi arabica* on different aphid species (Pooled data)

Sr. No.	*A. gossypii*					*M. persicae*				
	Incubation period	First instar	Second instar	Third instar	Total larval period	Incubation period	First instar	Second instar	Third instar	Total larval period
1.	3.50	2.50	2.00	3.50	8.00	3.50	2.50	2.50	3.00	8.00
2.	3.00	2.00	3.00	3.00	8.00	3.50	3.00	2.00	3.50	8.50
3.	3.00	2.50	2.50	3.50	8.50	4.00	2.50	2.50	2.50	7.50
4.	3.50	2.50	2.50	3.00	8.00	4.00	3.00	2.00	3.00	8.00
5.	4.00	2.50	2.50	4.00	9.00	3.00	3.00	2.50	3.00	8.50
6.	3.50	2.50	3.00	4.00	9.50	3.50	3.00	2.50	3.00	8.50
7.	4.00	2.50	3.00	4.00	9.50	3.50	2.50	2.00	3.00	7.50
8.	4.00	3.00	2.50	3.00	8.50	3.00	3.00	2.00	3.50	8.50
9.	3.53	3.00	2.50	3.50	9.00	3.00	3.00	2.00	3.00	8.00
10.	3.00	2.50	3.00	3.50	9.00	3.00	3.00	2.00	3.00	8.00
11.	3.50	2.00	3.00	4.00	9.00	3.00	3.00	2.50	3.50	9.00
12.	4.00	3.00	2.00	3.50	8.50	3.50	3.00	2.00	3.50	8.50
13.	4.00	3.00	2.00	3.00	8.00	3.50	3.00	2.00	3.50	8.50
14.	4.00	2.50	2.50	3.00	8.00	3.00	3.00	2.00	2.50	7.50
15.	4.00	2.50	2.50	3.50	9.00	4.00	3.00	2.00	3.50	8.50
16.	3.00	2.50	3.00	3.50	9.00	3.50	3.00	2.00	3.00	8.00
17.	3.50	2.50	2.50	4.00	9.00	3.00	3.00	2.00	3.00	8.00
18.	4.00	2.50	2.50	3.50	8.50	4.00	3.00	2.00	3.00	8.00
19.	3.50	3.00	2.50	3.00	8.50	4.00	2.00	2.50	3.00	7.50
20.	4.00	2.50	2.00	4.00	8.50	4.00	3.00	2.00	3.00	8.00
21.	3.50	2.50	3.00	3.50	9.00	3.00	3.00	2.50	3.00	8.50
22.	3.50	2.00	2.00	4.00	8.00	3.50	2.50	2.00	3.50	8.00
23.	3.50	3.00	2.50	3.50	9.00	3.50	3.00	2.50	3.00	8.50
24.	3.50	3.00	2.50	3.50	9.00	4.00	2.50	2.00	3.00	7.50
25.	4.00	3.00	3.00	3.50	9.50	3.50	2.50	2.50	3.00	8.00
26.	3.50	2.50	2.50	3.50	8.50	3.00	3.00	2.00	4.00	9.00
27.	3.50	2.50	2.50	3.00	8.00	3.50	3.00	2.00	2.50	7.50
28.	3.50	3.00	3.00	3.50	9.50	4.00	2.50	2.00	3.00	7.50
29.	3.50	2.00	2.50	4.00	8.50	3.50	3.00	2.00	3.50	8.50
30.	3.50	3.00	2.00	3.50	8.50	3.50	3.00	2.00	3.50	8.50
Average	3.60	2.60	2.55	3.52	8.68	3.48	2.85	2.15	3.13	8.13
S.D. ±	0.33	0.33	0.36	0.36	0.50	0.38	0.27	0.23	0.35	0.45
Min.	3.00	2.00	2.00	3.00	8.00	3.00	2.00	2.00	2.50	7.50
Max	4.00	3.00	3.00	4.00	9.50	4.00	3.00	2.50	4.00	9.00

irrespective to host on which *C. zastrowi arabica* was reared so it was considered as one days.

Pooled data of both trial concluded that, the average pupal period was 6.45 ± 0.33 and 7.30 ± 0.31 days when reared on *A. gossypii* and *M. persicae*, respectively (Table 2). Earlier Kapadia and Puri (1992) recorded pupal period was 6.50 ± 0.50 days when reared on *A. gossypii*, whereas according to Thite and Shivpuje (1999) it was 8.40 days when reared on *A. gossypii*. Patro and Behera (2002) recorded pupal period as 6.95 ± 0.56 days on *A. gossypii.*

The result was in conformation with Kapadia and Puri (1992) and Patro and Behera (2002). However, results of Thite and Shivpuje (1999) was somewhat differ from present findings, might be due to meteorological parameters.

Total developmental period :

The average duration of the total developmental period of *C. zastrowi arabica* from egg to adult emergence was recorded 18.70 ± 0.64 and 18.93 ± 0.55 days when reared on *A. gossypii* and *M. persicae*, respectively (Table 2). It is concluded from the present findings that the larvae of *C. zastrowi arabica* grow faster on *A. gossypii* compared to *M.*

Table 2 : Pupal period and total developmental period of *C. zastrowi arabica* on different aphid species (Pooled data)

Sr. No.	*A. gossypii*		*M. persicae*	
	Pupal period	Total developmental period	Pupal period	Total developmental period
1.	6.5	18.0	7.5	19.0
2.	6.5	17.5	8.0	20.0
3.	7.0	18.5	7.5	19.0
4.	6.5	18.0	7.0	19.0
5.	6.0	19.0	7.0	18.5
6.	6.5	19.5	7.5	19.5
7.	6.5	20.0	7.5	18.5
8.	6.0	18.5	7.0	18.5
9.	6.0	18.5	7.5	18.5
10.	7.0	19.0	7.5	18.5
11.	6.5	18.5	7.5	19.5
12.	6.5	18.5	7.0	19.5
13.	6.5	18.5	7.0	19.0
14.	6.0	18.0	7.5	18.0
15.	6.0	19.0	7.5	20.0
16.	6.5	18.5	7.5	19.0
17.	6.5	19.0	7.5	18.5
18.	6.5	19.0	7.5	19.5
19.	6.5	18.5	7.5	19.0
20.	6.5	19.0	7.5	19.5
21.	7.0	19.5	7.0	18.5
22.	6.0	17.5	7.0	18.5
23.	6.5	19.0	7.0	19.0
24.	6.5	19.0	7.0	18.5
25.	6.5	20.0	7.5	19.0
26.	6.5	18.5	7.5	19.5
27.	6.0	17.5	7.0	18.0
28.	6.0	19.0	6.5	18.0
29.	7.0	19.0	7.5	19.5
30.	7.0	19.0	7.0	19.0
Average	6.45	18.70	7.30	18.93
S.D. ±	0.33	0.64	0.32	0.55
Min.	6	17.5	6.5	18
Max	7	20	8	20

persicae.

Oviposition, longevity and fecundity :

The data on pre-oviposition, oviposition and post-oviposition period during November, 2007 to January, 2008 and November, 2008 to January, 2009 are presented in Table 3.

The data on pooled analysis revealed that pre-oviposition period was 3.90 ± 0.61 and 3.15 ± 0.24 days when *C. zastrowi arabica* reared on *A. gossypii* and *M. persicae*, respectively.

On the basis of pooled data it was concluded that, the oviposition period was 37.75 ± 5.46 and 26.55 ± 3.29 days when *C. zastrowi arabica* reared on *A. gossypii* and *M. persicae*, respectively.

The post-oviposition period was recorded 3.55 ± 0.83 and 2.80 ± 1.00 days (pooled data) when reared on *A. gossypii* and *M. persicae*, respectively.

It is concluded from the above data that the longest oviposition period of *C. zastrowi arabica* was recorded on *A. gossypii*, whereas shortest on *M. persicae* compared to other aphid species.

The longevity of male and female of *C. zastrowi arabica* are presented in Table 4.

The pooled data concluded that the longevity of male was 51.95 ± 5.60 and 41.90 ± 5.97 days on *A. gossypii* and *M. persicae*, respectively.

On the basis of pooled data it was concluded that the longevity of female recorded 46.1 ± 5.58 and 33.00 ± 3.89 days

Table 3 : Pre-oviposition, oviposition and post-oviposition period of *C. zastrowi arabica* on different aphid species (pooled data)

Sr. No.	*A. gossypii*			*M. persicae*		
	Pre-oviposition	Oviposition	Post-oviposition	Pre-oviposition	Oviposition	Post-oviposition
1.	3.5	32.0	2.5	3.0	34.5	2.5
2.	3.5	38.5	5.0	3.0	27.5	2.5
3.	5.0	29.0	3.0	3.0	25.0	4.5
4.	4.5	41.0	3.5	3.5	26.5	2.0
5.	4.0	46.0	4.0	3.0	21.5	1.0
6.	3.5	36.5	4.0	3.0	26.5	2.5
7.	4.0	41.0	2.5	3.5	27.0	3.0
8.	4.5	34.0	3.5	3.0	25.0	4.0
9.	3.5	35.0	4.5	3.5	27.0	2.5
10.	3	44.5	3.0	3.0	25.0	3.5
Average	3.90	37.75	3.55	3.15	26.55	2.8
S.D. ±	0.61	5.46	0.83	0.24	3.29	1.00
Min.	3	29	2.5	3	21.5	1
Max	5	46	5	3.5	34.5	4.5

Table 4 : Longevity of male and female and fecundity of *C. zastrowi arabica* on different aphid species

Sr. No.	*A. gossypii*			*M. persicae*		
	Male	Female	Fecundity	Male	Female	Fecundity
1.	50.5	38.0	500.5	51.5	40.0	767.0
2.	55.5	46.5	794.5	39.5	38.0	560.5
3.	43.0	41.0	565.0	45.5	32.5	599.5
4.	64.0	55.5	878.5	41.5	32.0	706.0
5.	54.5	53.0	907.5	33.0	25.5	520.5
6.	46.5	44.0	724.5	35.0	32.0	473.5
7.	51.0	47.5	872.0	46.5	33.5	544.5
8.	53.0	42.0	877.5	41.5	32.0	601.0
9.	50.0	43.0	637.5	37.0	33.0	573.0
10.	51.5	50.5	785.0	48.0	31.5	672.0
Average	51.95	46.1	754.25	41.9	33.0	601.75
S.D. ±	5.60	5.58	143.47	5.97	3.89	89.43
Min.	43	38	500.5	33	25.5	473.5
Max	64	55.5	907.5	51.5	40	767

when reared on *A. gossypii* and *M. persicae*, respectively.

Data on fecundity, the pooled data indicated that it was recorded 754.25 ± 143.47 and 601.75 ± 89.43 eggs when reared on *A. gossypii* and *M. persicae*, respectively(Table 4).

From the overall discussion on the various parameters *viz*., developmental period, longevity, oviposition and fecundity it is obvious that *A. gossypii* was the most suitable hosts for supporting the growth and development of *C. zastrowi Arabica* than *M. persicae.*

Predatory potential of *C. zastrowi arabica* on different aphid species :

The predatory potential of *C. zastrowi arabica* was studied on different aphid species during 2008-2009. The larva of *C. zastrowi arabica* was voracious feeder and especially active during predation. While feeding, larva holds the host in between two mandibles and sucked the inner content leaving behind the hard chitinized exoskeleton Jagadish and Jayaramaiah (2004) reported similar type of feeding behaviour of *C. carnea.*

On the basis of pooled data it was found that average number of aphid consumed was 62.90 ± 11.36 and 77.45 ± 9.93 by first instar larvae, 158.60 ± 26.26 and 150.25 ± 13.61 by second instar larvae and 411.10 ± 36.66 and 359.80 ± 49.72 by third instar larvae of *C. zastrowi arabica* on *A. gossypii* and *M. persicae*, respectively (Table 5).

The pooled data revealed that single larvae consumed an average of 627.60 ± 42.39 and 587.50 ± 55.59 number of *A. gossypii* and *M. persicae*, respectively (Table 5).

It is concluded from the present investigation that the *C. zastrowi arabica* feed more number of nymphs and adults of *A. gossypii* compared to *M. persicae.*

Thus, in nutshell study on biology of *C. zastrowi arabica* was carried out under laboratory condition on different four aphid species *viz*., *A. gossypii* and *M. persicae* and individual culture of aphid reared to compare biology and predatory potential. The study was repeated twice.

The average incubation period of *C. zastrowi arabica* was 3.60 ± 0.33 and 3.48 ± 0.38 days when reared on *A. gossypii* and *M. persicae*, respectively. On an average, duration of first instar larva was 2.60 ± 0.33 and 2.85 ± 0.27 days; second instar larva was 2.55 ± 0.36 and 2.15 ± 0.23 days and third instar larva was 3.52 ± 0.36 and 3.13 ± 0.35 days, when *C. zastrowi arabica* was reared on *A. gossypii* and *M. persicaea*, respectively. The total larval duration of *C. zastrowi arabica* was 8.68 ± 0.50 and 8.13 ± 0.45 days, when reared on *A. gossypii* and *M. persicae*, respectively.

The duration of prepupa was ranged between 6 to 8 hours. There was no sharp change in the duration of prepupa irrespective to host on which *C. zastrowi arabica* was reared so it was considered as one days. The average pupal period was 6.45 ± 0.33 and 7.30 ± 0.32 days when reared on *A. gossypii* and *M. persicae*, respectively.

The average total developmental period was 18.70 ± 0.64 and 18.93 ± 0.55 days when reared on *A. gossypii* and *M. persicae*, respectively. It is concluded from the present findings that the larvae of *C. zastrowi arabica* grow faster on *A. gossypii* compared to other species of aphid.

On an average pre-oviposition period was 3.90 ± 0.61 and 3.15 ± 0.24 days; oviposition period was 37.75 ± 5.46 and 26.55 ± 3.29 days and post-oviposition period was 3.55 ± 0.83 and 2.80 ± 1.00 days when *C. zastrowi arabica* was reared on *A. gossypii* and *M. persicae*, respectively. The longest oviposition period of *C. zastrowi arabica* was recorded on *A. gossypii* whereas it was shortest on *M. persicae*.

The mean longevity of male was 51.95 ± 5.60 and 41.90 ±

Table 5 : Feeding potential of first, second and third instar larva and total consumption of *C. zastrowi arabica* on different aphid species

Sr. No.	*A. gossypii*				*M. persicae*			
	First instar	Second instar	Third instar	Total consumption	First instar	Second instar	Third instar	Total consumption
1.	64.5	132.0	429.5	626.0	64.0	160.5	267.5	492.0
2.	42.5	211.0	470.5	724.0	86.5	142.5	367.5	596.5
3.	49.5	153.0	396.0	598.5	57.0	155.5	302.5	515.0
4.	59.0	165.0	440.5	664.5	85.5	162.5	350.5	598.5
5.	65.5	136.0	396.5	598.0	77.5	141.0	396	614.5
6.	73.5	156.5	377.0	607.0	84.5	175.0	426	685.5
7.	77.5	166.5	401.0	645.0	83.0	149.5	321	553.5
8.	77.0	178.0	390.5	595.5	84.5	144.5	374.5	603.5
9.	60.5	118.5	455.5	634.5	78.0	126.5	385.5	590.0
10.	59.5	169.5	354.0	583.0	74.0	145.0	407	626.0
Average	62.9	158.6	411.1	627.6	77.45	150.25	359.8	587.5
S.D. ±	11.36	26.26	36.66	42.39	9.93	13.61	49.72	55.59
Min.	42.5	118.5	354.0	583	57	126.5	267.5	492
Max	77.5	211	470.5	724	86.5	175	426	685.5

5.97, days and that of female it was 46.1 ± 5.58 and 33.00 ± 3.89 days, when *C. zastrowi arabica* was reared on *A. gossypii* and *M. persicae*, respectively. The fecundity of *C. zastrowi arabica* was 754.25 ± 143.47 and 601.75 ± 89.43 eggs when reared on *A. gossypii* and *M. persicae*, respectively. Amongst two aphid species, *A.gossypii* good hosts for supporting the growth and development of *C. zastrowi arabica*.

The larva of *C. zastrowi arabica* was voracious feeder and very active during predation. While feeding, larva holds the host in between two mandibles and sucked the inner content leaving behind the hard chitinized exoskeleton. The average number of aphids consumed was 62.9 ± 11.36 and 77.45 ± 9.93 by first instar larva, 158.60 ± 26.26 and 150.25 ± 13.61 by second instar larva and 411.10 ± 36.36 and 359.80 ± 49.72 by third instar larva of *C. zastrowi arabica* on *A. gossypii* and *M. persicae*, respectively. Single larva consumed an average of 627.60 ± 42.39 and 587.50 ± 55.59 number of *A. gossypii* and *M. persicae*, respectively. The consumption rate of third instar larva was higher compared to first and second instar larva of *C. zastrowi arabica*, thus, the final instar larva expected to exert a strong pressure on the aphid population even under field conditions. The *C. zastrowi arabica* consumed more number of nymphs and adults of *A. gossypii* compared to *M. persicae*.

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REFERENCES

Balakrishnan, N., Murali, Baskaran, R.K. and Mahadevan, N.R. (2004). Field efficacy of *Chrysoperla carnea* (Stephens) in combination with biopesticides against *Helicoverpa armigera* (Hubner) on cotton under rainfed condition. *J. Biol. Control*, **18**(2): 147-153.

Canard, M., Semeria Y. and New T.R.R. (1984). Biology of Chrysopidae: Dr. W. Junk, Publisher: The Haque, The Netherlands. 294.

Carvalho C.F., Souza B. and Ulhôa J.L.R. (2002). Selectividade de insecticide as a *Chrysoperla externa* (Hagen) (Neuroptera: Chrysopidae), *Neotrop Entomol.*, **31** (4) : 615-621.

Coppel, H.C. and Mertins, J.W. (1977). Biological insect pest suppression. Springer-Verlag, Berlin, Germany.

Gautam, R.D. and Paul, N.A.V. (1987). An artificial diet for the larvae of green lacewing, *Chrysopa scelestes* Banks (Neuroptera : Chrysopidae), *J. Ent Res.*, **11**(1) : 69-72.

Hagen, K.S. (1950). Fecundity of *Chrysopa californica* as affected by synthetic foods. *J. Econ Entomol.*, **43** : 101-104.

Hassan, S.A. (1974). Mass-culturing and utilization of *Chrysopa* spp. (Neuroptera: Chrysopidae) in the control of insect pests. *Zeitschrift fur Pflanzenkrankheiten und Pflanzenschutz.*, **81** : 620-637.

Henry, C.S., Brooks, S.J., Duelli, P. and Johnson, J.B. (2006). Courtship song of the south African lace wing, *Chrysoperla zastrowi* (Esben-petersen) (Neuroptera : Chrysopidae) evidence for a trans-equatorial geographic range. *J. Natural History*, **40** : 2173-2195.

Henry, C.S., Brooks, S.J., Johnson, J.B., Venkatesan, T. and Duelli, P. (2010). The most important lacewing species in Indian agricultural crops, *Chrysoperla sillemi* (Esben-Petersen), is a subspecies of *Chrysoperla zastrowi* (Esben-Petersen) (Neuroptera: Chrysopidae). *J. Nat. Hist.*, **44** : 2543-2555.

Ingole, D.A., Deotale, V.Y., Deotale, R.O. and Ramkumar, J. (2005). Preliminary study on the performance of *Mallada boninensis* (Okamoto) against *Aleurocanthus woglumi* Ashby on citrus. *J. Biol. Control.*, **19**(1) : 77-80.

Jagadish, K.S. and Jayaramaiah, M. (2004). Biology and Predatory of *Chrysoperla carnea* (Neuroptera) on the Tobacco Aphid, *Myzus nicotianae* (Homoptera). *J. Ecobiol*., **16**(3) : 161-167.

Kapadia, M.N. and Puri, S.N. (1992). Development of *Chrysoperla carnea* reared on aphids and whitefly. *J. Maharashtra Agric. Univ*., **17**(1) : 163-164.

Mc Ewen, P.K., New, T.R. and Whittington, A.E. (2001). *Lacewings in the crop improvement*. Cambridge University Press, New York.

Medina, P., Budia, F., Del Estal, P. and Viñuela, E. (2003). Effect of three modern insecticides, pyriproxyfen, spinosad and tebufenozide, on survival and reproduction of *Chrysoperla carnea* adults. *Ann. Appl. Biol.*, **142** (1) : 55-61.

New, T.R.R. (1975). The biology of Chrysopidae and Hemerobiidae (Neuroptera) with reference to their usage as biocontrol agents. *R. Entomol. Soc. Lond. Proc. A.*, **127** (2) : 115-140.

Patel, K.G. and Vyas, H.N. (1985). Biology of green lacewing *Chrysoperla scelestes* Banks (Neuroptera: Chrysopidae) an important predator in Gujarat. *GAU Res. J*., **11**(1) : 18-23.

Pathan, A.K., Sayyed, A.H., Aslam, M., Razaq, M., Jilani, G. and Saleem, M.A. (2008). Evidence of field-evolved resistance to organophosphates and pyrethroids in *Chrysoperla carnea* (Neuroptera: Chrysopidae). *J. Econ. Entomol.*, **101** (5) : 1676-1684.

Patro, B. and Behera, M.K. (2002). Biology and feeding potential of *Chrysoperla carnea* (Stephens) (Neuroptera : Chrysopidae) on the bean aphid, *Aphis craccivora* Koch. *J. Biol. Control*, **16**(1) : 77-79.

Symondron, W.U.C., Sunderland, K.D. and Greenstone, M.H. (2002). Can generalist predator be effective biocontrol agents? *Annu. Rev. Entomol.*, **47** : 561-594.

Sayyed, A.H., Pathan, A.K. and Faheem, U. (2010). Cross-resistance, genetics and stability of resistance to deltamethrin in a population of *Chrysoperla carnea* from Multan: Pakistan. *Pestic. Biochem. Physiol.*, **98** (3) : 325-332.

Tauber, M.J., Tauber, C.A., Daane, K.M. and Hagen, K.S. (2000). Commercialization of predators: recent lessons from green lacewings (Neuroptera: Chrysopidae). *Ann. Entomol. Soc. Am.*, **46** (1) : 26-38.

Tesfaye, A. and Gautam, R.D. (2002). Biology and feeding potential of green lacewing, *Chrysoperla carnea* on non-rice moth prey. *Indian J. Ent.*, **64**(4) : 457-464.

Thite, N.R. and Shivpuje, P.R. (1999). Biology, feeding potential and development of *Chrysoperla carnea* (Stephens) on *Aphis gossypii* (Glover). *J. Maharashtra agric. Univ.*, **24**(3) : 240-241.

Venkatesan, T., Jalali, S.K., Murthy, K.S., Rabindra, R.J. and Lalitha, Y. (2009). Occurrence of insecticide resistance in field populations of *Chrysoperla zastrowi arabica* (Neuroptera: Chrysopidae) in India. *Indian J. Agric. Sci.*, **79** : 910-912.