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Some parameters of *Chrysoperla Carnea* on floral feeds of castor and feeding potential on selective aphid species

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Abstract
The present study entitled some parameters of *Chrysoperla carnea* on floral Feeds of Castor and Selective aphid Species under laboratory conditions during 2014-2015. The present findings recorded that the maximum of 36.6 days was observed as oviposition period when females were fed with a combination of artificial feed (proteinex and glucose solution), while minimum oviposition period of 24.2 days was observed when females were provided with artificial feed alone. In that order, the maximum of 749.8 eggs per females was recorded when *C. carnea* were fed on combination of artificial feed + 20g floral, and lowest adult longevity was observed in control. The mean number of aphids consumed throughout the larval period recorded as 309.2±8.11 of *Aphis gossypii*; 197.6±5.99 of *Rhopalosiphum maidis* and 130±4.49 of *Lipaphis erysimi,* and it was also clear from the present study that proteinex along with glucose solution can be used to supplement honey that could result in long survival of male and female *C. carnea* adults.

Keywords: castor, aphid, parameters, *C. carnea*

Introduction
The *Chrysoperla carnea* (Stephens) commonly found in South Western Asia, Indonesia, Philippines, South Africa, Pakistan and India, this predator is an efficient feeder and prey on a wide range of soft bodied insects including aphids, plant hoppers, thrips, jassids, scale insects, mealy bugs and white fly infesting large number of cultivated crops [1, 2].Both adult and larval stages are voracious feeder of aphid species, many aphid species are serious pests of different cereal crops in Pakistan [3]. The bird cherry- oat aphid, *Rhopalosiphumpadi* (L.) has recently become one of the most important pests of wheat and been considered a serious threat to cereals. Temperature is one of the most important environmental factors that influence the developmental rate of *C. carnea* and affect its reproductive and predatory performance [4]. The predacious are of great economic importance and have been successfully employed in the biological control of many injurious insects [5]. The soft bodied insects including aphids are fed by *C. carnea* due to variations in colours this species is also well known by polymorphs [6]. It is widely distributed and common aphid feeding species in India, Pakistan, Borneo, Jawa Indonesia, U.K. Philippines, Islands of Bali, France, Sumatra and South Africa [7].
Cotton aphid is one of the most injurious insect pests which suck the cell sap and hence is one of the crop yield limiting factors they affect the general vigor of plant by secreting honey dew which encourages sooty mould development that disturbs the normal physiology of the leaves [8]. To protect the plants and environment, biological control of aphids is a good replacement of highly toxic insecticides which is a common practice for its control. It is not surprising that pests often develop resistance to these chemicals [9] sometimes Coccinellids larvae are not killed by systemic insecticides that are injurious to predators they are tolerant to many insecticides which is an advantage over other predators. It is the most important beneficial insect of cotton pests, with its immature and mature stages as voracious feeder of all the aphids [10].
Many scientists had different opinions on documentation of revised nomenclature of *carnea* group of *Chrysoperla* [11]. *Chrysoperla* species (*carnea*-group) widely used in India in augmentative biological control programmes was found to be *Chrysoperla zastrowi arabica* [12] by analyzing acoustic profile of the mating song of this species and found to match that of *C.*

zastrowi arabica, the song species characterized earlier as '*Cc5 generator*'. The correct taxonomic name for this species remains to be determined as it is morphologically identical to *C. sillemi* (Esben- Petersen), a species already known from India. [12]. However, in the present research, the name of green lacewing was mentioned as *C. carnea*.

Materials and Methods

Collection of castor floral feeds

The male flowers of castor were collected daily from castor fields of Agriculture Section Entomology Institute of Tandojam.

Experimental Design

Biology of adult *C. carnea* was studied on floral feed of castor (*Ricinus communis*) which was maintained individually in glass vials. The cocoons of *C. carnea* were separated and kept in a glass jar (21 cm high, 18 cm diameter) at 25±10 °C and 60 ± 5% R.H. Newly emerged adults were fed with artificial feed (proteinex and glucose solution). Male and female adults were separated based on morphological differences. Each treatment comprised one pair of newly emerged adults (0- 24 hrs) released in glass tubes (3.5 cm diameter and 6 cm high) and covered with brown paper using rubber bands. In all the treatments, proteinex solution was provided with different quantities of 5g, 10g, 15g, 20g, floral feeds. Control treatment with only proteinex solution was maintained for comparison. Feed was changed daily till death of adults. Observations on preoviposition/oviposition, per cent hatchability, total fecundity, male and female longevity were recorded to evaluate the effectiveness of floral food supplement with five replications.

Mass culturing of maize, cotton and mustard aphids

Different aphid species like *Rhophalosiphum maidis, Aphis gossypii* and *Lipaphis erysimi* were collected from maize, cotton and mustard plants respectively. The leaves of different host plants infested with respective aphid species were collected from plants after counting the number of aphids on leaves. Single predatory larva was confined to a glass vial (5 × 2.5cm) which was provided with 100 aphids on daily basis till the completion of larval period. Observations were made on number of prey consumed per day which was recorded by counting the number of remaining unfed aphids. Total number of prey consumed by individual instar throughout the life period was recorded. The number of prey eaten (empty chorions or collapsed larvae) on the previous day was recorded.

Results and Discussion

Biological parameters of *chrysoperla carnea*

Results presented in the Table 1 showed that the highest of (36.6 days), was recorded as oviposition period when females were fed with a combination of artificial diets (proteinex and glucose solution), either with 20g or 15g castor floral feed as food (36.4 days), which remained on par with each other followed by the combination of artificial feed+10g floral feed with (33.6 days), which was significantly different from other treatments. Combination of artificial feed + 5g floral feed examined significantly shorter oviposition period (30.8 days) respectively. Hence, the minimum oviposition period of (24.2 days), was observed when females were provided with artificial feed alone. In that order, (Kumar and Gautam, 2007) [13] reported that when castor (*Ricinus communis*), floral feed was used, it has significantly resulted in longest oviposition period (43.60 days), as recorded in the present study ranging from (30.8 to 36.6), indicating that oviposition period was greatly influenced by different floral feeds. However, present studies clearly indicated that though oviposition period is influenced by castor pollen itself but, its quantity also plays major role. A general increase in fecundity was noted when females were fed with increased quantity of castor floral feed. On the other hand, maximum of (749.8 eggs), per female was recorded when *C. carnea* were fed on combination of artificial feed + 20g floral which was + 15g floral feed (738.4 eggs/female) respectively. Present results are in conformation with the report of (Deotale *et al.*, 1998) [14] who found that egg production by *C. carnea* females was highest with castor pollen which was about two times greater than the standard diet. Minimum fecundity of 539.4 eggs per female was observed when females were fed with artificial feed (control) alone. The present finding is supported by the work of (Tasfaye and Gautam, 2002) [15] showing that reduction in fecundity was observed when *C. carnea* adults were fed with 50 per cent honey solution alone. Similarly, (Viji and Gautam 2005) [16] reported that reduction in fecundity of adults fed on honey without supplementing with other feeds indicating that honey alone was not a complete food for *C. scelestes.* Similar opinion was expressed by (Venzon *et al.*, 2006; Murthy *et al*., 2005) [17, 18] reported that protein containing diets like soya based diets was found to be better for high level of egg production.

Furthermore! Results discussed the highest egg% hatchability (87.0 percent), was obtained when artificial + 20 g floral feed of castor was offered which was on with the combination of feed + 15g floral become (84.4%). According to (Li *et al.*, 2010) [19] whom examined that lacewings provided with sucrose solution alone survived but did not produce fertile eggs. On the other hand, highest longevity of 28.0 days for males and 41.8 days for females was investigated when *C. carnea* larvae were offered with the combination of artificial feed + 20g floral feed and lowest adult longevity was observed in control. Artificial Feed + 15g floral feed exhibited male longevity of 26.2 days which was on par with artificial feed + 5g floral feed. Supply of combination of artificial feed + 5g floral feed resulted in female longevity of 35.2 days which was on par with artificial feed + 10g floral feed (36.4 days). Combination of artificial feed + 20g floral feed exhibited 41.8 days of female longevity which remained on par with artificial feed + 15g floral feed with 40.6 days respectively. Present results differ from observation of (Nandan *et al.*, 2014) [20] who have reported that addition of castor pollen with natural food (honey) has no significant impact on longevity of males and females of *C. zastrowi sillemi*.

However, more longevity of both male and female in the present study or variation in adult longevity due to supplementation with different quantity of castor pollen as floral feed might be due to the reason that only little quantity of 5g to 10g floral feed might be sufficient to increase adult longevity than 15g to 20g with artificial feed that will influence the composition of feed. It was clear from the present study that proteinex along with glucose solution can be used to supplement honey that could result in long survival of male and female *C. carnea* adults. Further results shown that use of either pollen grains or honey alone as diet for adults of *C. zastrowi sillemi* may not be adequate to fulfill their nutritional requirement as it has resulted in poor longevity of adults and fecundity of females suggesting that castor pollen + honey (50%) and cotton pollen + honey (50%)

were proved to be the most appropriate combination of pollen as feed. Same investigation made by (Kumar and Gautam 2007; Nandan *et al.*, 2014) [13, 20] have reported that free amino acid content and total soluble sugar content was high in pollen of castor flower. Thus, the pollen grains of castor had higher nutritional quality for *C. carnea* and could be exploited in the mass multiplication of *C. carnea.*

Table 1: Influence of different quantity of castor flower pollen on biological parameters of *Chrysoperla carnea*

Treatments	Oviposition Period (Days)	Fecundity (No. of eggs per female)	Hatchability (%)	Male Longevity (Days)	Female Longevity (Days)
Artificial Feed + 5g floral feed	30.8^{b}	659.8^{b}	82.2^{bc}	26.8^{bc}	35.2^{b}
Artificial Feed + 10g floral feed	33.6^{c}	692.2^{c}	80.4^{ab}	27.8^{cd}	36.4^{b}
Artificial Feed + 15g floral feed	36.4^{d}	738.4^{d}	84.4^{cd}	26.2^{b}	40.6^{c}
Artificial Feed + 20g floral Feed	36.6^{d}	749.8^{d}	87.0^{d}	28.0^{d}	41.8^{c}
Artificial feed (Proteinex + Glucose)	24.2^{a}	539.4^{a}	78.6^{a}	25.0^{a}	32.8^{a}
C.D (0.05)	2.08	13.33	2.66	1.13	1.42
S.E. m ±	0.70	4.49	0.90	0.38	0.48

Means followed by same alphabet do not differ significantly by DMRT (P = 0.05%)

Chrysoperla carnea on three Species of aphid

Results presented in Table 2 which shows that mean number of aphids consumed throughout the larval period recorded as 309.2±8.11 of *A. gossypii*; 197.6±5.99 *R. maidis* and 130±4.49 on *L. erysimi*. Present results are supported by (Vivek *et al*., 2013) [21] showing the same order of feeding potential among the four aphid species. Single larva of *C. carnea* could feed about 600-950 nymphs and adults of *M. persicae*, 487.2 of *A. gossypii* and 510.8 of whitefly pupae. However, the *L. erysimi* was found least preferred. Our observation also confirmed by (Sewak *et al.* 2011; Liu and Chen, 2001) [22, 23] whom investigated that the predatory larvae consumed more *A. gossypii* than *L. erysimi* which is another agreement with the finding of (Chakraborty and Korat, 2010) [24] suggesting that *C. carnea* could be utilized more efficiently in cotton ecosystem than others as it feeds not only on aphids and other sucking pests in addition to bollworm eggs and neonate larvae. Mean consumption rate of first and second instar larva of *C. carnea* on different aphid species was 23.0 ± 1.00 (*A. gossypii*), 14.4 ± 0.87 (*R. maidis*), 8.2 ± 0.66 (*L. erysimi*) and 122.0 ± 2.21 (*A. gossypii*), 62.4 ± 3.4 (*R. maidis*), 41.6 ± 2.06 (*L. erysimi*) respectively. Similarly, the third instar larva showed mean consumption rate of 205.6 ± 2.87 (*A. gossypii*), 120.8 ± 1.72 (*R. maidis*) and 80.2 ± 1.77 (*L. erysimi*) indicating its high feeding potential during third instar stage. It was clear from the result that as the larva has grown up its consumption rate was increased irrespective of the aphid species. Present findings supported by (Balasubramani and Swamiappan 1994) [25] reported that single *C. carnea* larva could consume 419.8 nymphs of *A. gossypii* out of which 60-80 per cent was consumed by the third instar. Similar investigation was made by (Chakraborty and Korat, 2010) [24] who reported that the predatory efficiency of *C. carnea* increased with the development of larva.

Results examined in Table 3 showed that per day consumption rate of *C. carnea* on different aphid species revealed that feeding was increased significantly from seventh day onwards that third instar was the main predatory stage. The results are in accordance with (Vivek *et al.*, 2013) [21] showing the contribution of third instar larva of *C. carnea* recording predation up to 68.8-80.2 per cent of total prey consumption and also indicated the prey consumption as 3.7-8.4 per cent by first instar and 15.9- 26.1% by the second instar of the predator. Accordance to a researcher (Zaki, 1987) [26] the food consumption rate for *C. carnea* could be increased with decrease in RH and increase in temperature. The more rate of food consumption at higher prey density also observed by (Satpathy *et al.*, 2001) [27]. Among the three aphid species, *C. carnea* larvae feeding on *R. maidis* have undergone pupation on tenth day whereas those feeding on *A. gossypii* and *L. erysimi* undergone pupation on ninth day indicating its forced pupation early when less preferred aphid species were provided as food. This indicates that on unperformed prey, when a predator like *C. carnea* will be reared, its development will be under stress that may lead to malfunctioning of metabolism ultimately lead to malformation of adults.

Table 2: Feeding potential of *Chrysoperla carnea* larva on different species of aphids

Mean Consumption Rate (Number / Instar)				
	First instar	Second instar	Third instar	Total
Aphis gossypii	23.0 ± 1.00	80.6 ± 4.24	205.6 ± 2.87	309.2 ± 8.11
Rhopalosiphum Maidis	14.4 ± 0.87	62.4 ± 3.40	120.8 ± 1.72	197.6 ± 5.99
Lipaphis erysimi	8.2 ± 0.66	41.6 ± 2.06	80.2 ± 1.77	130.0 ± 4.49
C.D (0.05)	2.47	9.40	7.62	_
S.E. m ±	0.82	3.11	2.52	_

Table 3: per day consumption of *Chrysoperla carnea* larva on different species of aphids

Treatments	1	2	3	4	5	6	7	8	9
T1 *Aphis gossypii*	7.2 ± 0.58	15.8 ± 1.16	20 ± 1.7	28.4 ± 1.44	32.2 ± 2.2	45.6 ± 3.59	78.2 ± 1.6	81.8 ± 2.27	—
T2 *Rhopalosiphum Maidis*	2.8 ± 0.2	3.8 ± 0.37	7.8 ± 0.66	14.8 ± 1.2	17.8 ± 1.2	29.8 ± 1.59	31.6 ± 1.1	39 ± 1.3	50.2 ± 1.66
T3 *Lipaphis Erysimi*	2.2 ± 0.2	6 ± 0.55	5.6 ± 0.75	13.6 ± 1.12	22.4 ± 0.51	22 ± 0.71	24.8 ± 0.8	33.4 ± 0.68	—
C.D (0.05)	1.497	2.400	3.084	3.552	4.012	6.190	4.179	4.675	3.200
S.E. m ±	0.50	0.79	1.02	1.18	1.33	2.05	1.38	2.54	1.06

Conclusions

From the present study it was concluded that biology of *C. carnea* were greatly influenced by quantity of floral feed supplemented with artificial feed. In all the biological parameters of *C. carnea* thereby resulting that use of either floral feed or artificial feed alone can‘t fulfill the nutritional requirement that resulted in poor fecundity and hatchability.

Suggestions

The results clearly suggesting that *C. carnea* could be a better biological control agent against different aphid species among them it could effectively control *A. gossypii* than *L. erysimi* where tritrophic interaction played much role.

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