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EFFICACY OF SOME NATURAL HOSTS ON THE DEVELOPMENT OF *CHRYSOPERLA CARNEA* (STEPHENS) (NEUROPTERA: CHRYSOPIDAE) - A LABORATORY INVESTIGATION

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Biology and feeding potential of the predator**,** *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) were studied on different hosts with particular reference to cotton crop. Various hosts viz., aphids (nymphs/ adults) and the eggs of cotton bollworms were used for the rearing of *C. carnea* and compared with the factitious host, Angoumois grain moth (*Sitotroga cerealella*) eggs on which the culture of the predator is maintained for the last many generations at the laboratory. The studies indicated that larval and pupal durations of the predator were significantly affected by the change of the hosts and the total developmental period was significantly shorter when the predator was offered with aphids for feeding. The fecundity, fertility, pupation, hatchability and longevity of the predator were also higher on aphids followed by pink bollworm, spotted bollworm, Angoumois grain moth and American bollworm eggs. However, the sex ratio was not affected due to change in the type of hosts. An identical trend in all the observed parameters was recorded in parental and first filial generations on all the tested hosts. Based on the studies, aphids appeared to be the most promising host for mass rearing of the predator. Further, successful predation on the cotton bollworm eggs manifested the potential of *C. carnea* for the management of cotton bollworms in the field.

Keywords: *Chrysoperla carnea,* Feeding potential, Cotton bollworms, Biology, Host.

1. Introduction

Cotton production is adversely affected by many insect pests, which are traditionally being managed by the application of large quantities of insecticides. Although chemical insecticides provide an excellent control in many instances, however, resistance in insect pests of cotton have been reported against many pesticides, which require the use of an increased amount of insecticides [1]. The excessive use of chemical insecticides has produced several undesirable effects including development of resistance to insecticides, toxic residues in lint and seed, environmental pollution, destruction of beneficial organisms and health risks [2]. Therefore, the use of insecticides is un-sustainable [3] and it is imperative to tap alternate methods of insect pests' control. The concept of Integrated Pest Management (IPM) is also becoming popular [4] because it encourages the use of several components in the pest control system in a harmonious combination, which has minimal impact on the environment. Biological control is a basic component of any IPM system and has been used successfully to combat many insect pests.

Biological control through parasites and predators can be exploited alone or as an adjunct to other management tactics. The use of *Chrysoperla carnea* (Stephens) in conjunction with *Trichogramma* wasp as bio-control agents is a recognized alternative of insecticides [5, 6] and has been applied successfully for the management of many insect pests [7]. The *C. carnea*, an effective predator of jassids, whiteflies, thrips, aphids and mites, also feeds on the eggs and tiny larvae of the cotton bollworms [8]. Kaitazov and Kharizanov [9] reported that *C. carnea* larvae can attack about 80 species of insects and 12 species of tetranychid mites. The adults are not predatory and can be easily cultured on relatively simple diets [10]. Mass rearing of parasites/ predators is a pre-requisite for any successful biological control programme, but it is impossible without using a standard host. The *C. carnea* was mass cultured on the eggs of rice grain moth (*Corcyra cephalonica*), but it has a good feeding potential on different insect pests of cotton.

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Because the constant exposure to the wings scales of these moths leads to health hazard of the workers [11], therefore, the aim of present studies was to evaluate different hosts for economical and quality production of the *C. carnea* for releases in the field to manage the insect pests.

2. Materials and Methods

The predator, *Chrysoperla carnea* was initially collected from the cotton field and reared at Bio-control Laboratory, Nuclear Institute of Agriculture, Tandojam. The culture of *C. carnea* was maintained at 27± 2°C, 60-75% relative humidity and a photoperiod of 16: 8 (L: D) h, and all the experiments were conducted at the same laboratory conditions. Newly hatched larvae (< 24 h) of *C. carnea* were used in the experiments. Predatory potential of the predator was tested by providing different hosts, like cotton bollworms eggs, aphids (nymphs/ adults) and fresh eggs of Angoumois grain moth, *Sitotroga cerealella* in the laboratory. The pink and American bollworms eggs were obtained by collecting their larvae from cotton (*Gossypium hirsutum* L.) field and rearing on casein wheat germ diet. After pupation, the adults emerging from pupae were paired in oviposition cages and 10% sucrose solution was provided as food. Paper toweling was placed in rearing cages as an oviposition substrate and host eggs were provided daily to feed predator *C. carnea*. For obtaining spotted bollworm's eggs, its larvae were collected from cotton crop and reared on okra fruit in the laboratory. The adults emerging from pupae were paired, and offered with 10% sucrose solution as food and paper toweling provided for egg laying. The aphids (*Aphis gossypii*) (nymphs/ adults) used in the experiments were also collected from the cotton field, and their culture maintained on cotton seedlings in the laboratory. For experimental purpose, the aphids of uniform age and size were collected from culture and offered to the predator. Besides these hosts, rearing of the predator was also done on *S. cerealella* eggs obtained from their adults cultured on wheat grain.

The prey consumption rate of the predator *C. carnea* was studied by providing known numbers of different hosts in 50 ml vials covered with muslin cloth. A filter paper was placed in the bottom of container and a few drops of water were added on its surface to keep moist. One recently hatched larva of *Chrysoperla* was placed in each container for development until adult emergence. Fresh prey was placed in the rearing container daily and old host was removed. The numbers of each host consumed by individual larva of *C. carnea* were recorded daily. Each lacewing larva was examined every day for development and survival. The developmental periods (larval instars, cocoon period etc.) of the predator were recorded on each of the hosts separately. The adults *C. carnea* emerged were sexed by pairing 10 adults in rearing glass jars (4 cm × 7.5 cm) and provided with water in combination with 10% honey. The eggs laid by the females on black muslin cloth on the inner sides of the rearing jars were removed and their numbers recorded daily during the experimental period. Fecundity, fertility, pupation and adult emergence percentage of the predator reared on each host was recorded. Longevity (days) of both sexes and sex ratio were recorded separately on each of the tested host. The experiments were continued up to first filial generation and all the mentioned parameters were studied in a similar way as for the parent generation. Rearing containers were cleaned frequently and all dead or unhealthy specimens were removed with a camel hair brush. Care was taken not to injure predator when transferring them to fresh food or while cleaning the container. All the experiments were set at completely randomized design and replicated thrice. The data collected on all biological parameters along with sex ratio of the parents and the first filial generation was analyzed statistically using DMR test.

3. Results and Discussion

The feeding potential of *C. carnea* varied on different host eggs such as cotton bollworms; *P. gossypiella, H. armigera, E. vittella* and grain moth *S. cerealella,* and nymphs or adults of aphids in present investigation. Maximum numbers of *S. cerealella* eggs were consumed by the predator as compared to the other hosts tested in the P_1 as well as in the F_1 generations followed by the aphids (Table 1). Comparatively, less consumption of cotton bollworms eggs by the predator may be attributed to the size of the eggs as the eggs of cotton bollworms are larger than the Angoumois grain moth eggs. Significantly shorter larval and pupal periods of the predator were recorded when reared on aphids. The fecundity, fertility and hatchability of the predator were also higher when it was reared on aphids followed by pink and spotted bollworms, and the Angoumois grain moth eggs. The fecundity, fertility and hatchability of the

Table 1. Feeding potential of *C. carnea* on different hosts.

Hosts	Mean no. of hosts predated per larva of *C. carnea* (P_1)	Mean no. of hosts predated per larva of *C. carnea* (F_1)
Aphids (nymphs or adults)	600 [b]	627 [b]
Earias vitella (eggs)	122 [d]	143 [d]
Pectinophora gossypiella (eggs)	150 [c]	167 [c]
Helicoverpa armigera (eggs)	120 [d]	130 [d]
Sitotroga cerealella (eggs)	1328 [a]	1350 [a]
LSD value	26.48	16.62

Means sharing similar letters in a column are non-significant ($P \leq 0.05$).

predator were comparatively lower when it was reared on American bollworm eggs. Similar trend for the pupation percentage of the *C. carnea* was observed when it was reared on different hosts. The male and female longevity of the predator was higher when they were offered aphids as host in comparison with other tested hosts. However, sex ratios were at par on all the natural hosts tested. Results revealed that aphids are the most suitable rearing host for the predator *C. carnea* followed by the eggs of pink and spotted bollworms. An identical trend in development of the predator was observed for both P_1 and F_1 generations (Tables 2 and 3).

Earlier studies by Ferrer [12] showed that rearing of *C. carnea* on the eggs of *S. cerealella* was better than the other tested hosts [*Aphis fabae* (Scopoli) and *A. gossypii* (Glover)] as he recorded decreased cocoon weight and egg viability in the individuals reared on aphids. Similar results have been reported by Michaud [13], he showed the results after rearing *C. carnea* on *S. cerealella* eggs. In our studies, although aphids proved more useful for the rearing of *C. carnea,* but its mass culturing still remained more economical on Angoumois grain moth *S. cerealella* eggs because other live insects are not available throughout the year and their rearing in the laboratory is also a laborious job. However, aphids culturing on cotton seedlings in the laboratory is easy and also economical.

Likewise, Karuppuchammy et al. [14] studied the feeding potential of the predator, *C. carnea* on aphids and reported that it consumed 423 nymphs or 216 adults in the entire larval period, while, Kharizanov and Dimitrov [15] reported the feeding potential of *C. carnea* larva on *Myzus persicae*, which ranged 600- 950 nymphs and 487.2 mean number of adults consumed. Zohdy [16] recommended the *M. persicae* as the most suitable host for the rearing of *C. carnea.* Abdal Salam and Abdal Baky [17] studied the effects of four aphids spp., on the biological parameters and life table of *C. carnea*. They observed that all the aphids species were suitable for the rearing of *C. carnea*. Our results are not in agreement with Tesfaye and Gautum [18] who observed the feeding potential of predator *C. carnea* on different hosts as *Aphis carccivora*> *Drosophila melongaster*> *Corcyra cephalonica* and *Helicoverpa armigera*. They found that the predator did not complete its life cycle on *H. armigera* eggs successfully. But, the present findings are in agreement to the observations of Afzal and Khan [19] who reported that 160-200 eggs of *H. armigera* were consumed by single larva of this predator.

Larval period of the predator was significantly shorter on aphids and pink bollworm eggs followed by spotted bollworm and the Angoumois grain moth eggs, and it was higher on *H. armigera* eggs, an identical trend in the pupal duration was recorded on all the tested hosts. Fecundity, fertility, pupation, hatchability and longevity of the predator were higher when reared on aphids followed by the pink

Table 2. Influence of different hosts on the developmental periods of *C. carnea* (Parents).

Hosts	Larval period (days)	Pupal period (days)	Fecundity	Fertility (%)	Pupation (%)	Emergence (%)	Longevity (days) *M F**	Sex ratio (M:F)
Aphids (nymph/ adult)	8.3 ^{d}	5.6 ^{c}	630 ^{a}	72 ^{a}	68.6 ^{a}	87.3 ^{a}	25 ^{a} 27 ^{a}	1:1
E. vitella (eggs)	9.4 ^{c}	6.6 ^{bc}	417 ^{c}	63 ^{c}	59.2 ^{b}	62.9 ^{c}	15 ^{c} 21 ^{b}	1:1.2
H. armigera (eggs)	11.2 ^{a}	10.4 ^{a}	190 ^{e}	38 ^{e}	42.0 ^{c}	58.2 ^{c}	14 ^{cd} 17 ^{c}	1:1
P.gossypiella (eggs)	8.9 ^{c}	6.0 ^{c}	520 ^{b}	68 ^{b}	63.0 ^{ab}	78.5 ^{b}	21^{b} 26 ^{a}	1:1.3
S. cerealella (eggs)	10.0 ^{b}	8.3 ^{ab}	312 ^{d}	55 ^{d}	55.3 ^{b}	60.0^{c}	12 ^{d} 20 ^{bc}	1:1.6
LSD value	0.57	2.20	57.97	3.92	8.53	7.64	3.17 3.06	

*Male, **Female. Means followed by similar letters are not significantly different at P≤ 0.05.

Table 3. Influence of different hosts on the developmental periods of first filial generation of *C. carnea* (F1).

Hosts	Larval period (days)	Pupal period (days)	Fecundity	Fertility (%)	Pupation (%)	Emergence (%)	Longevity (days) M* F**	Sex ratio (M:F)
Aphids (nymphl/adult)	8.5^{d}	5.6^{c}	725^{a}	64.6^{a}	83.0^{a}	86.6^{a}	36 ^{a} 37 ^{a}	1:1
E. vittella (eggs)	9.6^{c}	6.6 ^{bc}	460^{b}	58.0^{ab}	59.6^{c}	63.0^{c}	15 ^{bc} 21 ^{b}	1:1
H. armigera (eggs)	11.4^{a}	10.4^{a}	190^{d}	38.0^{c}	42.0^{e}	58.2^{d}	14 ^{c} 20 ^{b}	1:1.3
P. gossypiella (eggs)	9.2^{c}	6.0 ^{c}	520^{b}	60.0^{ab}	71.0^{b}	68.5^{b}	17 ^{b} 20 ^{b}	1:1
S. cerealella (eggs)	10.6^{b}	8.3 ^{ab}	314^{c}	55.0^{bc}	55.5^{d}	62.3^{c}	16 ^{bc} 19 ^{b}	1:1.7
LSD value	0.42	1.67	87.93	7.24	3.96	3.89	1.68 3.31	

*Male, **Female. Means followed by similar letters in a column are not significantly different at P≤ 0.05.

and spotted bollworms eggs. The minimum longevity of the predator was recorded on *H. armigera* eggs. The results showed that rearing of *C. carnea* on different tested hosts effected its development. In the present studies, mean numbers of aphid hosts consumed per larva of *C. carnea* in (F_1) and (P_1) generations varied from 600- 627, respectively. Henn and Weinzierl [20] reported each larva of *C. carnea* to eat between 100 and 600 aphids. To understand the feeding behaviour of the different instars of *C. carnea*, Lawo and Romeis [21] examined their prey consumption. A single *C. carnea* larva was found to consume an average of 1330 *Ephestia kuehniella* eggs throughout its larval development. The current studies indicated that aphids appeared to be the most promising host for mass rearing of the predator *C. carnea*. The different developmental times observed for the different life stage of *C. carnea* could be due to the ability of predator to efficiently utilize one type of prey than the other hosts tested. Thus, the quality and type of larval diet has significant effects on the biology of chrysopid *C. carnea*. Further, successful feeding of the predator on cotton bollworms eggs and aphids indicated that the predator could be successfully employed as a biocontrol agent in the cotton crop which is an important component of an Integrated Pest Management.

4. Conclusions

The studies indicate that larval and pupal durations of the predator *C. carnea* were significantly affected due to feeding upon different hosts and the total developmental period was significantly shorter when the predator was offered with aphids as host. The fecundity, fertility pupation, hatchability and longevity of the predator were also higher on aphids followed by pink and spotted bollworms, and Angoumois grain moth eggs. However, sex ratios were not affected due to the feeding upon different hosts. An identical trend in all the observed parameters was recorded in parental and first filial generations on all the tested hosts. Based on the studies, aphids appeared to be the most promising host for mass rearing of the predator. Additionally, successful predation on the cotton bollworms eggs evidenced the potential of *C. carnea* for the management of cotton bollworms in the field which is an instrumental for biological pest control strategy.

References

[1] E.T. Natwick. Cotton insects and production, Colorado River cotton growers association, El Centro, CA. (1987) 3.

[2] L.A. Carruth and L. Moore. Arizona. J. Econ. Entomol. **66** (1973) 187.

[3] A.R. Van Steenwyk, N.C. Toscano, G.R. Bollmer, K. Ido and H.T. Reyonolds. Environ. Entomol. **4** (1975) 993.

[4] V.T. Sundaramurthy and R. Tahukar. Outlook on Agriculture **27** (1998) 247.

[5] N. Ahmad, M. Ashraf, B. Fatima and Nasrullah. Pak. J. Zool. **30** (1998) 39.

[6] S. Naranjo, Environ. Entomol. **22** (1993) 1051.

[7] R.E. Stinner. Annual. Rev. Entomol. **22** (1977) 515.

[8] N. Ahmad, B. Fatima, G.Z. Khan, Nasrullah and A. Salam. Asian J. Plant Sci. **2** (2003) 563.

[9] A. Kaitazov and A. Kharizanov. Rastitelna Zashchita. **24** (1976) 22.

[10] D.A. Nordlund and R.K. Morrison. Mass rearing of *Chrysoperla* spp*. In:* Anderson,T. E., N.C. Leppla (eds). Advances in insect rearing for research and pest management. Boulder, Colorado Westview press. (1992) 427.

[11] V. Balasubramani and M. Swamiappan. Anzeiger für Schädlingskunde **67** (1994) 165.

[12] F. Ferrer. Bio-control News and Information **22** (2001) 67.

[13] J.P. Michaud. Entomol. News **113** (2002) 216.

[14] P. Karuppuchamy, G. Balasubramanian and P.C.S. Babu. Madras Agric. J. **85** (1998) 224.

[15] A. Kharizanov and A. Dimitrov. Rastitaelna Development and feeding potential of the green lacewing *Chrysoperla carnea* Steph. (Neur. Chrysopidae) on different insect pests of cotton. Zashchita. **20** (1972) 36.

[16] N.Z.M. Zohdy, Research Bulletin, Faculty of Agriculture Ain Shans University No. 1810. (1982) 13.

[17] A.H. Abdal-Salam and N.F. Abdal-Baky. Pak. J. Biol. Sci. **3** (2000) 239.

[18] A. Tesfaye and R.D. Gautum. Indian J. Entomol. **64** (2002) 457.

[19] M. Afzal and M.R. Khan. Pak. J. Zool. **10** (1978) 83.

[20] T. Henn and R. Weinzierl. Beneficial insects and mites. University of Illinois, Circular 1298 (1990) 24.

[21] N.C. Lawo and J. Romeis, Bio. Cont. **44** (2008) 389.