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Population, Host Preference and Feeding Potential of *Chrysoperla Carnea* (Stephens) on Different Insect Hosts in Cotton and Mustard Crops

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Abstract: Studies on the population, host preference and feeding potential of *Chrysoperla carnea* (Stephens) on different insect hosts were conducted in field and laboratory conditions in the year 2011. The results revealed that the maximum numbers of *Bemisia tabaci* 19.84 (±2.46), *Aphis gossypii* 23.14 (±0.84), *Amrasca devastan* 13.42 (±2.10) and mealybug 50.62 (±5.44) per leaf were found on cotton crop. Similarly, maximum population of *B. tabaci*, *A. devastan*, and eggs of *Bagarada Picta* was recorded as 9.44 (±1.14), 6.44 (±0.74), 38.13 (±1.44) and 22.144 (±7.83), respectively on mustard crop. More activities of *C. carnea* (0.32±0.10) per plant were recorded on mustard as compared to cotton (0.32±0.14). The population of *C. canea* was negatively correlated with *B. tabaci* population (-0.019 NS) and positively with *A. devastan* (0.145 NS), *A. gossypii* (0.700**) and mealybug (0.834**), respectively on cotton. Similarly, negative correlation with *B. tabaci* population (-0.193 NS) and positive correlations with *A. devastan* (0.202NS), *L . erysimi* (0.923**) and *B. picta* (0.925**), respectively were recorded on mustard crop. The 3rd instar larvae voraciously fed on 3rd instar nymphs of all sucking insects. They consumed 66.14 (±2.18) *A. gossypii*, 61.14 (±1.06) *P. solinopsis*, 32.78 (±1.32) *B. tabaci* and 19.66 (±1.34) *A. devastan*s, respectively. The green lacewing fed 30.37 (±1.51) aphid day^{-1}, followed by mealy bug (12.30± 1.48), whiteflies (1.94± 0.30), and jassid (0.43±0.095). It is concluded from the results that *C. carnea* displayed its maximum activities when pest population were at their peaks. The third instar grubs were voracious on 3rd instars of all prey hosts. *A. gossypii* was the most preferred host in cotton and *L. erysimi* in mustard crop. *B. tabaci* had no impact on population activities of *C. carnea*.

Keywords: Prey, *C. carnea*, population, host preference, feeding potential.

1. INTRODUCTION

Chrysoperla carnea (Chrysopidae: Neuroptera) is a common predator of soft bodied insect pests in Pakistan (Muzmil *et al.* 2007). Adults feed on flower nectar and pollen (Kareim, 1998). Saminathan and Baskaran (1999) reported that before inflorescence, they eat honeydue excretion of *A. gossypii* as their diet. Its larvae are voracious on *A. gossypii*s and consume all life stages. Besides *A. gossypii*, they also feed on different insect pests. Complete destruction of *A. gossypii* colonies was recorded by (Jagadish and Jayaramaiah, 2004). The predatory range of *C. carnea* is more than seventy insects and non-insect species (Hoftman, and Frodsham, 1993). The larvae of *C. carnea* were used as bio controlling agent, which effectively controls *B. tabaci* on cotton in Pakistan (Muzmil *et al.*, 2007). Similarly, Chakraborty and Korat (2010) reported that *A. gossypii* is the most preferred host of *C. carnea*, followed by *Uroleucon compsoitae*, *Lipaphis erysimi* (Kalt.), *Brevicoryne brassicae* Linn. *Aphis craccivora* Koch. and *Aphis nerii.* Rana and Srivastava (1998) tested *C. carnea* consumption on different aphid species; the larval voracity in decreasing order was recorded as *L. erysimi*, *A. craccivora*, and *B. brassicae*. Bansod *et al*. (2001) reported that the larvae of this predator consumed more *A. gossypii* than *U. compositae*. Similarly, Liu and Chen (2001) revealed that the predatory larvae consumed more *A. gossypii* than *L. erysimi*. *C. arnea* can be utilized more efficiently in cotton ecosystem than other predators as it feeds not only on *A. gossypii*s and other sucking pests but also on bollworm eggs and neonate larvae (Aijun *et al*., 2004). Ahmed *et al.* (2011) conserved *C. carnea* by food supplements for suppression of all sucking insect pest in cotton crop, with special reference to cotton mealybug. Looking at its predatory range and varicosity on different insect hosts, the experiments were conducted on its population, host preference and feeding potential on cotton and mustard crops in the field conditions and laboratory as well.

2. MATERIALS AND METHODS

Studies on population, host preference and feeding potential of *Chrysoperla carnea* (Stephens) on different hosts were carried out in field and laboratory conditions at Entomology Section, Agriculture Research Institute Tandojam during 2011. The data was recorded on field population of insect pests and the predator in summer. For this purpose cotton variety NIAB- 78 was sown on one acre land. The population of insect pests was recorded on 50 randomly selected leaves of cotton plants. The leaves were examined from different strata

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of 50 randomly selected plants. The same plants were thoroughly examined to sample *C. carnea population*. The same procedure was adopted to record the population of insect pests and predator on Mustard crop in winter season.

Host preference (Free Choice)

Experiment on host preference of *C. carnea* was carried out in the laboratory of Entomology Section, ARI, Tandojam. For host preference 3rd instar larvae of *C. carnea* were given 3rd instar nymphs of each of *B. tabac*i, *A. devastans*, *A. gossypii*, *Phenococus solinopsis* for a day (24 hours) in a glass jar (7x3cm). The experiment was repeated twice on various dates with cotton crop and once with mustard crop to observe host preference on *B. tabaci, A. devastans, L. erysimi and* eggs of *B.picta*. There were 5 replications of each treatment.

Feeding potential on different nymphal instars of various insects (No choice)

Feeding efficiency of *C. carnea* larval instars was studied on 1st, 2nd, 3rd and 4th instars of *B. tabac*i, *Amrasca devastans*, *A. gossypii*, *Phenococus solinopsis* separately. Neonate 1st, 2nd and 3rd instar larvae of *C. carnea* were placed singly in glass jars (7x3cm) in three sets. Counted numbers of each instar nymphs of prey were provided to larvae of *C .carne*a. Nymphal consumption day^{-1} of each instar of *C. carnea* was recorded. The experiment was laid out by using CRD with 5 replications. The temperature and relative humidity were maintained as 26±2°C and 65±5%, respectively.

3. RESULTS

Pre-predator interaction on cotton and mustard crops

The data in indicated that *C. carnea* appeared in the field of cotton crop just after the resurgence of insect pests (Table 1). *B. tabaci* appeared in very early stage of the crop. Maximum number of *B. tabaci* (19.84±2.46) was recorded in the 3rd week of May, whereas, *A. devastan* and *A. gossypii* appeared after 2 weeks of germination of the crop. The population of *C. carnea* was much synchronized with the pest populations. The maximum population of *A. gossypii* was recorded (23.14±0.84) in 3rd week of May, whereas, the maximum population (13.42±2.10) of *A. devastan* was recorded in the 1st week of May. The mealy bug appeared when the crop was 2 months old. Its population was low in the beginning, which erupted in later stage of the crop and reached to its peak (50.62 ±5.44 per leaf) in the 1st week of July. During peak activities of *A. gossypii* and mealy bug, the maximum activities (0.32±0.14 per plant) of *C. carnea* were also recorded.

The data in Table 2 indicated that *C. carnea* appeared in the field of mustard crop just after the resurgence of insect pests. *B. tabaci* appeared with a population of 5.44 (±1.43) in the last week of November when the crop was one week old. Its maximum population (9.44±1.14) per leaf was recorded in 3rd week of December, whereas, *A. devastan* and *L. erysimi* appeared after 2 weeks of germination of the crop. The maximum populations of *A. devastan* and *L. erysimi* was recorded (6.44±0.74) and (38.13±1.44) in 2nd week of December and 1st week of January, respectively. The eggs of *B. picta* were found on the crop leaves and twigs from the last week of December to 2nd week of February. The maximum number of eggs (22.144±7.83) were found in the last week of January. Like cotton crop *C. carnea* was synchronizing with prey population. The maximum activities of *C. carnea* were recorded during peak activities of *L. erysimi* and *B. picta*. During this period its population ranged 0.10±0.08 to 0.38±0.10 per plant. However, on cotton crop the population of green lacewing was negatively correlated with *B. tabaci* population (-0.019 NS) and positively with *A. devastan* population (0.145 NS). Highly significant correlation was observed between populations of *C. carnea* and *A. gossypii* (0.700**) and mealy bug (0.834**), respectively. Similarly, negative correlations with *B. tabaci* (-0.193 NS) and positive with *A. devastan* (0.202NS) population were recorded on mustard crop. Highly significant correlation was observed between the population of *C. carnea* with *L. erysimi* (0.923**) and B. picta (0.925**), respectively.

Feeding potential of *C. carnea* (No choice)

Data in Table 4 indicated that *C. carnea* fed on all nymphal instars of *B. tabaci*, *A. gossypii*, *A. devastans* and mealy bug. However, its 1st instar larvae voraciously fed on 3rd instars of all the preys, except mealy bug. The 1st instar of *C. carnea* consumed (27.16±1.82 per day) 3rd instars of *A. gossypii*, followed by *A. devastan* (6.44±0.56), *B. tabaci* (6.14±0.78) and 1st instars of *P. solinopsis* (27.00±0.40). The second instar of *C. carnea* also voraciously fed on 3rd instar of all sucking insects. It consumed 45.82 (±2.64) *A. gossypii*s, followed by mealy bug (40.78±1.32), *B. tabaci* (18.62±1.44) and *A. devastan* (10.14±0.76). Similar trend of prey consumption was displayed by 3rd instar larvae of *C. carnea*. It consumed 66.14 (±2.18) 3rd instar *A. gossypii*, 61.14 (±1.06) *P. solinopsis* 32.78 (±1.32) *B. tabaci* and 19.66 (±1.34) *A. devastan*, respectively. It was concluded from the results that mostly 3rd instars of all the preys were preferred by all instars of *C. carnea*. Among preys *A. gossypii* was the most preferred host followed by *P. solinopsis*, *B. tabaci* and *A devastan*.

Table 1. Mean population of predator and prey on cotton crop during Summer 2011.

Date of observation	Predator per plant	Prey per leaf			
	C. carnea	*B. tabaci*	*A. gossypii*	*A. devastans*	Mealy bug
March 22	0.00	3.78±0.68	0.00	0.00	0.00
April 5	0.00	7.42±1.86	0.84±0.46	1.08±0.64	0.00
20	0.10±0.06	14.14±1.22	2.28±1.04	9.41±2.14	0.00
May 5	0.18±0.08	6.44±1.84	5.17±1.63	13.42±2.10	9.44±0.04
20	0.22±0.06	19.84±2.46	19.44±0.44	10.01±2.46	16.32±3.41
June 5	0.17±0.11	2.14±0.74	23.14±0.84	2.11±0.64	28.13±0.62
20	0.22±0.13	2.44±0.41	10.32±1.34	1.32±0.86	44.42±0.98
July 5	0.32±0.14	1.32±0.46	2.90±1.04	3.42±0.46	50.62±5.44
20	0.15±0.09	0.44±0.12	1.32±0.84	6.18±1.20	32.44±6.66
August 5	0.11±0.08	1.14±0.84	0.0±00	2.18±0.64	13.14±3.44
20	0.06±0.04	00	00	2.11±0.87	22.64±2.48
Sept. 5	00	00	00	1.48±0..36	10.16±1.03

Table 2. Mean population of predator and prey on mustard crop during Winter 2011.

Date of observation	Predator per plant	Prey per leaf			
	C. carnea	*B. tabaci*	*L.erysimi*	*A. devastans*	*B. picta* egg
Nov. 11	0.00	5.44±1.43	00	00	00
Dec. 13	0.10±0.08	3.44±0.42	7.44±1.32	6.44±0.74	00
28	0.16±0.10	9.44±1.14	20.44±2.46	2.14±0.84	12.01±6.14
Jan. 12, 2012	0.29±0.12	4.84±1.82	38.13±1.44	0.84±0.43	18.34±6.13
27	0.38±0.10	1.86±0.94	26.42±1.62	0.36±0.18	22.144±7.83
Feb. 12	0.14±0.08	0.34±0.22	12.44±2.46	00	8.09±4.01

Host preference of *C. carnea* **(Free choice)**

(Table 3) revealed that *A. gossypii* was highly preferred host of *C. carnea* where as A. *devastan* was the least preferred *host* in free choice preference. The larvae of *C. carnea* consumed maximum (30.56±3.58) *A. gossypii*, followed by *P. solinopsis* (13.48± 1.64) *B. tabaci* (6.43± 1.03), and (4.84±1.22) *A. devastans* day^{-1}. During mustard season the most preferred *host* was *L. erysimi* and the least preferred was *B. tabaci. C. carnea* consumed 36.49 (±2.14) individuals of *L. erysimi* day^{-1}. It consumed 10.14 (±1.44) eggs of *B. picta* eggs day^{-1}, followed by *A. devastans* (8.86±1.18) and *B. tabaci* (4.44±0.88).

Table 3. Host preference of *C. carnea* on various hosts.

Crop	**Date of observation**	**Insect pest**					
		B. tabaci	*A. gossypii*	*A. devastans*	*P. solinopsis*	*L. erysimi*	*B. picta* eggs
Cotton	April 12-2011	2.44±0.42	24.14±0.89	2.01±0.44	10.17±0.42	-	-
	June 12-2011	6.43±1.03	30.56±3.58	4.84±1.22	13.48±1.64	-	-
Mustard	Dec:08-2011	4.44±0.88	-	8.86±1.18	-	36.49±2.14	10.14±1.44

Table 4. Feeding potential of green lace wing, *C. carnea* on different hosts in the laboratory condition.

C. carnea larval stage	Prey	Consumption rate on various life stages			
		1st Instar	2nd Instar	3rd Instar	4th instar
1st Instar	White fly	4.2 ± 0.38	3.47±0.72	6.14±0.78	5.44±0.86
	A. devastan	4.01±0.42	6.41±0.34	6.44±0.56	--
	A.gossypii	13.74±2.06	22.44 ±2.45	27.16±1.82	6.44±0.74
	Mealy bug	22.0±0.4	5.32±1.84	3.44±1.64	--
2nd Instar	White fly	14.35±2.01	16.42±1.34	18.62±1.44	20.32±1.06
	A. devastan	9.14±1.74	9.47±0.84	10.14±0.76	9.14±0.59
	A.gossypii	26.82±3.18	42.66±3.14	45.82±2.64	29.62±0.56
	Mealy bug	26±4.78	38.74±2.14	40.78±1.32	--
3rd Instar	White fly	34.14±3.42	34.44±2.72	32.44±2.14	38.80±1.44
	A. devastan	17.66±2.44	13.43±0.92	19.66±1.34	17.86±1.22
	A.gossypii	55.14±4.41	59.11±3.74	66.14±2.18	44.13±0.7
	Mealy bug	48±3.60	50.42±2.32	61.14±1.06	--

4. DISCUSSION

The result showed that the soft bodied insect pests such as *B. tabaci*, *A. devastans*, *A. gossypii* and *P. solinopsis* appeared at various growing stages of cotton crop in summer, whereas, in winter, *L erysimi* and *B. picta* appeared on mustard instead of *A. gossypii* and *P. solinopsis.* Dhawan (2000) mentioned *A. devastans, A. gossypii* and *B. tabaci as* the important key pests of cotton. A new mealy bug (*Phenacoccus solenopsis* Tinsley) appeared recently and has attained the status of a serious pest on a wide range of host plants including cotton (Arif *et al.,* 2009). Sahito *et al.* (2010) reported that *L. erysimi* and *B. picta* appeared on mustard crop from seedling to its harvesting. In contrast to the results, Haider (1999) and Balakrishnan (2005) mentioned voracity of *C. carnea* on *A. devastans.* The results further indicated that *C. carnea* fed on all types of soft bodied insect pests and their eggs found in cotton and mustard crops as well. These findings are in agreement with those of Hoftman, and Frodsham (1993). They reported insects and non-insect species as hosts of *C. carnea*. Aijun *et al.* (2004) mentioned that the host range of *C. carnea* extended to all soft body insects including bollworm eggs and neonate larvae. Singh and Kumar (2000) reported that *Chrysoperla carnea* (Stephens) successfully suppressed aphid population in mustard. The population of *C. carnea* was very synchronizing with the population of host insect. As host population increased, the activities of *C. carnea* were also increased. Its population was positively correlated with the population of *A. devastans A. gossypii* and eggs of *B. picta.* Vennila (1998) reported positive and negative correlation between the population of *A. devastan* and *C. carnea* on various cotton varieties. Mari *et al.* (2007) reported positive correlation with *A. gossypii* population. Solangi *et al.,* (2008) and Mari *et al.* (2009) also support our results. They mentioned that the populations of some predators including *C. carnea* were positively correlated with sucking complex on cotton. The result further showed that in free choice *A.gossypii* and *L. erysimi* were the most preferred hosts in both the crops and *A. devastans* was the least preferred host during cotton crop as compared to mustard crop. Chakraborty and Korat (2010) reported that *A. gossypii* is one of the most preferred hosts of *C. carnea* among all the aphid species. It strongly preferred *A. gossypii*s over eggs and neonate 1st instar larvae of *Pieris brassicae* (Huang and Enkegaard, 2010), while, Sahito *et al.* (2010) mentioned that *C. carnea* (Stephens) were seen occasionally feeding on nymphs and adults of the *A. devastan*s. Sattar (2011) reported that *C. carnea* reduced more than 80 and 50% population of *A. devastan* and *B. tabaci*, respectively in cotton**.** Malleshaiah *et al.* (2000) reported that the grub of *C. carnea* consumed more than three thousand eggs, seven hundred nymphs and ninety adult females of citrus mealy bug. The results also revealed that the 3rd instar larvae of *C.carnea* were highly voracious on almost all later nymphal stages of prey hosts. Gautam and Tesfaye (2002) found that the predatory potential of the predator was higher in the older instars than the younger ones. The estimated handling time was somewhat lower for the third instar because of the higher prey consumption. Nordlund and Correa (1995) studied the same correlation between the predator and its prey and found similar findings as we had. Balakrishnan *et al. (*2005) mentioned that the final instar grub consumed more number of preys compared to earlier instars. Syed *et al.* (2005) reported *C. carnea* consumed more *B. tabaci* nymphs (200.5 nymphs) as compared to *A. devastans* (171.8 nymphs).

5. CONCLUSION

It is concluded from the results that *C. carnea* was more active on mustard crop than cotton. It fed on all types of sucking insects; however, aphids were more preferred host. Third instar larvae of *C. carnea* voraciously fed on 3rd instar nymphs of most of the sucking insect pests.

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