



Full Length Article

Predation Rate in Selected Coccinellid (Coleoptera) Predators on some Major Aphidid and Cicadellid (Hemipteran) Pests

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ABSTRACT

Predation rate of adult and larvae of *Coccinella septempunctata*, *Cheilomenes sexmaculata*, and *Hippodamia variegata* on aphids *Macrosiphum miscanthi*, *Schizaphis graminum*, *Aphis maidis* and jassid *Empoasca kerri*, the major pests in croplands of Punjab was studied in laboratory. The experiments were carried out at 25°C±5°C, at relative humidity of 60±5 and 12:12 (light: darkness) hours photoperiod. Two experiments were designed. In first experiment, each predator (adult/larvae) was fed a prey species at different densities (30, 40 & 50). In second experiment, all the predators (adult/larvae) were fed different prey species with fixed number (20). The average predation rate ranged from 10.6±0.71 to 33±5.43 aphids and 4.8±0.84 to 8.8±1.48 jassid/day. Predation rate of each predator species increased with the increase in prey density of each species. Overall larval feeding rate was 2.0 fold greater than those of adults. Adult *Hippodamia variegata* and *Cheilomenes sexmaculata* had greater predation rate as compared to *C. septempunctata*; whereas larval feeding rate was almost same within each prey density. Predators preferred aphids over jassids. Among the aphids, *Schizaphis graminum* was the preferred species. Adults did not consume jassid in presence of aphid. Findings may be helpful in understanding the role of some coccinellids as natural pest suppressors and their possible use in biological control programmes against aphid/jassid species. © 2011 Friends Science Publishers

Key Words: Coleoptera; Hemiptera; Predation rate; Biological control

INTRODUCTION

Trophic relations play a major role in structuring natural communities and probably largely determine local species abundance. Predator-prey interactions are one of the best-studied phenomena in ecology (Arditi & Ginzburg, 1989). Coccinellids, the most widespread and abundant predators in many agricultural regions, are known to have the strongest impact on aphid and/or jassid species (Hodeck & Honek, 1996). Determining the impact of species considered potentially important natural enemies of crop pests, is crucial for making robust management decisions as a part of an IPM programme (Ives, 1980; Johnson *et al.*, 2000; Wilson, 2002). *Schizaphis graminum*, *Aphis maidis*, *Macrosiphum miscanthi* and *Empoasca kerri* are some of the predominant pest species in agro-ecosystems of Central Punjab-Pakistan. *Coccinella septempunctata*, *Cheilomenes sexmaculata* and *Hippodamia variegata* populations comprise major part of coccinellid predator species present in the croplands. The aims of this work were (i) to elucidate, via laboratory tests, the consumption rate of the predators to different densities of most frequent pests present in the croplands, and (ii) to assess the utility of the results for

predicting the impact of the predator on the population dynamics of the pests under natural conditions.

MATERIALS AND METHODS

The study was conducted at the Experimental Research Laboratory in the Department of Zoology and Fisheries, University of Agriculture, Faisalabad in controlled conditions, at temperature of 25±5°C, 60±5% RH, and a light regime of 12hL: 12hD. Unsexed adult and 4th instar larva of *C. septempunctata*, *C. sexmaculata* and *H. variegata* (the predator's species) and *S. graminum*, *A. maidis*, *M. miscanthi* and *E. kerri* (the prey species) were collected from the crop field. For this purpose, two experiments were designed. In 1st experiment, each predator (adult/larvae) was fed single prey species at different densities (30, 40 & 50) placed in petri dishes, 9 cm in diameter and 2 cm deep lined with a moistened filter paper with small pieces of wheat leaves. In the 2nd experiment, all the predators (adult/larvae) were fed different prey species with fixed number (20). The predators were kept starved for 24 h before each trial. There were five replicates of each run. Numbers of prey consumed by each individual

predator, in each run, were recorded. Preys were not added during the experiment.

RESULTS

All the predators' adult/larvae showed maximum prey consumption at 30 prey density. The general trend was an increase in the number of prey consumed, but at a decreasing rate, with increase in prey density offered. Adult feeding rate was nearly 1.5 to 2 fold lesser than those of the larvae for nearly all preys at each prey density. Adult's predation rate varied for aphid species, *H. variegata* consumed maximum number of prey, and minimum consumption rate was shown by *C. septempunctata*.

Adult/larvae coccinellid consumption rate for *Aphis maidis* is presented in Table I. Maximum consumption was shown by *H. variegata* at 50 prey density (adult: 20.4 ± 1.14 , 40.8%; larva: 30 ± 1.58 , 60%). Minimum predation rate was by *C. septempunctata* (adult: 10.8 ± 1.30 , 36%; larva: 23.2 ± 1.48 , 77.3%).

Adult/larvae coccinellid consumption rate for *Schizaphis graminum* is presented in Table II. Consumption rate was similar to that of *Aphis maidis*. No significant differences were observed except at 50 prey density/day offered, where consumption rate of *C. sexmaculata* (adult: 22.4 ± 2.51 , 44.8%; larva: 33 ± 5.43 , 66.0%) and *H. variegata* (adult: 23 ± 3.54 , 46.0%; larva: 33.2 ± 5.31 , 66.4%) was higher for *Schizaphis graminum* than *Aphis maidis*.

Adult/larvae coccinellid consumption rate for *Macrosiphum miscanthi* is presented in Table III. No significant differences were observed. *C. sexmaculata* (adult: 22 ± 1.92 , 44.0%; larva: 33.2 ± 2.59 , 66.4%) and *H. variegata* (adult: 22.2 ± 1.79 , 44.4%; larva: 32 ± 3.54 , 64.0%) showed maximum consumption at 50 prey density.

Adult/larvae coccinellid consumption rates for *Empoasca kerri* is presented in Table IV. There was a marked difference in consumption rate for aphids and jassids. Number of jassids consumed by coccinellids was significantly lower than aphids. *C. sexmaculata* adult (7.6 ± 1.82 , 15.2%), *C. septempunctata* and *H. variegata* larvae (8.8 ± 0.84 & 8.8 ± 1.48 , 17.6% 2), showed maximum consumption at 50 prey density.

Adult coccinellid consumption for mixed prey species is presented in Table V. Adult coccinellids did not consume *Empoasca kerri* in the presence of the aphid species. *H. variegata* showed maximum consumption at each prey density.

Coccinellid larva consumption rates for mixed prey species are presented in Table VI. coccinellid larvae consumed *Empoasca kerri* but in significantly lower number than aphids. At each prey (aphid) density, the larvae of each predator showed similar consumption rate. Overall each predator adult/larvae of each predator species consumed more of *Schizaphis graminum*. Consumption of *Aphis maidis* was minimum.

DISCUSSION

The present study examined the predation rate of *C. setempunctata*, *C. sexmaculata* and *H. variegata* for *S. graminum*, *A. maidis*, *M. miscanthi* and *E. kerri* at different prey densities. Adult/larvae predation rate ranged from (10.8 ± 1.30 , 36% to 33 ± 5.43 , 66.0%). This was also reported by Omkar *et al.* (2005), who studied aphid consumption rate in *Cheilomenes sexmaculata*, *Harmonia curcuata*, *Coccinella* spp. and *Veronia crocea*. Adult predation rate ranged between 28-33.2 aphids/day/50 aphids, showing no significant differences in their daily feeding capacity.

It was observed that the number of prey consumed increased, while the percentage of prey consumed decreased with the increase in prey density. Maximum consumption rate was seen at 30 prey density. Shukla *et al.* (1990) also reported that the rate of prey consumption of *C. septempunctata* on *Lipaphis erysimi* increased significantly with an increase in predation period and the prey density and more than 50% of consumed prey were eaten during the first three hours, which shows that the predation rate is maximum during initial phase.

In the present study, predation rate of larvae was found to be higher than adults Doghairi (2004) observed 2.0 fold greater predation rates in larvae than those of adults. High predation rate by larvae may be because of the need of the larvae to cumulate high quantity of its food requirement to be able to proceed with its development and metamorphose to the pupal stage. Findings in present study indicate that larvae of coccinellids may have a stronger impact on pest populations than the adults as suggested earlier (Khan & Suhail, 2001; Pervez & Omkar, 2005).

High predation rate of *H. variegata* and *C. sexmaculata* adult/larvae in comparison to *C. setempunctata* was recorded in the present study. This may be because of sluggish behavior of *C. setempunctata* and therefore, it probably takes more time in searching and handling the prey species as compared to *H. variegata* and *C. sexmaculata*. Pervez and Omkar (2005) studied the functional response parameters and patterns of three coccinellid predators, *Cheilomenes sexmaculata*, *Propylea dissecta*, and *Coccinella transversalis*, in terms of consumption of the aphids, *Aphis craccivora* and *Myzus persicae* and reported differences in coefficients of attack rates of the predators. *C. sexmaculata* was observed to be the best predator for the management of both prey species, particularly *A. craccivora* as its searching and handling time was found to be lesser than other predator species.

Preference of *S. graminum* over *A. maidis*, *M. miscanthi* may be due to body size and shape difference in aphid species. The lesser predation rate for *E. kerri* (jassid) than aphid species, may be probably, because of its winged hard body and large size in comparison to wingless, soft body and small size of aphid.

Present study indicated high predation of coccinellid predators for aphid species. Predation rates obtained from

Table I: Comparative account of predation rate of three Coccinellid predators and their larvae on the aphid *Aphis maidis*

Predator	Mean±S.E. Number of prey consumed/day/density offered					
	30		40		50	
	Adult	Larvae	Adult	Larvae	Adult	Larvae
<i>Coccinella septempunctata</i>	10.8±1.30 (36%)	23.2±1.48 (77.3%)	12.2±0.84 (30.5%)	26.2±1.92 (65.5%)	17±1.00 (34%)	29.4±1.14 (58.8%)
<i>Cheilomenes sexmaculata</i>	14±1.58 (46.7%)	23.6±1.14 (78.7%)	16.2±0.84 (40.5%)	26.6±2.074 (66.5%)	19.4±1.14 (38.8%)	29.4±1.14 (58.8%)
<i>Hippodamia variegata</i>	14.2±1.64 (47.33%)	24.2±0.84 (80.7%)	17±0.71 (42.5%)	26.8±0.84 (67%)	20.4±1.14 (40.8%)	30±1.58 (60%)

Table II: Comparative account of predation rate of three Coccinellid predators and their larvae on the aphid *Schizaphis graminum*

Predator	Prey consumed/day/density offered (Mean±S.E.)					
	30		40		50	
	Adult	Larvae	Adult	Larvae	Adult	Larvae
<i>Coccinella septempunctata</i>	10.6±0.71 (35.3%)	22±1.58 (73.33%)	13±0.89 (32.5%)	25.2±1.92 (63%)	16±1.82 (32%)	32.4±3.36 (64.8%)
<i>Cheilomenes sexmaculata</i>	14.8±2.28 (49.33%)	23.6±1.82 (78.7%)	17.8±0.84 (44.5%)	25.8±2.39 (64.5%)	22.4±2.51 (44.8%)	33±5.43 (66.0%)
<i>Hippodamia variegata</i>	15.6±2.07 (52.0%)	24.6±1.67 (82.0%)	18.4±2.51 (46.0%)	26.2±1.92 (65.5%)	23±3.54 (46.0%)	33.2±5.31 (66.4%)

Table III: Comparative account of predation rate of three Coccinellid predators and their larvae on the aphid *Macrosiphum miscanthi*

Predator	Prey consumed/day/density offered (Mean±S.E.)					
	30		40		50	
	Adult	Larvae	Adult	Larvae	Adult	Larvae
<i>Coccinella septempunctata</i>	11±1.00 (36.7%)	21.6±1.52 (72.0%)	13±1.58 (32.5%)	26±1.58 (65.0%)	18.2±0.84 (36.4%)	32.6±3.05 (65.2%)
<i>Cheilomenes sexmaculata</i>	13.8±0.84 (46.0%)	21.4±2.70 (71.3%)	16.6±2.07 (41.5%)	26.2±1.48 (65.5%)	22±1.92 (44.0%)	33.2±2.59 (66.4%)
<i>Hippodamia variegata</i>	14.4±1.14 (48.0%)	22.4±2.41 (74.7%)	17.6±1.67 (44.0%)	27±1.58 (67.5%)	22.2±1.79 (44.4%)	32±3.54 (64.0%)

Table IV: Comparative account of predation rate of three Coccinellid predators and their larvae on the jassid *Empoasca kerri*

Predator	Prey consumed/day/density offered (Mean±S.E.)					
	30		40		50	
	Adult	Larvae	Adult	Larvae	Adult	Larvae
<i>Coccinella septempunctata</i>	4.8±0.84 (16.0%)	7.8±1.30 (26.0%)	6±1.00 (2.8%)	7.6±1.14 (19.0%)	7±1.58 (14.0%)	8.8±0.84 (17.6%)
<i>Cheilomenes sexmaculata</i>	4.8±1.00 (16.0%)	7.8±0.84 (26.0%)	6±0.89 (15.0%)	8.2±1.79 (20.5%)	7.6±1.82 (15.2%)	8.6±1.52 (17.2%)
<i>Hippodamia variegata</i>	5±0.84 (16.7%)	7.4±1.14 (24.7%)	6.8±0.84 (17.0%)	7.8±0.84 (19.5%)	7±1.00 (14.0%)	8.8±1.48 (17.6%)

Table V: Prey preference of three Coccinellid adult predators on three different prey species

Predator	<i>Schizaphis graminum</i> (20)	<i>Aphis maidis</i> (20)	<i>Macrosiphum miscanthi</i> (20)	<i>Empoasca kerri</i> (20)	Total 80
<i>Coccinella septempunctata</i>	6.4±1.14	5.6±1.52	6±1.58	0±0.00	18±1.87
<i>Cheilomenes. Sexmaculata</i>	8.2±1.92	7.6±1.14	8±1.00	0±0.00	24.2±1.92
<i>Hippodamia variegata</i>	8.4±2.19	7.8±1.79	8±1.41	0±0.00	24.2±2.17

Table VI: Prey preference of three Coccinellid adult predators on three different prey species

Predator	<i>Schizaphis graminum</i> (20)	<i>Aphis maidis</i> (20)	<i>Macrosiphum miscanthi</i> (20)	<i>Empoasca kerri</i> (20)	Total 80
<i>Coccinella septempunctata</i> larvae	10.75±1.34	10±1.30	10.5±1.82	0.6±0.89	31.2±0.84
<i>Cheilomenes sexmaculata</i> larvae	12±1.87	10.8±1.30	10.6±3.05	1.8±1.30	34.6±3.21
<i>Hippodamea variegata</i> larvae	11.6±1.14	10.6±1.52	12.2±2.28	1.4±1.22	36.4±3.71

laboratory studies may have little resemblance to those that could be measured in the field (Wang *et al.*, 1984; Hussain & Ahmed, 2003). However, such studies can be used to infer basic mechanisms underlying predator-prey interactions. Further studies on predation rate of coccinellids on hemipteran preys both in the laboratory and field need to be done to successfully incorporate them into IPM programs and enhance the ecological functions of agro ecosystems.

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