Feeding Potential of Ladybird Beetle, *Coccinella septempunctata* (L) (Coleoptera: Coccinellidae) on Cabbage Aphid, *Brevicoryne brassicae* (L) under Laboratory Conditions.

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Abstract

Among the different predators, coccinellid beetles play an important role in the natural suppression of destructive insect pests. *Coccinella septempunctata*, an important coccinellid beetle with worldwide distribution is found very active on different insect pests. An experiment was conducted to study the feeding potential of C. *septumpunctata (*Linnaeus) on Cabbage aphid, *Brevicoryne brassicae* (Linnaeus) under laboratory conditions [26 ± 2˚C and 65 ± 5% Relative Humidity (R.H)]. The present study was conducted in Entomology Laboratory, Department of Zoology, University of Kashmir during the year 2014-2015. The results revealed that both adults and grubs of C. *septumpunctata* were found voracious feeders on cabbage aphid. The fourth instar devoured maximum number of aphids. The mean aphid consumption under different host density was observed. Also higher prey consumption rate was observed in adult female as compared to adult male.

Keywords: Coccinellid beetle, voracious, cabbage aphid, consumption, instar

Introduction

Coccinellids, persistently known as ladybird beetles belonging to the order Coleoptera and the family Coccinellidae, are the forthcoming predators of an array of insect pests, principally aphids, scale insects, mealy bugs, thrips and other soft bodied insects, besides phytophagous mites. This family gained interest as an important group of predators in the biological control of insect pests attacking different crop plants. On the other hand, much data is available with respect to predation of ladybird larvae and adult ladybirds on mobile stages of aphids, especially in spring and summer and about the possibilities of using ladybird beetles in biological control (Honek, A. and Hodek, 1996; Obrycki and Kring 1998; Dixon 2000; Harrington *et al*., 2007; Mrowczynski and Wachowiak 2009; Obrycki *et al.*, 2009; Gospodarek 2012).The biological control with Coccinellids has contributed greatly and suppressed the pests below economic damage (Hoy and Nguyen 2000). In addition to this Coccinellid predators are tolerant to many insecticides which are an advantage over other predators (Banken and Stark 1998).

C. *septempunctata* is a common species used for biological control in agriculture settings, as its main prey is the aphid, a major agricultural pest and is one of the most successful aphidophagous insects to control aphid populations. The ability of C. *septempunctata* to be so successful in a large range of habitats makes it especially beneficial to humans who need crop security from aphid infestations (Honek and Martinkova 2005). The predator beetle is an efficient feeder and preys on wide range of soft bodied insects. Both adults and grubs are voracious feeder of various aphid species. Many aphid species are serious pests of different crops. *B. brassicae* commonly known as cabbage aphid is important pest of cruciferous vegetables in Kashmir valley. Colonies of this aphid are found on both lower and upper leaf surfaces and in leaf folds of developing heads, on leaf stalks, and on leaf axles of various plants and vegetables. Sucking of sap from their hosts causes wilting, yellowing and general stunting of the plants (Opfer and McGrath 2013). They prefer feeding on young leaves and flowers and often go deep into the heads of Brussels, sprouts and cabbage (Natwick 2009). The cabbage aphid is of agricultural concern because it is a vector of at least 20 viral pathogens that can cause diseases in crucifers and citrus. Both wingless (apterae) and winged (alate) forms are able to transmit viruses, but the wingless aphids demonstrate a higher rate of transmission (Toba 1962). Aphids also cause major losses to broccoli by reducing yield, with real damage being contamination of harvested heads of broccoli (Natwick 2009; Opfer and McGrath 2013). The present study in view of the above reasons was undertaken for obtaining information on predatory potential of C. *septumpunctata* on cabbage aphid, *B. brassicae* under laboratory conditions.

Materials and Methods

The experiment was conducted in the Entomology Laboratory of Department of Zoology, University of Kashmir, under controlled conditions (26 ±2˚C and 65 ±5% R.H.) during the year 2014-2015. Adults of C. *septumpunctata* were collected by net sweeping method and hand picking method (Jonathan 1995). The net used for collection was made of white muslin cloth with long handle. Hand picking method was mostly adopted for collection. The collected specimens were kept in collecting jars and collection tubes and brought to Entomology laboratory Department of Zoology for rearing.

Mating pairs were kept in glass jars (11.0cm and 8.5cm) covered with muslin cloth. They were provided with abundant supply of food in the form of infested twigs of aphids until oviposition. Dry twigs were replaced with fresh ones after every 24hrs in order to avoid any microbial contamination. The glass jars were also provided with crumpled paper to act as oviposition site. The eggs laid by female were removed from culture and kept separately.

After hatching from eggs, the first instar grubs of C. *septempunctata* were transferred into petri dishes (9cm dia.) with the help of camel hair brush. For feeding potential, a single grub (per petri dish) were supplied with known number of *B. brassicae* along with leaf and replicated three times. In order to record consumption rate, the number of aphids left after 24 h were counted. The number of aphids consumed during 24 h was recorded and whole experiment was repeated four times but with increased number of known aphids. Same experiment was repeated for determining the feeding potential of 2nd, 3rd and 4th instars grubs. Newly emerged adults were kept separately in petri dishes and same experiment was repeated by providing known number of *B. brassicae* to both sexes of adult beetles. The consumption of *B. brassicae* was recorded at 24 h intervals daily by counting the number of live aphids. Statistical analysis was done by using SPSS (Version 07), Minitab statistical software and MATLAB software. Further data was subjected to one way ANOVA using Tukey's test at 5%.

Results and Discussion

Feeding potential of grubs of C. septempunctata

The results obtained during the present study showed the comparative feeding rate of different grubs of C. *septumpunctata* on *B. brassicae* **(Figure 1).** The present data showed that as grubs increased with age and as they underwent successive moulting to next instar the feeding rate also get increased. Similar observations were found by Azim and Bhat (2005). The results also revealed that all the grubs of C. *septempunctata* were voracious feeders; however the 4th instar devoured more number of aphids **(Figures 2 to 5)**. Singh and Singh (1993, 1994) reported that larvae of lady bird beetle, C. *septempunctata* behaved aggressively and their feeding on aphids was voracious.

Figure 1: Leaf showing cabbage aphids, *Brevicoryne brassicae*

Figure 2: 1st instar grub of *Coccinella Septem-punctata* feeding on aphids

Figure 3: Second instar grub of *Coccinella septempunctata* feeding on aphids

Figure 4: Third instar grub of *Coccinella septempunctata* feeding on aphids

Figure 5: Fourth instar grub *Coccinella septempunctata* feeding on aphids

When the data was subjected to one way ANOVA, the results revealed that in first instar grub treatment I, II and III were significantly similar to each other but IV treatment was found insignificant to treatment I and significant to II and III treatment at $p \leq 0.05$ (**Table 1**). In second instar grub treatment I was found significantly similar to II treatment but insignificant to III and IV treatment **(Table 2).** Likewise in case of third instar grub treatment I and II were significantly similar to each other but different from IV treatment. Treatment III and II were also significantly similar to each other but showed insignificance difference with IV treatment **(Table 3).** In fourth instar grub, all the four treatments were found significantly different. This showed that increase in number of aphids offered is significantly different **(Table 4).**

Also aphid consumption of 1st, 2nd, 3rd and 4th instar grubs of C. *septempunctata* was affected significantly by host density. The mean aphid consumption under host density of 40 in four instars was 37.5%, 70%, 87.5% and 95% respectively under laboratory conditions. Similarly mean aphid consumption under host density of 60 in four instars was 36.6%,6.6%, 70% and 91.6% respectively. under host density of 80 it was 31.24%,53.75%,65% and 95% respectively and for 100 it was 28%,50%,66% and 93% respectively.

Table 1. Feeding potential of first instar grub

Treatments	No. of Aphids offered	Mean of Aphids consumed* (Consumption)	Mean Consumption (Percentage %)
I	40	15± 4.35^{a}	37.5
II	60	22± 3.00^{ab}	36.6
III	80	25± 2.64^{ab}	31.25
IV	100	28± 6.24^{b}	28

***Mean of 3 replications/ treatment. Mean followed by same letter in each column are not significantly different by Tukey's test at 5%.**

Table 2. Feeding potential of second instar grub

Treatments	No. of Aphids offered	Mean of Aphids consumed* (Consumption)	Consumption (Percentage %)
I	40	28 ± 2.64^{a}	70
II	60	34 ± 3.00^{ab}	56.6
III	80	43 ± 5.00^{bc}	53.75
IV	100	50 ± 3.00^{c}	50

***Mean of 3 replications/ treatment. Mean followed by same letter in each column are not significantly different by Tukey's test at 5%.**

Table 3. Feeding potential of third instar grub

Treatments	No. of Aphids offered	Mean of Aphids consumed* (Consumption)	Consumption (Percentage %)
I	40	35±3.60a	87.5
II	60	42±3.60ab	70
III	80	52±4.58b	65
IV	100	66±3.60c	66

***Mean of 3 replications/treatment. Mean followed by same letter in each column are not significantly different by Tukey's test at 5%.**

Table 4. Feeding potential of fourth instar grub

Treatments	No. of Aphids offered	Mean of Aphids consumed* (Consumption)	Consumption (Percentage %)
I	40	38±6.55^{a}	95
II	60	55±3.00^{b}	91.6
III	80	76±3.60^{c}	95
IV	100	93±5.00^{d}	93

***Mean of 3 replications/treatment. Mean followed by same letter in each column are not significantly different by Tukey's test at 5%.**

The statistical data showed that 4th instar grub consumed more aphids than any other grubs **(Figure 6).** Dixon (2000), Srivastiva *et al.* (1987) and Sattar *et al.* (2008) also reported that among all larval stages, 4th instar fed voraciously for many days.

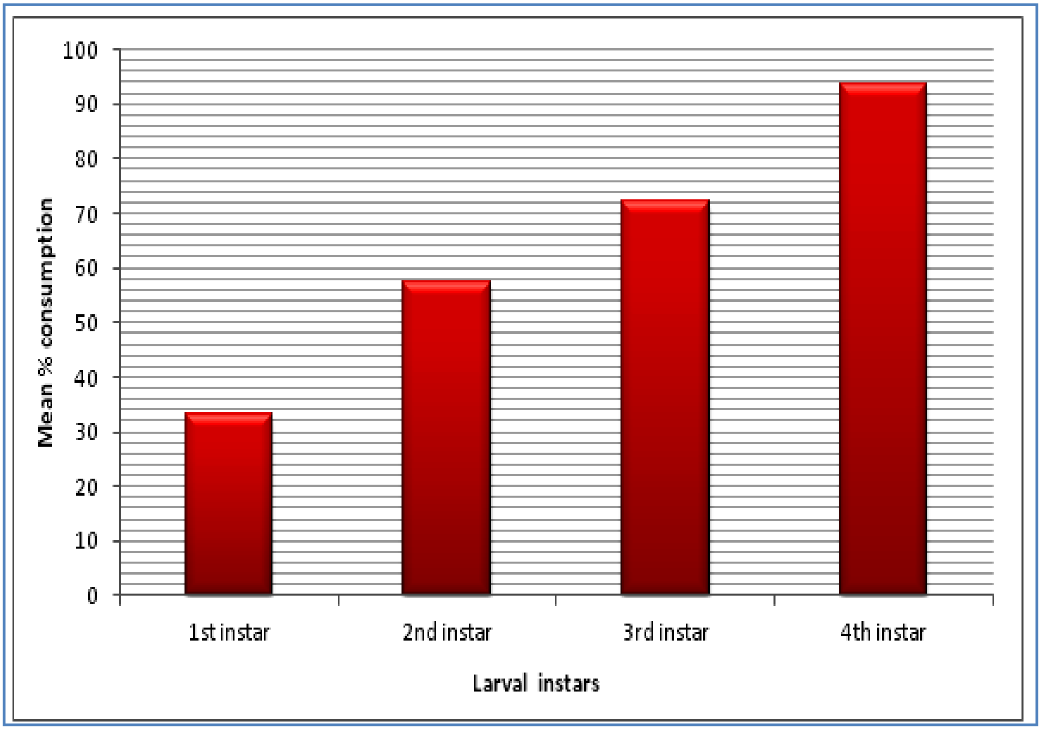

Figure 6: Graph showing mean consumption of aphids by different grubs of *C. septempunctata*

Feeding potential of adults

The feeding potential of adult males and females of C. *septumpunctata* on aphid, *B. brassicae* was done under similar conditions as in grubs **(Figure 7).** The one way ANOVA results revealed that in adult males all the four treatments were insignificant to each other at $P \leq 0.05$ **(Table 5).** Similarly in adult female all the four treatments were found insignificant to each other **(Table VI).**The data showed that adult female consumed more than adult male. The higher prey consumption rates of adult females may be due to a higher nutrient requirement for special purposes such as oviposition due to delayed satiation (Mills 1982) or due to possible faster digestive rate of adult females (Pervez and Omkar 2005). Mean aphid consumption under host density of 120 in adult male and female was 95.83% and 98.33% respectively. Likewise mean aphid consumption under host density of 140 was 97. 14% in males and 97.85% in females, under host density of 160 it was 98. 12% in males and 98. 12% in females and for 180 it was found that consumption rate in males was 97. 77% and in females it was 99. 4% **(Figure 8)**.

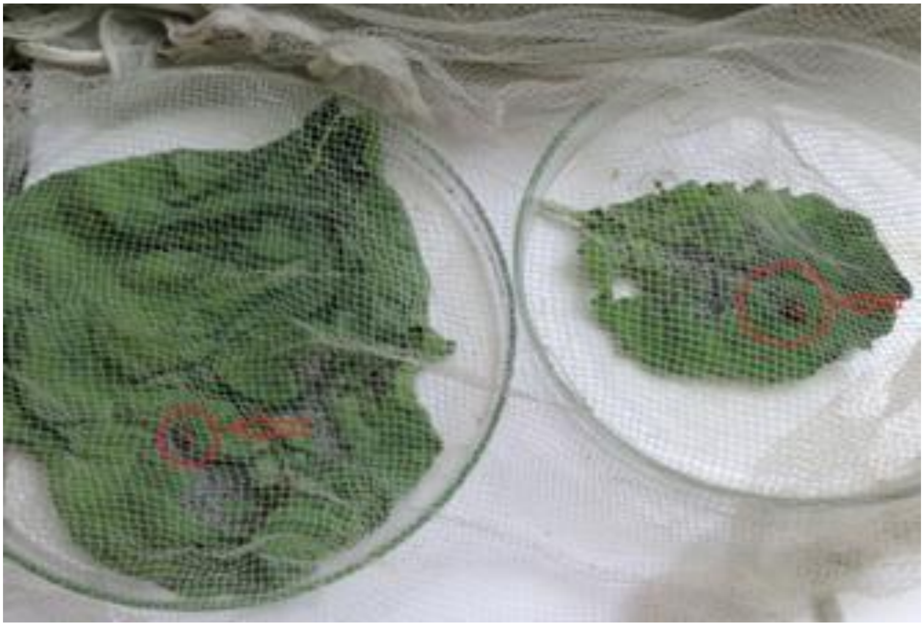

Figure 7: Adult male and female of C. *septempunctata* feeding on aphids

Table 5: Feeding potential of adult male

Treatments	No. of Aphids offered	Mean of Aphids consumed* (Consumption)	Consumption (% age)
I	120	115±5.03[a]	95.83
II	140	136±2.00[b]	97.14
III	160	157±2.64[c]	98.12
IV	180	176±3.00[d]	97.77

***Mean of 3 replications/treatment. Mean followed by same letter in each column are not significantly different by Tukey's test at 5%.**

Table 6: Feeding potential of adult female

Treatments	No. of Aphids offered	Mean of Aphids consumed* (Consumption)	Consumption (% age)
I	120	118±1.00[a]	98.33
II	140	137±2.00[b]	97.85
III	160	157±2.00[c]	98.12
IV	180	179±1.50[d]	99.4

***Mean of 3 replications/treatment. Mean followed by same letter in each column are not significantly different by Tukey's test at 5%.**

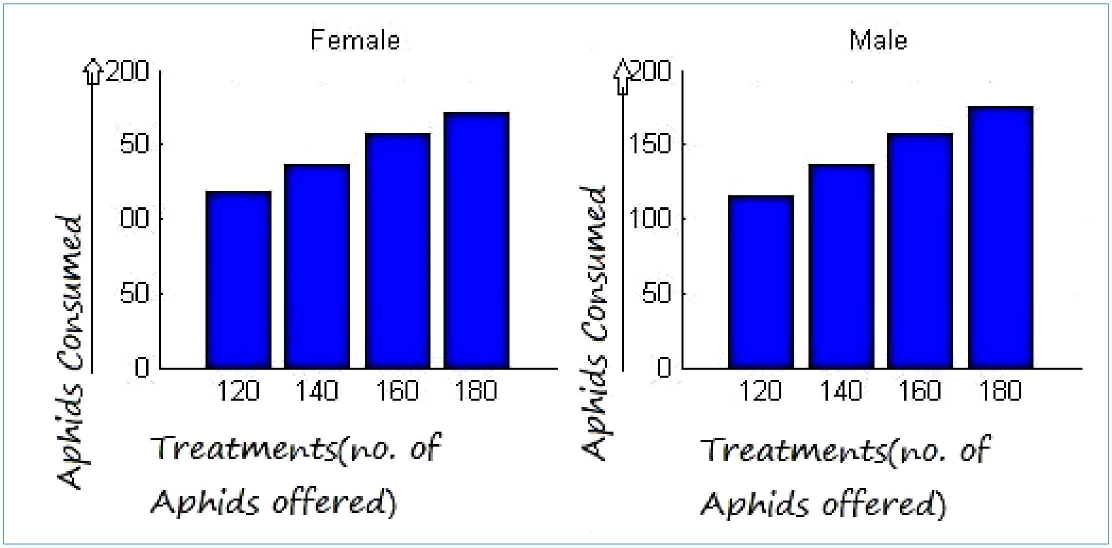

Figure 8: Graph showing consumption of aphids by male and female C. *septempunctata*

Conclusion

On the basis of present study, it is concluded that C. *septempunctata* is the main predator of aphids and can be used as a biological control agent against aphid species. Aphid density greatly affected the feeding potential of this beetle. At higher density, predation was higher and at lower density the rate of predation was also observed low which reflects the good quality of the predator to feed more at higher prey density and less at lower prey density. This quality of predator not only allows the predators to survive at low prey density but also helps in reducing pest population at higher density which can prove to be an efficient management strategy for the control of aphid species in horticulture and cropland habitats.

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