Feeding Potential of Seven Spotted Ladybeetle, *Coccinella septumpunctata* (Linnaeus) on Mustard Aphid, *Lipaphis erysimi* (Kaltenbach) and Cotton Aphid, *Aphis gossypii* (Glover)

[*]Pushpendra K. Sharma and Prakash C. Joshi

[*]Department of Zoology, D.A.V. (P.G.) College, Dehradun-248001 (U.K.), India
Department of Zoology and Environment Science, Gurukul Kangri University, Hardwar249404,U.K., India
[*]**Corresponding author. E. mail** <pushp_phd@yahoo.com> Phone- +919410164962, 91-135-2743555

Abstract: Feeding potential of seven spotted ladybeetle, *Coccinella septumpunctata* (Linn) was studied under laboratory conditions on mustard aphid, *Lipaphis erysimi* (Kaltenbach) and cotton aphid, *Aphis gossypii* (Glover). *C. septumpunctata* showed high feeding performance on mustard aphids *L. erysimi* than *A. gossypii*. The fourth instar larvae of *C. septumpunctata* consumed the highest number of aphids of *L. erysimi* and the hourly consumption was 6.50±0.80, 6.10±0.73 and 6.40±0.96 for first, second and third hours, respectively in unstarved condition, while in starved condition the hourly consumption was 11.20±0.91, 8.30±0.94 and 8.00±1.05 for first, second and third hours, respectively. The hourly consumption of fourth instar larvae *C. septumpunctata* on aphid, *A. gossypii* was 2.60±0.69, 2.20±0.78 and 2.00±0.66 for first, second and third hours, respectively in unstarved condition, while in starved condition, the hourly consumption was 3.30±0.67, 2.70±0.67 and 2.30±0.67 for first, second and third hours, respectively.

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1. Introduction

The family Coccinellidae comprises 5,200 described species worldwide (Hawkeswood, 1987). Joshi and Sharma (2008) have reported 31 species of Ladybeetles with 19 new records from district Haridwar, India. Recently, Sharma and Joshi (2010) have also reported 25 species of Ladybeetles with 14 new records from district Dehradun, India. In all study, it was observed that seven spotted ladybeetle *C. septumpunctata* is a dominant species in almost all ecosystems and is cosmopolitan in distribution.

Aphids are very serious insect pests in agriculture everywhere in the world (Minks and Harrewijn, 1987). Most aphids are extremely host specific, feeding on one or a few plant species that are usually closely related. However, some of aphids occurred in greenhouses are polyphagous, e.g., green peach aphid, *Myzus persicae* (Sulzer) and the cotton aphid, *Aphis gossypii* (Glover). The cotton aphid, *A. gossypii* Glover, is a serious pest of the cucumber, *Cucumis sativus* L., a greenhouse in Japan (Matsuzaki, 1974; Nozato, 1993). The mustard aphid, *Lipaphis erysimi* (Kaltenbach) is a major pest of *Brassica campestris* and *Brassica juncea* (Ghosh, 1975). These aphid species can cause serious problems on vegetable crops even at low densities, since they can transmit plant viruses among phylogenetically desperate host plants. Therefore, it is necessary to find new control measures for the aphid management programme. The natural enemies once established in the ecosystem are self powered, self sufficient and self regulating, requiring no further investments in control (Pimental, 1991). These beetles are of extremely diverse habits. The majority of beetles are useful because of their predaceous nature; but some are harmful, being polyphagous. The other coccinellids are predators of a variety of pests viz., aphids, leaf-hoppers, scale insects, mealybugs, mites and other softbodied insects (Omkar and Bind, 1996; Joshi and Sharma, 2008; Sharma and Joshi 2010).

The introduction of the vedalia ladybird, *Rodolia cardinalis* Mulsant from Australia into California in 1888 to control cottony cushion scale, *Icerya purchasi*, which threatened the citrus industry, is widely regarded the most successful instance of biological pest control by coccinellids (Majerus, 1994). The classification of coccinellids is still partially artificial and thus discussing the food specialization of whole tribes cannot but have its limitation. Predaceous coccinellids have a wide range of accepted food. The larvae prey on the same prey as the adults. Hence, it is the adults, which select a certain type of food for the larvae, while laying their eggs. Because, larvae can also play an important role in biological control of pests, therefore experiments were designed for feeding behaviour of larvae and adults of seven spotted ladybeetle, *C. septumpunctata* (Linn) on mustard aphid, *L. erysimi* (Kaltenbach) and cotton aphid, *A. gossypii* (Glover).

2. Materials and Methods

The study was carried out in the Entomology laboratory of the Department of Zoology and Environmental Science, Gurukul Kangri University, Haridwar, India during 2006-07. Feeding potential of adults and instars of grubs of seven spotted ladybird beetle *C. septumpunctata* was studied in two different sets viz., starved and unstarved under room temperature with ten replications completely. Both species of aphids were reared in the laboratory on the mustard and cotton plants.

The experiment was carried in Petri dishes (15x2 cm) having moistened filter paper at the bottom to the avoid desiccation and for maintaining optimum humidity. Twenty five freshly collected aphids viz., *L. erysimi* and *A. gossypii* were placed on fresh and tender mustard and cotton leaves, respectively, which were then placed over the filter paper. The aphids were then allowed to settle. Different instars of grubs and adults were starved for 2 hours except first instar grubs. Single starved and unstarved grub/ adult was released inside each Petri dish with the help of hair brush. The experiment was run for 3 hours. The hourly consumption of instars of larvae and adult of *C. septumpunctata* were calculated. Thereafter, the number of unconsumed aphids left over in the Petri dishes were collected hourly and calculated for consumed ones. The actual number of aphids consumed by grubs/adult was obtained by subtracting the number of aphids left over from the total number of aphids supplied in each hour for 3hours.

3. Results and Discussion

Feeding potential of different stages of *C. septumpunctata* on two different aphids species were studied under unstarved and starved conditions, separately.

(i) Feeding performance of *C. septumpunctata* (Linn.) on mustard aphid *L. erysimi* (Kalt.)

(a) Feeding potential of *C. septumpunctata* during 3h in unstarved condition: In unstarved conditions, the first instar larvae consumed 2.60±0.96 aphids in the first hour, while during the second and third hours the consumption was only 1.70±0.67 and 1.70±0.82. The second instar larvae consumed 4.60±0.84 aphids in the first hour, while during the second and third hours the consumption was only 4.40±0.69 and 3.50±0.97. The third instar larvae consumed 5.10±0.87, 4.50±0.97, 4.10±0.87 aphids in the first, second and third hour, respectively. The fourth instar larvae consumed the highest number of aphids and the hourly consumption was 6.50±0.80, 6.10±0.73 and 6.40±0.96 for first, second and third hours, respectively. The hourly consumption of adults of *C. septumpunctata* was 6.20±0.78, 5.90±0.87 and 6.00±0.66 for first, second and third hours, respectively (Table-1).

(b) Feeding potential of *C. septumpunctata* during 3h after 2h of starvation: In starved conditions, the first instar larvae consumed 2.80±0.78 aphids in the first hour, while during the second and third hours the consumption was only 2.60±0.69 and 2.50±0.70. The second instar larvae consumed 5.10±0.73 aphids in the first hour, while during the second and third hours, the consumption was only 4.80±1.13 and 4.30±0.94. The third instar larvae consumed 6.20±0.78, 6.20±1.03 and 5.50±0.92 aphids in the first, second and third hour, respectively. The fourth instar larvae consumed the highest number of aphids and the hourly consumption was 11.20±0.91, 8.30±0.94 and 8.00±1.05 for first, second and third hours, respectively. The hourly consumption of adults of *C. septumpunctata* was 9.20±0.78, 8.50±0.97 and 8.22±1.22 for first, second and third hours, respectively (Table-1).

(ii) Feeding performance of *C. septumpunctata* (L.) on cotton aphid *A. gossypii* Glover

(a) Feeding potential of *C. septumpunctata* during 3h in unstarved condition: In unstarved conditions, the first instar larvae consumed 1.40±0.69 aphids in the first hour, while during the second and third hours, the consumption was only 1.30±0.48 and 1.00±0.66, respectively. The second instar larvae consumed 1.60±0.51 aphids in the first hour, while during the second and third hours, the consumption was only 1.20±0.63 and 1.10±0.56. The third instar larvae consumed 2.00±0.66, 1.70±0.67, 1.20±0.63 aphids in the first, second and third hour, respectively. The fourth instar larvae consumed the highest number of aphids and the hourly consumption was 2.60±0.69, 2.20±0.78 and 2.00±0.66 for first, second and third hours, respectively. The hourly consumption of adults of *C. septumpunctata* was 2.50±0.70, 2.10±0.73 and 1.80±0.78 for first, second and third hours, respectively (Table-2).

(b) Feeding potential of *C. septumpunctata* during 3h after 2h of starvation: In starved conditions, the first instar larvae consumed 1.60±0.51 aphids in the first hour, while during the second and third hours, the consumption was only 1.40±0.51 and 1.10±0.56. The second instar larvae consumed 2.00±0.47 aphids in the first hour, while during the second and third hours, the consumption was only 1.50±0.52 and 1.30±0.48. The third instar larvae consumed 2.40±0.69, 1.90±0.56 and 1.50±0.70 aphids in the first, second and third hours, respectively. The fourth instar larvae consumed the highest number of aphids

and the hourly consumption was 3.30±0.67, 2.70±0.67 and 2.30±0.67 for first, second and third hours, respectively. The hourly consumption of adults of *C. septumpunctata* was 3.10±0.73, 2.60±0.69 and 2.10±0.56 for first, second and third hours, respectively (Table-2).

Table 1. Feeding potential of different stages of *C. septumpunctata* on *Lipaphis erysimi* under two different conditions.

Stage	*Average number of aphids consumed per insect at indicated hrs. ±S.D.			Mean±S.D.
	1hr	2hr	3hr	
Unstarved conditions				
Grub Ist instar	2.60±0.96	1.70±0.67	1.70±0.82	2.00±0.51
Grub IInd instar	4.60±0.84	4.40±0.69	3.50±0.97	4.16±0.58
Grub IIIrd instar	5.10±0.87	4.50±0.97	4.10±0.87	4.56±0.50
Grub IVth instar	6.50±0.80	6.10±0.73	6.40±0.96	6.33±0.16
Adult	6.20±0.78	5.90±0.87	6.00±0.66	6.03±0.12
Starved conditions				
Grub Ist instar	2.80±0.78	2.60±0.69	2.50±0.70	2.63±0.15
Grub IInd instar	5.10±0.73	4.80±1.13	4.30±0.94	4.73±0.40
Grub IIIrd instar	6.20±0.78	6.20±1.03	5.50±0.92	5.96±0.40
Grub IVth instar	11.20±0.91	8.30±0.94	8.00±1.05	9.16±1.76
Adult	9.20±0.78	8.50±0.97	8.22±1.22	8.64±0.50

*Average of ten observations (n =10).

Table 2. Feeding potential of different stages of *C. septumpunctata* on *Aphis gossypii* under two different conditions.

Stage	*Average number of aphids consumed per insect at indicated hrs. ±S.D.			Mean±S.D.
	1hr	2hr	3hr	
Unstarved conditions				
Grub Ist instar	1.40±0.69	1.30±0.48	1.00±0.66	1.23±0.20
Grub IInd instar	1.60±0.51	1.20±0.63	1.10±0.56	1.30±0.26
Grub IIIrd instar	2.00±0.66	1.70±0.67	1.20±0.63	1.63±0.40
Grub IVth instar	2.60±0.69	2.20±0.78	2.00±0.66	2.26±0.30
Adult	2.50±0.70	2.10±0.73	1.80±0.78	2.13±0.35
Starved conditions				
Grub Ist instar	1.60±0.51	1.40±0.51	1.10±0.56	1.36±0.25
Grub IInd instar	2.00±0.47	1.50±0.52	1.30±0.48	1.60±0.36
Grub IIIrd instar	2.40±0.69	1.90±0.56	1.50±0.70	1.93±0.45
Grub IVth instar	3.30±0.67	2.70±0.67	2.30±0.67	2.76±0.50
Adult	3.10±0.73	2.60±0.69	2.10±0.56	2.60±0.50

*Average of ten observations

The results reveal that both grubs and adults of *C. septumpunctata* consumed varying number of aphids at different exposure hours. The data presented in Table 1 & 2 revealed that both grubs and adults of the predator *C. septumpunctata* showed greater preference for *L. erysimi* than *A. gossypii*. It was observed that the number of *L. erysimi* consumed by all the grubs instars and adults of *C. septumpunctata* was higher than the number of *A. gossypii*. The results indicate that the fourth instars of *C. septumpunctata* consumed more number of aphids than adults. *C. septumpunctata* showed high feeding performance on mustard aphids *L. erysimi*. The results also indicate that the starved grubs and adults consumed more number of aphids than unstarved or wellfed grubs and adults. Malik *et al*., (1998) observed that *C. septumpunctata* could consume the greatest number of *L. erysimi* followed by *M. sexmaculatus*, *C. repanda* and *C. transversalis*. Kumari and Singh (1999) studied the feeding potential of *C. septumpunctata* var *divaricata* on *L. erysimi* during February and March of 1996 and observed that a grub consumed 116.61 and 141 aphids per individual and adult consumed 518 and 636 aphids per individual during the months of February and March, respectively. Das and Sagar

(2001) observed that *C. septumpunctata* consumed maximum number of *A. craccivora* (39.75±5.22 aphids / adult / day) followed by *M. sexmaculatus* (31.30±3.48 aphids / adult / day) and *C. repanda* (26.97 ± 4.52 aphids/ adult / day). The starvation of *C. septumpunctata* increased the feeding potential of grubs and adults on *L. erysimi* (Pandey, 2002).

Similar observations about the feeding capacity of *C. septumpunctata* were recorded by Saxena *et al*., (1970), Verma and Choudhuri (1975), Srivastava *et al.*, (1978), Sinha *et al.*, (1982), Gupta and Yadav (1985), Mani and Krishnamoorthy (1999), Agarwala and Ghosh (1988) and Pandey & Khan (2002) who have reported that generally grubs consumed more aphids than adults. George (2000) reported that the beetle *C. transversalis* consumed the greatest number of *A. gossypii* followed by *A. nerii* and *Peatalonia* sp. Omkar and Pervez (2004) have also reported that predatory stages of *Propylea dissecta* exhibit Holling's type II functional response with fourth instar being most efficient in detecting and consuming aphid prey *Aphis gossypii*. These results are further in conformity with the previous studies of Jandial and Malik (2006).

The results of present study show that *C. septumpunctata* is able to keep aphid population below economic threshold and starved grubs and adults play potentially important role. Fourth instars consumed more number of aphids than adults. These results support the findings of Karnatak and Thorat (2006) that starved adult of *C. septumpunctata* consumed more aphids than unstarved or well fed ones and also those of Gour and Pareek (2003) that fourth instar of this ladybird consumed highest number of aphids.

It may further be concluded from the above details that 4th instar grubs are more useful than other instars in control programme as they consume maximum number of aphids. It is evident that *C. septumpunctata* is a better biocontrol agent of mustard and cotton aphid. Further, the predators starved for 2 h before release could be effective in increasing feeding potential of all the stages of ladybird under field conditions. The present investigation may be supportive in the identification of an efficient predator for its utilization as one of the important and eco-friendly tools for the management of aphid pests in IPM.

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Corresponding Author
Dr. Pushpendra K. Sharma
M.Sc., NET, M.Phil., Ph.D.
Assistant Professor
Department of Zoology,
D.A.V. (P.G.) College, Dehradun
Uttarakhand- 248001, India
E. mail <pushp_phd@yahoo.com

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