Findings on pray consumption and best preferred pray for a coccinallid *Coccinella transversalis* fab. (Coleoptera: Coccinellidae) on different species of aphids (Aphididae: Homoptera)

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***Abstract*: Aphids are small sap-sucking insects, and *Coccinella transversalis* is a small beneficial insect, used as biocontrol. They are economically important for agriculture. It plays a very important role in the place of insecticides, by feeding aphids. To study the total prey consumption by the adult male and female ladybeetle in their lifetime, experiments were conducted to observe the consumption of *C. transversalis* in different life stages of aphid species. The prey consumption by the first larval instar of *C. transversalis* on the different aphids species was statistically significant (F=79.52; P<0.001). By second instar larva was also statistically significant (F=112.11; P< 0.001). By third larval instar in their lifetime was statistically significant (F= 108.05; P< 0.001) for all the species, and fourth larval instar in their lifetime was significantly different (F= 205.47; P<0.001) for all the prey species. Total larval consumption of the different aphid species was significantly different (F= 375.37; P<0.001). The consumption by adult male *C. transversalis* in their lifetime was significantly different (F= 285.04; P<0.001). The lifetime prey consumption of female *C. transversalis* was significantly different for all the prey species (F=368.30; P<0.001). Thus, it is clear from the results that the prey consumption of *C. transversalis* increased with the increase in predatory stages, and the consumption of prey, *A. gossypii* was the maximum in all the predatory stages, whereas the consumption of *A. nerii* was the minimum.**

Keywords*: Feeding efficiency, Beetle, *Lipaphis erysimi, Coccinella transversalis, A. gossypii

INTRODUCTION

The aphids are small insects, which are most notorious among several other pests, owing to their tremendous damaging potential. Several economically important agricultural and vegetable crops are severely destroyed by them. Numerous species of coccinellids are predatory against Hemipteran insect pests such as aphids, mealy bugs and scale insects, as well as thrips (Thysonoptera) and mites (Acarina) in all parts of the world, (Majerus, 1994). The aphids also act as vectors for numerous plant viruses. Chemical control method are largely effective and provide quick relief from majority of aphids, but at the same time cause several adverse effects such as killing non-targeted species, bioaccumulation and health hazard to humans and cattles . The application of biocontrol is considered to be the most efficient and target specific, as the natural enemies subsist in the nature as and after the persistence of the pest. Majority of ladybirds (Coleoptera: Coccinellidae) are generalist predators of aphids, amongst them *Coccinella transvesalis* feed on many species of aphids. (Mani M. 1995).. The important features of C. transversalis includes its wide geographic distribution and host range, tolerance to certain pesticides, enhanced searching ability, voracious larval feeding capacity and easy rearing in laboratory makes it potential predators against aphids. Debaraj et al. (1989). It is suggested that because aphids are generally abundant and palatable, ladybirds prefer to consume them and so behave as biocontrol agents (Hodek et al., 2012).

MATERIALS AND METHODS

Methods to study the prey consumption by the different feeding life stages of *C.transversalis* in relation to different aphid preys

The method of Singh and Malhotra (1979) was followed to study the prey consumption by the different feeding life stages of *C. transversalis*, such as, first, second, third and fourth larval instars and adult male and female ladybeetle on different aphid preys, *viz. A. gossypii, A. craccivora, L. erysimi, M. persicae, U. compositae,* and *A. nerii*. For this purpose, the eggs were taken out from the laboratory reared culture and after the hatching the different stages were kept into glass tubes (height 7.5 x diameter 5.0 cm) along with their host plant twig and the open end of the tubes was covered by fine muslin cloth with the help of rubber bands. According to the feeding potential of different mobile life stages, the experiment was designed in three ways:

Prey Consumption by first and second larval instars

To record the total consumption by first and second larval instars, the experiments were performed in glass tubes (height 7.5 x diameter 5.0 cm). One hundred aphid nymphs along with their respective host plant twigs were kept in glass tubes. The newly hatched first instar/second instar larvae were placed gently in each tube near the prey. The open end of the tubes was covered by fine muslin cloth with the help of rubber bands. After twenty four hours the unconsumed aphids were removed from the glass tubes and counted to calculate the number of consumed aphids. Again one hundred fresh aphids were added in the beaker. The experiments were continued till the completion of first/second larval instars. The experiments were replicated ten times. The data obtained were subjected to analysis of variance (One way ANOVA) using personal computer with statistix 4.1 (1985, 1994) software.

Prey Consumption by third and fourth larval instars

To study the total prey consumption by third/fourth larval instar, four hundred aphids of different species, *viz. A. gossypii, A. craccivora, L. erysimi, M. persicae, U. compositae,* and *A. nerii* were kept in the separate glass beakers (height 11.0cm x diameter 8.5 cm) along with host plant leaves and a single newly moulted third instar/newly moulted fourth instar was gently introduced in each beaker with the help of camel hair-brush (zero number). The open ends of the beakers were covered by fine muslin cloth with the help of rubber bands. After twenty four hours, the unconsumed aphids were removed from the beaker and counted to calculate the number of consumed ones. Again four hundred fresh aphids were added in the beaker. The experiment was continued till the next ecdysis of third larval instar /pupation of fourth larval instar occurred. The experiment was performed in ten replicates. The data obtained were subjected to analysis of variance (One way ANOVA) using personal computer with statistix 4.1 (1985, 1994) software.

Prey Consumption by the adult male and female

To study the total prey consumption by the adult male and female ladybeetle in their lifetime, two hundred aphids of six different species were kept in separate glass beakers (height 11.0cm x diameter 8.5cm) along with host plant twig and one newly emerged male/ female was gently introduced in each beaker with the help of camel hair-brush (zero number). The open ends of the beakers were covered by fine muslin cloth with the help of rubber bands. After twenty four hours, the unconsumed aphids were removed from the beaker and counted to calculate the number of consumed aphids. Again two hundred fresh aphids were added in the beaker. The experiment was continued till the death of adults. The experiment was performed in ten replicates. The data obtained were subjected to analysis of variance (One way ANOVA) using personal computer with statistix 4.1 (1985, 1994) software.

Table-1: Prey consumption by different life stages of *C. transversalis* in their lifetime in relation to different aphid species.

Aphid species	First larval Instar	Second larval Instar	Third larval Instar	Fourth larval Instar	Total larval consumption	Adult male	Adult Female
A. gossypii	31.80± 0.68	63.60± 1.08	166.50± 2.75	403.40± 3.41	665.30±5.75	4831.10± 123.54	5412.30± 94.51
A. craccivora	26.40± 0.78	58.40± 0.93	153.30± 1.76	388.30± 2.54	626.40±3.53	3883.70± 81.95	4494.00±140.14
L. erysimi	22.10± 1.29	52.60± 1.19	137.40± 1.43	360.60±2.43	572.70± 2.99	3068.70±130.50	3587.80± 61.49
M. persicae	17.60± 0.67	43.90± 1.22	131.00±1.50	337.70± 2.69	530.20± 3.05	2161.40± 61.93	2620.70± 81.27
U. compositae	15.40± 0.58	39.30± 1.43	125.80± 2.09	315.20± 2.32	495.70± 4.99	1435.70± 72.79	1689.70± 61.19
A .nerii	13.50± 0.45	32.00± 0.90	109.60± 1.92	274.70± 3.30	434.80± 4.03	802.80± 34.37	905.20± 52.48
F-value	**79.52***	**112.11***	**108.05***	**205.47***	**375.37***	**285.04***	**368.30***

Values are mean±S.E. * Significant at P<0.001.

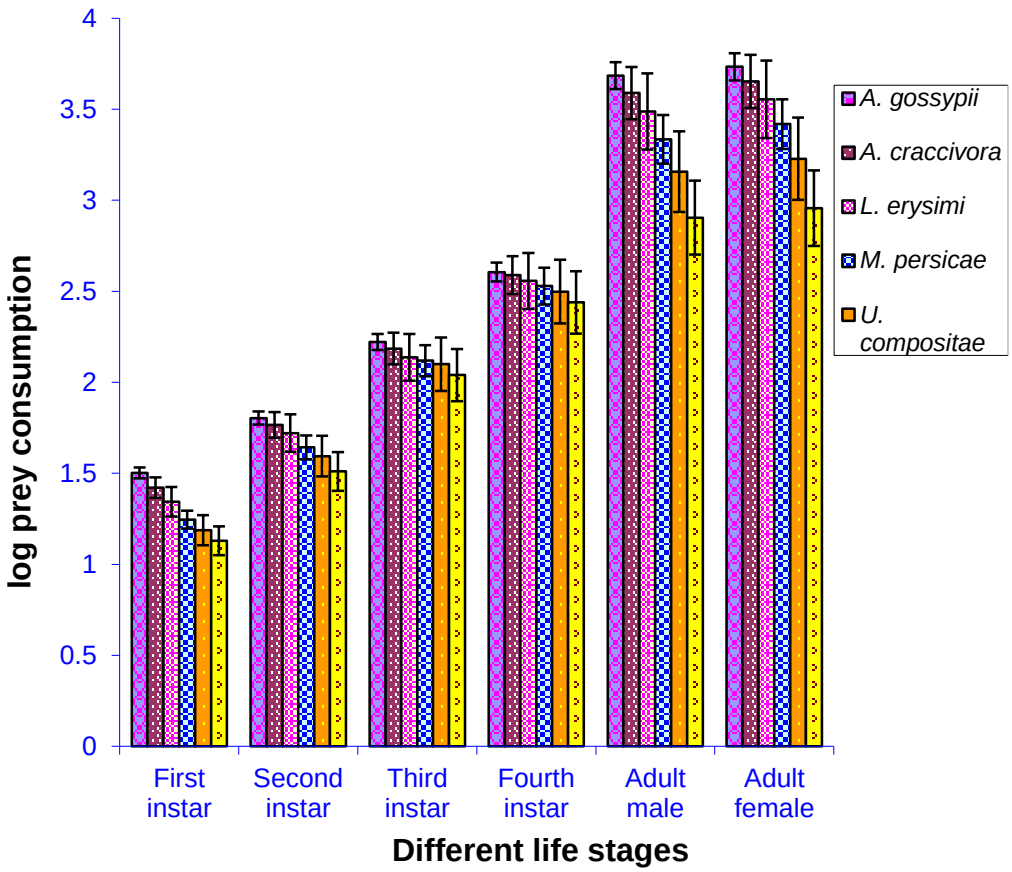

Figure 1: Life time log prey consumption by different life stages of C. transversalis

RESULTS

The data on prey consumption by different life stages of *C. transversalis* in their lifetime on different aphid species is presented in Table-15 and Figure-10 (Plate-V). The prey consumption by the first larval instar of *C. transversalis* was 31.80±0.68, 26.40±0.78, 22.10±1.29, 17.60±0.67, 15.40±0.58 and 13.50±0.45 individuals of *A. gossypii, A. craccivora, L. erysimi, M. persicae, U. compositae* and *A. nerii*, respectively. The analysis of variance revealed that mean consumption of first instar larva on different aphids species was statistically significant (F=79.52; P<0.001).

The prey consumption by second instar larva was 63.60±1.08, 58.40±0.93, 52.60±1.19, 43.90±1.22, 39.30±1.43 and 32.00±0.90 individuals of aphids, *A. gossypii, A. craccivora, L. erysimi, M. persicae, U. compositae* and *A. nerii*, respectively. ANOVA showed that the consumption by second larval instar was statistically significant (F=112.11; P< 0.001).

The third larval instar of *C. transversalis* consumed 166.50±2.75, 153.30±1.76, 137.40±1.43, 131.00±1.50, 125.80±2.09 and 109.60±1.92 individuals of *A. gossypii, A. craccivora, L. erysimi, M. persicae, U. compositae* and *A. nerii*, respectively. The prey consumption by third larval instar in their lifetime was statistically significant (F= 108.05; P< 0.001) for all the six prey species.

The fourth larval instar of *C. transversalis* consumed 403.40±3.41, 388.30±2.54, 360.60±2.43, 337.70±2.69, 315.20±2.32 and 274.70±3.30 individuals of *A. gossypii, A. craccivora, L. erysimi, M. persicae, U. compositae* and *A. nerii*, respectively. The prey consumption of fourth larval instar in their lifetime was significantly different (F= 205.47; P<0.001) for all the six prey species.

The total consumption during total larval period of C. *transversalis* was 665.30±5.75, 626.40±3.53, 572.70±2.99, 530.20±3.05, 495.70±4.99 and 434.80±4.03 individuals of *A. gossypii, A. craccivora, L. erysimi, M. persicae, U. compositae* and *A. nerii*, respectively. ANOVA revealed that total larval consumption on the different aphid species was significantly different (F= 375.37; P<0.001).

The consumption by adult male *C. transversalis* in their lifetime was 4831.10±123.54, 3883.70±81.95, 3068.70±130.50, 2161.40±61.93, 1435.70±72.79 and 802.80±*ae*34.37 individuals of *A. gossypii, A. craccivora, L. erysimi, M. persicae, U. composit* and *A. nerii*, respectively. The mean prey consumption by adult male *C. transversalis* for all the six aphid species was significantly different (F= 285.04; P<0.001).

The lifetime prey consumption of female *C. transversalis* was 5412.30±94.51, 4494.00±140.14, 3587.80±61.49, 2620.70±81.27, 1689.70±61.19 and 905.20±52.48 individuals of *A. gossypii, A. craccivora, L. erysimi, M. persicae, U. compositae* and *A. nerii*, respectively. The mean consumption during the life span of female on different aphid species was significantly different for all the six prey species (F=368.30; P<0.001).

Thus, it is clear from the results that the prey consumption of *C. transversalis* increased with the increase in predatory stages and the consumption of prey, *A. gossypii* was the maximum by all the predatory stages, whereas the consumption of *A. nerii* was the minimum.

DISCUSSION

Radke *et al.* (1977) found that larvae of *C. septempunctata* consumed 5.89, 11.22, 15.74, 18.22, and 19.44 aphids/days at the age of 1-5 days, and 40.25, 40.66, 40.16, and 32.50 aphids/day at age of 6 to 9 days, respectively. The adult beetle consumed 6.67, 13.44, 15.67, 16.89, and 17.22 aphids/day from first to fifth day and 41.50, 42.08, 43.40, and 30.25 aphids from sixth to ninth day, respectively. Srivastava *et al.* (1978) found that aphid *Hyadaphis erysimi* was the most preferred prey and *Dactynotus carthami* the least preferred prey of *C. septempunctata* amongst nine aphid species. The order of preference was *H. erysimi, B. coriandri, R. maidis, Aphis pisum, A. gossypii, Macrosiphum euphorbiae, B. brassice, A. craccivora*, and *D. carthami.* The grubs consumed more aphids than its adults. Singh and Malhotra (1979) found that an individual larva of *C. septempunctata* consumed 284.6 aphids during its larval duration and an adult consumed 95 aphids per day.

Buntin and Tamaki (1980) observed that the larvae of *Scymnus marginicollis* consumed 16 individuals of aphid, *M. persicae* before the pupation and the male and female ladybeetles consumed 5 aphids per day. Ellioff and Little (1980) observed that the larvae of ladybeetles, *Cleobora mellyi* and *Harmonia conformis* consumed on an average 261.15 and 212.20 eggs of *C. maculata*, respectively, during their life time. McLean (1980) evaluated that the male *C. septempunctata* consumed 57.50 percent of the total aphids consumed by the female. Srivastava *et al.* (1982) found that the adults of *C. transversalis* consumed 70, 55.33, 36.09, 62.33, 75.66, 52.00, 42.66 and 34.66 and the larvae consumed 75.66, 61.33, 38.66, 67.66, 81.00, 50.00, 42.33 and 36.00 individuals aphid species *viz. H. erysimi, A. craccivora, D. carthami, M. persicae, A. gossypii, R. maidis, B. brassicae* and *M. pisi*, respectively, during larval development. Anand (1983) found that *L. erysimi* was the most preferred food and *A. gossypii* the least for the *C. septempunctata* and *C. sexmaculata* amongst five aphid species, *viz. L. erysimi, B. brassicae, A. craccivora, M. pisum* and *A. gossypii*.

Palacio (1983) observed that *Scymnus sp*. consumed on an average 49.90 scales during its larval period of 8.90 days, whereas *Pseudoscymnus* sp. preyed on an average 39.50 scales in 8.08 days of larval period. Patel and Vyas (1984) recorded the prey consumption by larvae of *C. sexmaculata* to be an average 474 individuals of A. *craccivora* during the six days of larval period. Hsieh *et al.* (1985) recorded that the larvae of *C. sexmaculata* consumed an average of 74.70 individuals of *M. persicae* and 304.40 mulberry psyllids. Verma *et al.* (1985) investigated that first instar larvae of *C. sexmaculata* have no particular preference for aphid species, while second instar larva preferred *A. craccivora*, third and fourth instar larvae preferred *A. craccivora* and *A. gossypii* and the adult preferred *A. craccivora* and *A. gossypii.*

Yang (1985) observed the larvae of *H. axyridis* devoured 600 to 1180 aphids during its larval period. Agarwala and Saha (1986) observed that the larvae of coccinellids, *viz. C. septempunctata, C. transversalis, C. sexmaculata, Scymnus pyrocheilus* and *M. discolor* consumed an average of 761.20, 551.96, 217.40, 194.80 and 251.00 individuals of *A. gossypii* during their larval time, respectively. Agarwala *et al.* (1988) observed that the larva of *M. discolor* consumed 35.77 aphids of *A. craccivora* daily. Ofuya (1986) observed the daily prey consumption by first instar larva of *C. vicina* was 22.3, 20.8, 15.4, 10.3 and 5.3, by fourth instar larva was 89.1, 88.3, 62.6, 53.8 and 34.5, by adult male was 92.7, 90.4, 63.9, 56.2 and 41.6 and by adult female was 95.8, 94.2, 72.5, 63.7 and 47.4 individuals of first, second, third, fourth instars and female of the prey, *A. craccivora*, respectively.

Pa-nan-Ngammuang (1987) found that larval instars and the adult of *M. discolor* consumed 21.80±3.29, 41.90±7.78, 66.25±20.13, 122.15± 25.22 and 1295±605.69 individuals of *A. craccivora, M. persicae* and *L. erysimi*. Of these species, *A. craccivora* was most suitable prey. Babu and Azam (1987) found that the daily consumption of *C. montrouzieri* larvae on *M. hirsutus* was more at 30°C than at 20°C, but over all consumption was greater at the lower temperature due to the extended larval duration. Bathon and Pietrzik (1987) observed that the larva of ladybeetle, *Clitothorus arcuatus* consumed 544 eggs of whitefly, *Aleurodes proletella* during its lifetime, while male and female consumed 27.40 and 60.70 eggs per day, respectively.

Rhamhalinghan (1987) studied the difference in the feeding potential of different forms of *C. septempunctata* at different temperatures and found that the virgin males and females consumed more aphids than the reproducing ones. Nathapol and Pensook (1988) recorded that first, second; third, fourth instar larvae and adult male *C. sexmaculata* consumed 8.35, 20.60, 36.05, 44.65 and 1012.7 individuals of aphid, *Aphis glycines*, respectively. The predation capacity of different larval stages and female was 9.3, 22.25, 36.15, 48.25 and 1106.9 aphids, respectively. Yan (1988) recorded that the adult of *C. septempunctata, P. japonica, H. variegata* and *H. axyridis* daily consumed 1954, 64, 78 and 90-287 individuals of *A. gossypii*, respectively. Gupta and Yadav (1989) found that the adults of *C. sexmaculata, B. suturalis*, and *H. variegata* consumed an average of 30, 15 and 15 individuals of *M. persicae*, respectively. Malik *et al.* (1989) observed that *C. septempunctata* devoured daily 76.2, 44.3 and 56.6 aphids during December, January and February, respectively.

Debraj and Singh (1989) evaluated that first, second, third and fourth larval instars of *C. transversalis* consumed 35.5, 68.4, 131.6 and 288.5 individuals of aphid, *A. craccivora*, respectively. Debraj and Singh (1990) reported that single larva of *C. transversalis* consumed 526 individuals of *A. craccivora* during its lifetime. Lokhande and Mohan (1990) found that the larvae of *C. sexmaculata* consumed 8.50 adults and 73.52 nymphs of *A. craccivora*, whereas an adult beetle consumed 24.34 adults and 176.15 nymphs per day. Rahim (1990) recorded that *B. suturalis, C. sexmaculata, C. septempunctata* and *C. undecimpunctata* consumed 3.10, 3.78, 3.90 and 3.70 eggs of *Aintherigona socata* per day, respectively. Rehman (1990) observed that average feeding rate at the larval stage of *M. discolor* increased from 5.2 to 26.8 and of *Micraspis cerocea* increased from 4.8 to 22.2 aphids from first day to eighth day. The adult consumption of *M. discolor* and *M. cerocea* increased from 21.0 to 86.4 and 16.2 to 74.0 aphids, respectively, from first day to ninth day.

Das (1991) studied that *C. sexmaculata* consumed 9.0 to 13.0 individuals of *A. craccivora* on first day but from second day, the consumption gradually increased and reached to 53.05 aphids on eighth day. Rizvi *et al.* (1992) investigated the comparative predation by larvae and adults of *C. septempunctata* and concluded that fourth instar larvae were more voracious than the younger instars. Babu and Ananthakrishnan (1993) found that *C. sexmaculata* showed lower predatory efficiency than *C. transversalis* on *A. fabae, A. gossypii* and *A. nerii*, respectively. Kanika (1993) observed the feeding potential of larval stages and adults of ladybeetle, *Exochomus flaviventris* on *P. citri* and *P. manihoti* and found that in each case fourth instar larvae of the predator were

most voracious with 70% of the total consumption. Females feed lesser than the fourth instar larvae. Rahman (1993) observed that first instar larva of *Harmonia octomaculata* consumed 4.0 individuals of *A. gossypii* during 24 hours and this increased gradually up to ninth day followed by a marked decline on the tenth day due to its pupal initiation. Similarly, the adult consumed 20 aphids on the first day and the rate increased from ninth day onward. Singh and Deol (1993) noticed that the daily consumption of adult and larvae of *C. septempunctata* was 30.5 and 23.8 aphids per day, respectively.

Singh *et al.* (1993) found that the larva of ladybeetle *Oenopia quadripunctata* consumed 341 individuals of *Tuberculatus (=Acanthocallis) nervatus* during larval duration and concluded that fourth instar larva was relatively most voracious than other larval instars. Verma *et al.* (1993) found that the larvae of *C. sexmaculata* consumed 598.5±45.8 aphids during the larval period while adult male and female consumed 208.2±21.1 and 277.1±41.5 individuals of *A. gossypii* per day, respectively. Ali *et al.* (1994) found that third and fourth instars larvae of *C. septempunctata* were the most efficient than other predatory stages on aphid, *U. carthami*. Patro and Sontakke (1994) observed the daily prey consumption on *A. craccivora* by first, second, third, fourth instar larvae and adult of *C. transversalis* to be 11.4±1.6, 20.7±2.0, 29.2±1.4, 41.2±1.8 and 65.3±8.3 aphids, respectively. The larva consumed on average 22.1±13.4 aphids during the larval period. Singh and Singh (1994) observed that first to fourth instar larvae of *C. septempunctata* consumed an average of 22.78, 66.00, 172.50, and 333.11 individuals of *L. erysimi*, respectively and male and female beetle consumed 119.80 and 140.68 aphids per day. The larval instars of *H. variegata* consumed 21.83, 79.11, 162.55, and 243.01 aphids and adult male and female ladybeetles consumed 91.56 and 115.30 aphids per day, respectively.

Singh *et al.* (1994a) reported that adult *C. septempunctata* consumed 78-80 nymphs of *L. erysimi*, whereas the larvae consumed 56-57 nymphs and found that older larvae consumed more nymphs than the younger larvae. Singh *et al.* (1994) investigated that in *C. septempunctata* the prey consumption was 25.0, 37.5, 67.0, 100.0, and 78.5 aphids by first, second, third, fourth instar larvae and adult respectively at 18.35 to 20.90^{0}C temperature, whereas it was 22.0, 34.0, 66.5, 100.0 and 80.5 aphids at 21.60 to 23.60^{0}C, respectively. Chakrabarti *et al.* (1995) observed that larvae of *Harmonia eucharis* consumed an average of 668.86, 646.14 and 623.86 individuals of aphids, *Macrosiphoniella pseudoartimisiae, Brachycaudus helichrysi* and *Eriosoma lanigerum*, respectively, during their larval period at 23.70°C. Lapiz and Gopud (1995) found that first, second, third and fourth instar larvae of *Acarinus philippensis* consumed 1-5, 3-9, 6-10, 38-97 individuals of *A. gossypii*, respectively.

Padmaja *et al.* (1995) evaluated the consumption of eggs of mealy-bug by the adults and larvae of *Scymnus coccivora*, which was found to consume 864.4 and 314.2 eggs of mealy-bug respectively. Mora *et al.* (1995) found that first, second, third and fourth instar larvae of *Coelophora inaequalis* consumed 4.05±1.04, 8.45±2.4, 9.20±2.4 and 21.60±5.6 individuals *A. craccivora*, respectively on daily basis and from eclosion to death the male beetles consumed 2821-3509 aphids and female beetles consumed 2959-4779 aphids. Devi *et al.* (1996) found that *C. septempunctata* consumed 291.65 aphids during its larval period and an adult consumed 141.33 aphids per day.

Jagdish *et al.* (1996) reported that larvae of *C. septempunctata* and *C. transversalis* consumed 308 and 226 individuals of aphid *Hysteroneura setariae*, respectively, during their larval period. Jayaramaiah *et al.* (1996) found that first, second, third, fourth instar larvae and adults of *C. transversalis* consumed an average of 13.40, 37.86, 46.06, 141.60 and 49.09 aphids per day, respectively, while the life stages of *C. sexmaculata* consumed 21.86, 23.66, 34.66, 66.20 and 31.20 aphid per day, respectively, on the aphid, *Myzus nicotianae.* Akram *et al.* (1996) observed that the total lifetime consumption of *C. septempunctata* was 1203.56 individuals of cabbage aphid. Singh and Devi (1996) found the preference of aphid preys by the adults and larvae of *C. septempunctata* was *A. gossypii* > *A. craccivora* > *L. erysimi* > *B. brassicae*. Saraswati and Ghosh (1996) evaluated daily feeding potential of first, second, third, fourth instars and adult of *C. septempunctata* was 2.6, 3.6, 5.6, 8.6 and 18.4 individuals *of Rhopalosiphum nymphaeae*, respectively. Sharma *et al.* (1997) studied the feeding propensity of Ist, IInd, IIIrd, IVth larval instars, adult male and female individuals of *C. sexmaculata* and *C. septempunctata* on *L. erysimi* and found that *C. sexmaculata* consumed on an average 25.50, 76.40, 118.80, 167.40, 36.32 and 39.76 aphids, respectively, whereas life stages of *C. septempunctata* consumed on an average 45.0, 90.30, 176.4, 252.70, 62.24 and 69.42 aphids per day, respectively.

Debraj *et al.* (1997) observed that larvae of *C. septempunctata* and *C. sexmaculata* consumed 222.21±8.89 and 224.23±4.46 individuals of *B. brassicae*, respectively in their larval period of 15.28±0.14 and 13.26±0.33 days, respectively. Liu *et al.* (1997) found that male and female ladybeetle *Nephaphis oculatus* consumed daily 79 and 86 whitefly eggs respectively, and the first, second, third and fourth instar larvae consumed 16, 68,128 and 124 eggs per day, respectively. The total eggs consumed were 51, 132, 192 and 373 in each successive larval stage. Adult pair consumed 184.10 eggs per day over a period of 16 weeks. Lucas *et al.* (1997a) observed that the male of *H. axyridis* consumed 56 percent of the female consumption. Lucas *et al.* (1997b) found that the male *C. septempunctata* consumed 88.70 percent of female consumption.

Omkar *et al.* (1997) observed that adults of *C. septempunctata* consumed 40.20, 27.00, 47.60, 31.40, 10.83, 49.33, 49.00 and 67.50 individuals of aphid species, *A. craccivora, A. gossypii, U. compositae, L. erysimi, A. nerii, M. persicae, B. brassicae* and *H. coriandri*, respectively within three hours. Afroze and Shujauddin (1998) found that male and female ladybeetles of *Synia melanaria* consumed 40 and 44 nymphs of pentatomid bug, *Coptosoma ostensum* per day, respectively and total prey consumption in the lifetime of larva, adult male and female was 426, 4800 and 6600, respectively. Lakhanpal and Raj (1998) found that *C. septempunctata* devoured 72, 47 and 60 individuals of daily and 1435±12.01, 1021.05±8.16 and 628±3.42 individuals of *L. erysimi, B. brassicae* and *M. persicae*, respectively, during its lifetime. Babu (1999) observed that the *C. transversalis* preferred A. *fabae* than *A. nerii*. Joshi *et al.* (1999) found that the larvae *C. septempunctata, C. transversalis* and *C. sexmaculata* consumed 20.8 to 33.0, 20.0 to 39.0 and 20.1 to 38.5, and adult ladybeetles consumed 29.6 to 47.4, 31.0 to 47.7 and 33.1 to 49.6 individuals of *A. craccivora, A. gossypii, A. nerii, L. erysimi, R. maidis* and *U. compositae.*

Omkar *et al.* (1999) observed that adult *C. transversalis* consumed 61.25, 36.33, 31.20, 16.60, 6.40, 38.83, and 35.75 individuals of *A. craccivora, A. gossypii, U. compositae, L. erysimi, A. nerii, M. persicae* and *B. brassicae*, respectively within three hours.

George (1999) found that *C. transversalis* preferred *A. gossypii* the most (41.42) followed by *A. nerii* (38.48) and *Pentalonia* sp. (30.42).

Patro and Behera (2000) observed per day prey consumption of *A. craccivora* by first, second, third, fourth instar larvae and adult *M. discolor* was 9.0±0.9, 14.07±1.7, 28.2±2.9, 63.8±6.0 and 27.5±1.7 aphids, respectively under laboratory conditions. Zalavadia and Kapadia (2000) found that total larval consumption of *C. septempunctata* was 368.7, 315.7 and 256.1 and daily larval consumption was 84.9, 101.4 and 57.8 nymphs of *L. erysimi, H. coriandri* and *A. gossypii,* respectively. The adults consumed 70.7, 55.2 and 44.1 individuals of *L. erysimi, H. coriandri* and *A. gossypii*, respectively.

Omkar and Pervez (2000c) evaluated that adult *M. discolor* consumed 64.38±6.59, 54.50±6.07, 52.25±4.77, 47.75±4.06, 45.67±2.34, 42.67±6.06, 40.38±4.63, 39.00±1.79 individuals of *A. gossypii, A. craccivora, Melanaphis bambusae, L. erysimi, U. compositae, B. brassicae, R. maidis* and *M. persicae*, respectively, within 24 hours. Raj (2000) observed daily prey consumption of adult and larvae of *C. septempunctata* varied from 20 to 25 and 21 to 26 aphids, respectively. It varied from 9 to 15 and 9 to 11 in case of *C. sexmaculata*, respectively. Reddy *et al.* (2000) found that adults and larvae of *C. sexmaculata* consumed 25.12 to 33.46 and 45.08 to 57.45 individuals of *Macrosiphum rosae* per day and 201-263 and 1764-2454 aphids in their lifetime, respectively.

The consumption rate of fourth instar larvae was higher than that of the earlier instars on the three diets is possibly because they are larger, have a higher energy requirement (Ahlawat et al., 2008; Finlayson et al., 2010; Mishra et al., 2012) and store energy for future development and metamorphosis (Ferran & Larroque, 1977; Isikber & Copland, 2001). Omkar (2004) noticed that C. sexmaculata was feeding basis overall performance of ladybird the order of suitability of prey species was A. craccivora>A. gossypii>R. maidis > M. persicae > U. compositae > L. erysimi > A. nerii. Omkar et al., (2009) further reported that the performance of A. cardoni was preydependent and the order of suitability of the prey tested was A. gossypii > A. craccivora > L. erysimi. Sharma and Joshi (2010) recorded that C. septumpunctata high feeding performance on mustard aphids L. erysimi than A. gossypii. Similar findings were also reported by Omkar and Kumar (2013) in the management strategies of A. cordoni against mustard aphid. Muhammad et al., (2017) reported that C. septumpunctata consumed of pea aphid (77.64) was statistically high followed by spinach (66.27), coriander (66.14) and cabbage (61.48) aphids. Jesu et al. (2018) suggested that because of high prey consumption rate, *C. transversalis* may play a more effective role in controlling aphid *B. brassicae* and this predator may be used in biological pest control strategies with greater efficiency.

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