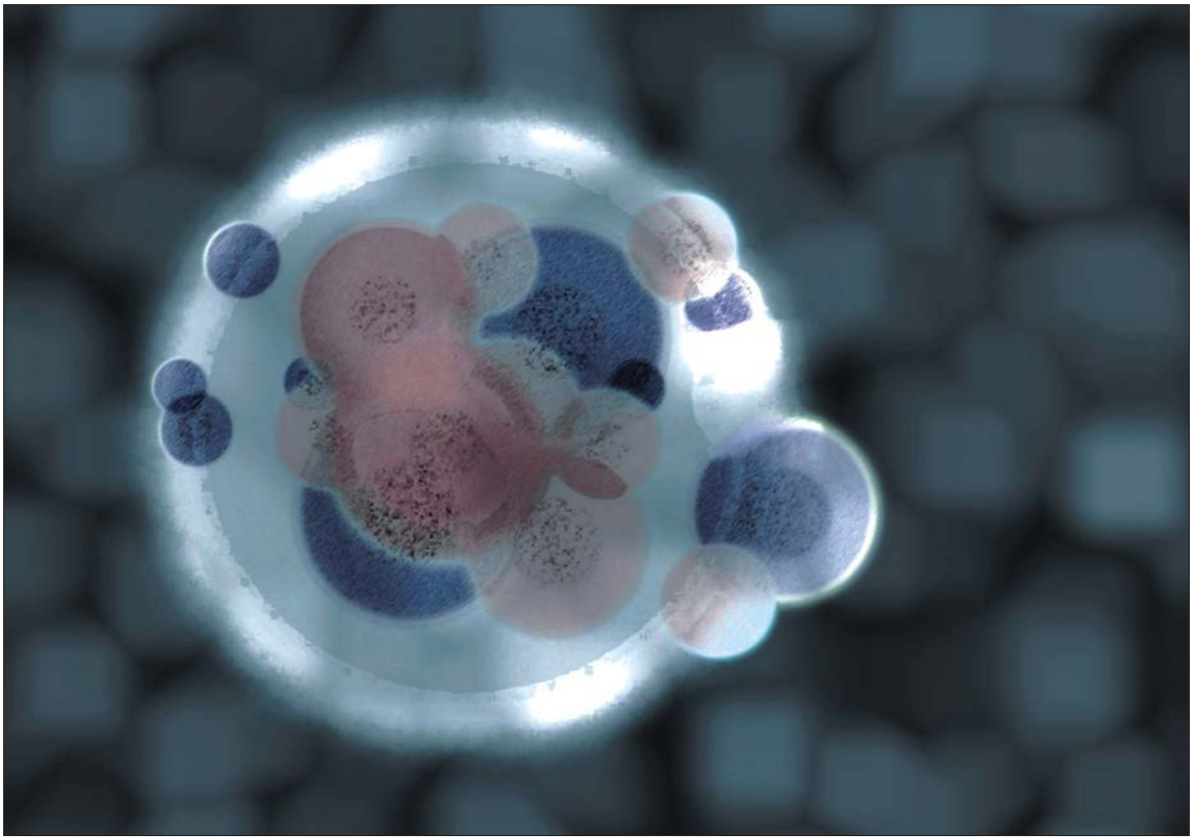

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Development and Predatory Performance of *Coccinella septempunctata* L. (Coleoptera: Coccinellidae) on Different Aphid Species

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Abstract: The performance of *Coccinella septempunctata* was investigated on five-aphid species viz., *Lipaphis erysimi*, *Aphis craccivora*, *Hyadaphis coriandri*, *Rhopalosiphum nymphae* and *Macrosiphum rosae* under controlled conditions (25±1°C, 70±5% RH and 12 h L: 12 h D). The overall developmental period of *C. septempunctata* was found significantly longer on *L. erysimi* and shorter on *M. rosae*. The grubs, however, required significantly longer developmental period on *H. coriandri* and shorter on *M. rosae*. Nonetheless, the adult longevity was higher on *L. erysimi* and shorter on *M. rosae*. Between the sexes, the female required longer period for its development than male with respect to all aphid species. With regard to predation, the grubs consumed maximum *H. coriandri*, whereas, adult preferred *L. erysimi*. The last larval stage (grub 4), irrespective of aphid species, devoured more aphids than the other grub stages. The predation by female of all aphid species was more as compared to male. The overall predation by *C. septempunctata* was significantly higher on *L. erysimi* than other species. A linear correlation curve showed the dependency of predation on the developmental period of *C. septempunctata*.

Key words: *Coccinella septempunctata*, predation, development, aphid

INTRODUCTION

Aphids are a diverse group of plant feeding insects belong to family Aphididae of order Hemiptera, predominantly found in temperate climate zones such as North America, Europe, Central and Eastern Asia (Nelson and Rosenheim, 2006). Approximately 4000 species of aphids have been described feeding over 250 agricultural and horticultural crops throughout the world. The eggs of aphids develop parthenogenetically within the mother (female body) and nymphs born after few days, hence, population density increases rapidly (Blackman and Eastop, 2000). In the early stage of infestation, adult have no wings but as they become crowded, winged forms appeared in subsequent generations for dispersal from one plant to another (Braendle *et al*., 2005). They are found primarily on the growing points of the host plants, including tips, flowers and developing pods and cover whole plant at high density (Blackman and Eastop, 2000). They cause damage directly by sucking cell sap, secrete honeydew resulting in development of sooty mould on leaves and shoots and indirectly as vectors of certain plant viruses (Kennedy *et al*., 1962; DiFonzo *et al*., 1997; Raboudi *et al*., 2002). Many insecticides have been recommended for its control but these are known to cause mortality of the beneficial organisms, residue problem, hazards to man and animals besides polluting the environment. On several occasions, insecticidal applications have accentuated the aphid population and quite often resulted in outbreaks (Orlandao *et al*., 1970). Therefore, use of natural enemies in biological control is a good pest management tactic to minimize the population level of invasive pests (Delfosse, 2005).

Ladybirds are generalized predator that feed on a diverse range of foods. Aphids are the principal food of ladybirds, whereas coccids, mites, honeydew, pollen, nectar and mildew are recorded as secondary foods (Bianchi *et al*., 2004; Deligeorgidis *et al*., 2005). Among ladybeetle group, seven spotted ladybird, *Coccinella septempunctata* is one of the potential predators of aphids in India (Pervez and Omkar, 2005). Both larvae (grubs) and adults of *C. septempunctata* feed on aphids. The development and potential feeding of coccinellids vary with their choice food and change with the environment condition. Therefore, present study was initiated to determine the development and predatory performance of *C. septempunctata* on five aphid species (*Lipaphis erysimi*, *Aphis craccivora*, *Hyadaphis coriandri*, *Rhopalosiphum nymphae* and *Macrosiphum rosae*) under controlled conditions. The information, so generated, will provide a preliminary step in exploitation of *C. septempunctata* in biological control of above mentioned aphids of economic significance.

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MATERIALS AND METHODS

Aphid cultures: To maintain the culture of different aphid species, various crops viz., Indian mustard (*Brassica juncea* L.), common bean (*Phaseolus vulgaris* L.), coriander (*Coriandrum sativum* L.) and ornamental plant, verbena (*Verbena laciniata*) were grown in the micro-plots sized 3×4 meter (each replicated thrice) in winter season of year 2005 and 2006 and five year old rose (*Rosa indica*) plants were maintained at experimental fields of the Department of Plant Protection, Faculty of Agricultural Sciences, Aligarh Muslim University, Aligarh, India. The infestation of aphid appeared naturally in the last week of December on indian mustard, coriander and rose plants, whereas, on common bean and verbena it appeared in the second week of January. They multiply parthenogenetically and their density increased rapidly on the growing points of plants. The aphid species collected from the respective crops were got identified from the Laboratory of Aphidology in the Department of Zoology, University of Kalyani, West Bengal. The aphid species, which attacked on indian mustard, common bean, coriander, verbena and rose plants were identified as: *Lipaphis erysimi*, *Aphis craccivora*, *Hyadaphis coriandri*, *Rhopalosiphum nymphae* and *Macrosiphum rosae*, respectively. For natural control of these aphid species, various ladybird species were also attributed with the aphid colonies on respective host plants. Of all the ladybird beetles, *Coccinella septempunctata* was predominantly predating all aphid species.

Ladybird cultures: The grubs and pupae of *Coccinella septempunctata* were collected from naturally infested field crops and kept in BOD incubator for adult emergence. The condition maintained in BOD incubator was 25±1°C temperature coupled with 70±5% relative humidity and the photoperiod of 12 h L: 12 h D.

Freshly emerged adult beetles were reared on respective aphid species in pairs in petridishes (90 mm diameter and 10 mm height). A blotting paper was spread over its inner surface for egg laying. The eggs laid by females were counted and transferred in other petridishes, with the help of soft camel hair brush, for hatching. After hatching, a total of twenty newly hatched (zero day old) grubs of predator species were reared individually in plastic vials (measuring 4.0 cm in diameter and 6.0 cm in height) on respective aphid species. Each experiment was replicated thrice. For newly born grubs, 30-40 nymphs of respective aphid species with the twig of respective plants were provided as food. The number of aphids was subsequently increased, reaching maximum up to 100 nymphs daily with advancement in the age of grubs. This procedure was followed till pupation. Side by side, the exuvae found in each of vials was removed when the grub entered into next instar. Total number of aphid consumed by each grub, dead and unconsumed aphids were counted daily and were replaced by fresh aphids. After the emergence of adult (male and female), they were again provided with a minimum of 100 aphid nymphs daily, till their death. In this way, daily consumption by grub, male and female of *C. septempunctata* on different aphid species was recorded. Sexing of adult was made as per suggestion of Sathe and Bhosale (2001).

Statistical analysis: Development and predation at different life stages of *C. septempunctata* was recorded with respect to aphid species. To determine statistical difference, ANOVA was computed and the mean values were compared using Duncan's multiple range test ($p \leq 0.05$). Correlation between developmental period and predation of *C. septempunctata* on different aphid species was also calculated.

RESULTS

Development: The developmental period of all immature stages of *C. septempunctata* fed with *H. coriandri* was significantly longer than those fed with *L. erysimi*, *R. nymphae*, *A. craccivora* and *M. rosae* (Fig. 1). However, the longevity of the adult (male and female) was significantly higher on *L. erysimi* and lower on *M. rosae*. The female required longer period for their development as compared to male with respect to all aphid species (Fig. 1).

The total developmental period of immature stages was statistically different among the aphid species. Both, total grub and total pupal period of *C. septempunctata* showed significantly high value (17.00±0.533 and 13.30±0.144 days) on *H. coriandri* against the low (15.70±0.186 and 9.40±0.153 days) on *M. rosae*, respectively. However, the overall developmental period was significantly longer (62.75±1.430 days/progeny) on *L. erysimi* and shorter (47.55±0.678 days/progeny) on *M. rosae* (Table 1).

Duncan's multiple range test on different developmental stages (total grub, total pupal and average adult) of *C. septempunctata* revealed a significant difference ($p \leq 0.05$) with respect different aphid species.

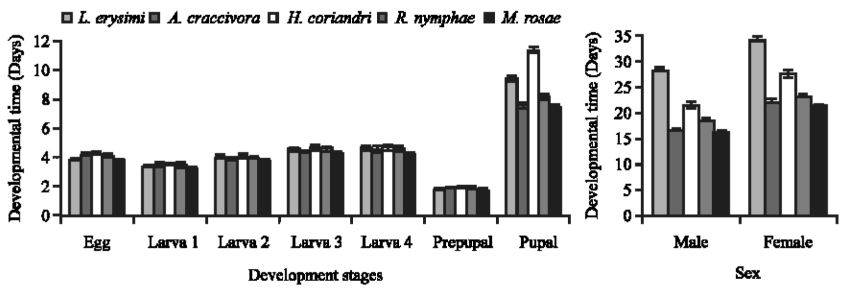

Fig. 1: Developmental time (days±SE) of *Coccinella septempunctata* on different aphid species

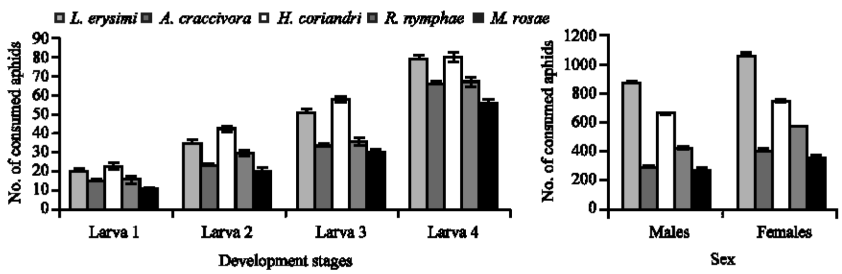

Fig. 2: Predation (number of aphids±SE) of *Coccinella septempunctata* on different aphid species

Table 1: Development and predation of *C. septempunctata* on different aphid species

Stage	*L. erysimi*	*A. craccivora*	*H. coriandri*	*R. nymphae*	*M. rosae*	CD ($p\leq 0.05$)
Development						
Total grub	16.50±0.502ab	16.30±0.533ab	17.00±0.533b	16.60±0.653b	15.70±0.186a	0.83
Total pupal	11.30±0.208b	9.60±0.279a	13.30±0.144c	10.10±0.298ab	9.40±0.153a	1.42
Average adult	31.05±0.685d	19.30±0.442ab	24.55±0.699c	20.85±0.485b	18.65±0.297a	1.97
Overall	62.75±1.430d	49.40±1.311ab	59.15±1.444c	51.65±1.485b	47.55±0.678a	2.53
Predation						
Total grub	182.50±4.808d	136.30±3.902b	202.70±7.879e	147.60±7.365c	116.20±5.687a	4.98
Average adult	960.25±13.898e	350.00±6.465b	698.95±7.401d	490.45±5.444c	320.60±4.712a	15.41
Over all	1142.75±18.706e	486.30±10.367b	901.65±15.280d	638.05±12.262c	436.80±10.399a	16.31

Given values are developmental period in days±SE and number of aphid consumed±SE; Same alphabets showing non-significance and different alphabets indicate significance in accordance to Duncan's multiple range test

Predation: The predatory response of different developmental stages of *C. septempunctata* exhibited significant difference with respect to all aphid species. The grub stages devoured voraciously *H. coriandri* followed by *L. erysimi*, *A. craccivora*, *R. nymphae* and *M. rosae*. The last larval stage (grub 4) consumed more aphids than the other grub stages. The adults (male and female) ate significantly higher *L. erysimi* than other aphid species. Nonetheless, the consumption of female was higher in contrast to male with respect to all aphid species (Fig. 2).

It was observed that, the overall feeding efficiency of *C. septempunctata* was significantly higher on *L. erysimi* (1142.75±18.706 aphids/progeny) followed by *H. coriandri* (901.65±15.280 aphids/progeny), *R. nymphae* (638.05±12.262 aphids/progeny), *A. craccivora* (486.30±10.367 aphids/progeny) and *M. rosae* (436.80±10.399 aphids/progeny) (Table 1). Duncan's multiple range test also exhibited that the predation of *C. septempunctata* was significantly different ($p\leq 0.05$) with respect to all aphid species.

When the correlation was made between the predation and the developmental period of *C. septempunctata*, a linear curve was obtained with respect to all aphid species. Figure 3 clearly showed that the predation of *C. septempunctata* depends on the developmental period; it increased with the advancement in age and registered the highest R^2-value (0.9994) on *L. erysimi* and the lowest (0.9942) on *M. rosae*.

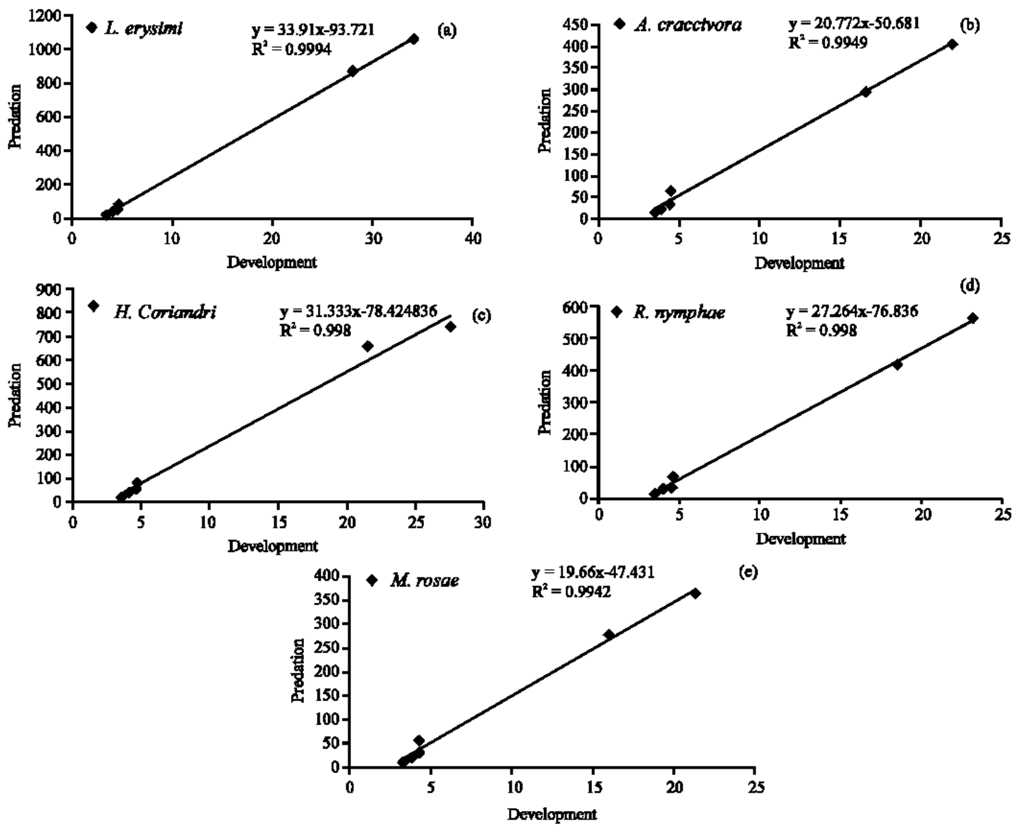

Fig. 3: Correlation between the development and predation of *C. septempunctata* on different aphid species; (a) *L. erysimi*, (b) *A. craccivora*, (c) *H. coriandri*, (d) *R. nymphae* and (e) *M. rosae*

DISCUSSION

The observations revealed that the developmental period of *C. septempunctata* varied significantly with respect to aphid species. The variation could be attributed on account of difference in size/biomass of different aphid species (Bhadauria *et al*., 2001). In present studies, it was also found that the female gave more attention to survive on all aphid species in comparison to male. Atlihan and Kaydan (2002) and Omkar and James (2004) also held the same opinion.

In our experiments, grubs of *C. septempunctata* tended to eat maximum *H. coriandri* than other species, probably due to small size of the prey (Alikhan and Yousuf, 1986; Singh *et al*., 1994). The adults (male and female) devoured maximum *L. erysimi* in comparison to other aphid species. This observation is in consonance with the findings of Hodek (1973) Kring and Gilstrap (1984) and Lee and Kang (2004).

Advancement in the age of *C. septempunctata* clearly showed the increase in the consumption of prey and has been well supported by the findings of other workers (Elliott *et al*., 1994; Babu, 1999). Besides this, host specificity (Elliott *et al*., 2000; Aslan and Uygun, 2005) and plant characteristics (Hodek and Honek, 1996) do influence on the predation potential, which have also been observed in the present investigation.

Coccinella septempunctata adult devoured more aphids than grubs, such investigations are in consonance with the judgment of Haque and Islam, 1982 and Singh *et al*., 1994. However, between sexes, female consumed more aphids than the male (Singh and Singh, 1994; Ba M'Hameed and Chemseddine, 2001; Brown, 2004; Omkar and Mishra, 2005).

It could be accomplished from the present findings that *Lipaphis erysimi* gave more response to *C. septempunctata*, under laboratory conditions, in terms of development and predatory preference as compared to other aphid species (*A. craccivora*, *H. coriandri*, *R. nymphae* and *M. rosae*) and hence, offer preliminary information to introduce *C. septempunctata* in the biological control programme of aphids of economic significance.

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REFERENCES

Alikhan, M.A. and M. Yousuf, 1986. Temperature and food requirements of *Chilomenes sexmaculata* (Coleoptera: Coccinellidae). Environ. Entomol., 15: 800-802.

Aslan, M.M. and N. Uygun, 2005. The aphidophagus coccinellid (Coleoptera: Cociinellidae) species in Kahramanmaras, Turky. Turk. J. Zool., 29: 1-8.

Atlihan, R. and M.B. Kaydan, 2002. Development, survival and reproduction of three coccinellids feeding on *Hyalopterus pruni* (Geoffer) (Homoptera: Aphididae). Turk. J. Agric. For., 26: 119-124.

Ba M'Hameed, T. and M. Chemseddine, 2001. Assessment of temperature effects on the development and fecundity of *Pullus mediterraneus* Fabr. (Coleoptera: Coccinellidae) and consumption of *Saissetia oleae* Olivier (Homoptera: Coccidae) eggs. J. Applied Entomol., 125: 527-531.

Babu, A., 1999. Influence of prey species on feeding preference, post-embryonic development of *Coccinella transversalis* F. (Coleoptera: Coccinellidae). Entomonlogy, 24: 221-228.

Bhadauria, N.K.S., S.S. Jakhmola and N.S. Bhadauria, 2001. Biology and feeding potential of *Menochilus sexmaculatus* on different aphids. Indian J. Entomol., 63: 66-70.

Bianchi, J.J., A. Felix and W. Werf, 2004. Model evaluation of the function of prey in non-crop habitats for biological control by ladybeetles in agricultural landscapes. Ecol. Modelling, 171: 177-193.

Blackman, R.L. and V.S. Eastop, 2000. Aphids on the World's Crops: An Identification and Information Guide. 2nd Edn., John Wiley and Sons, Chichester, UK.

Braendle, C., I. Friebe, M.C. Caillaud and D.L. Stern, 2005. Genetic variation for an aphid wing polyphenism is genetically linked to a naturally occurring wing polymorphism. Proceedings of the Royal Society of London, 272: 657-664.

Brown, M.W., 2004. Role of aphid predator guild in controlling spirca aphid population on apple in West Virginia, USA. Biol. Cont., 29: 189-198.

Delfosse, E.S., 2005. Risk and ethics in biological control. Biol. Cont., 35: 319-329.

Deligeorgidis, P.N., C.G. Ipsilandis, M. Vaiopoulou, G. Kaltsoudas and G. Sidiropoulos, 2005. Predatory effect of *Coccinella septempunctata* on *Thrips tabaci* and *Trialeurodes vaporariorum*. J. Applied Entomol., 129: 246.

DiFonzo, C.D., D.W. Ragsdale, E.B. Radcliffe, N.C. Gudmestad and G.A. Secor, 1997. Seasonal abundance of aphid vectors of potato virus Y in the Red River Valley of Minnesota and North Dakota. J. Econ. Entomol., 90: 824-831.

Elliott, N.C., B.W. French, J.G.J. Michels and D.K. Reed, 1994. Influence of four aphid prey species on development, survival and adult size of *Cycloneda ancoralis* (Germar) (Coleoptera: Coccinellidae). Southwest. Entomol., 19: 57-61.

Elliott, N.C., R.W. Kieckhefer and D.A. Beck, 2000. Adult coccinellid activity and predation on aphids in spring cereals. Biol. Cont., 17: 218-226.

Haque, M.E. and M.A. Islam, 1982. Effect of three species of aphids as food on the fecundity of ladybird beetle. Bangladesh J. Agric., 3: 375-376.

Hodek, I., 1973. Biology of Coccinellidae Junk. The Hague, The Netherlands.

Hodek, I. and A. Honek, 1996. Ecology of Coccinellidae. Kluwer Academic Publishers, Dordrecht, pp: 464.

Kennedy, J.S., M.F. Day and V.F. Eastop, 1962. A Conspectus of aphids as vectors of plant viruses. Commonwealth Inst. Ent., London, pp: 114.

Kring, T.J. and F.E. Gilstrap, 1984. Efficacy of natural enemies of grain sorghum aphids (Homoptera: Aphididae). J. Kans. Entomol., 76: 57-62.

Lee, J.H. and T.J. Kang, 2004. Functional response of *Hormonia oxyridis* (Pallas) (Coleoptera: Coccinellidae) to *Aphis gossypii* Glover (Homoptera: Aphididae) in the Laboratory. Biol. Cont., 31: 306-310.

Nelson, E.H. and J.A. Rosenheim, 2006. Encounters between aphids and their predators: The relative frequencies of disturbance and consumption. Entomol. Exp. Applic., 118: 211-219.

Omkar and B.E. James, 2004. Influence of prey species on immature survival, development, predation and reproduction of *Coccinella transversalis* Fabricius (Col., Coccinellidae). J. Applied Entomol., 128: 150.

Omkar and G. Mishra, 2005. Preference-performance of a generalist predatory ladybird: A Laboratory study. Biol. Cont., 34: 187-195.

Orlandao, A., T. CamauBa, Sobrinho and F.N. Suplicy, 1970. Tests on the control of yellow beetle *C. vulgata* on guava with new pesticides. Biologica, 36: 79-82.

Pervez, A. and Omkar, 2005. Functional responses of coccinellid predators: An illustration of a logistic approach. J. Insect. Sci., 5: 5.5. Available online: Insectscience.org/5.5.

Raboudi, F., A. Ben Moussa, H. Makni, M. Marrakchi and M. Makni, 2002. Serological detection of plant viruses in their aphid vectors and host plants in Tunisia. EPPO Bull., 32: 495-498.

Sathe, T.V. and Y.A. Bhosle, 2001. Insect Pest Predators. Daya Publishing House, Delhi, pp: 23-24, 38-42.

Singh, D. and H. Singh, 1994. Predatory potentiality of coccinellids, *Coccinella septempunctata* Linnaeus and *Hippodamia variegata* (Goetze) over mustard aphid, *Lipaphis erysimi* (Kaltenbach). Crop Res. Hisar., 7: 120-124.

Singh, V.S., R.P. Yadav and R. Singh, 1994. Post-embryonic development, survival rate and predation potential of *Coccinella septempunctata* Linn. In: relation of mustard aphid (*Lipaphis erysimi* Kalt.). J. Entomol. Res., 18: 5-10.