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Rearing of Predatory Seven Spotted Ladybird Beetle *Coccinella septempunctata* L. (Coleoptera: Coccinellidae) on Natural and Artificial Diets Under Laboratory Conditions

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Abstract.- Seven-spotted ladybird beetle *Coccinella septempunctata* L., a natural enemy of aphids, had been reared on natural and alternative artificial foods. Both larvae and adults of *C. septempunctata* fed on aphid and artificial diet, the predator normally completed its development from egg to adulthood in 20.6 days on aphid prey, in contrast to 29.0 days, when fed on artificial diet. These results indicated that artificial diet containing important ingredients for adults and larvae of *C. septempunctata* can serve as substitute food for the coccinellids, and reproduction nevertheless can occur in the absence of preferred aphid prey. The present findings can best be utilized for effective mass production of coccinellids species intended for biological control of insect pests.

Key words: Ladybird beetle, predator, artificial diet, natural diet.

INTRODUCTION

The aphidophagous ladybird beetle *Coccinella septempunctata* L., is one of the potential predators of the mustard aphid, *Lipaphis erysimi* (Kalt.) that is a key pest of the rapeseed and mustard. This beetle occupies quite a remarkable place among the naturally occurring biocontrol agents of mustard aphid (Mathur, 1983). Lady beetles, both adults and larvae, are known primarily as predators of aphids (plant lice), but they also prey upon many other pests such as soft-scale, mealy bugs, spider mites and eggs of the Colorado potato beetle as well as European corn borer, while, a few feeds on plant and pollen mildews. These predatory beetles can be used in biological control of insect pests. For most agricultural systems, the augmentative releases and conservation techniques for ladybird beetle are greatly emphasized to maximize their uses in biological control (Rizvi *et al.*, 1994).

Singh *et al.* (2003) studied relative abundance of the effective natural enemies of mustard aphid *L. erysimi*, in farmers' fields; the *C. septempunctata* was the highest (41.97%) occurring species. All the natural enemies showed increasing trend till harvest of the crop, whereas, the coccinellids occupied a major share with maximum relative abundance of *C. septempunctata.* Bianchi *et al.* (2004) reported the availability of alternative prey considered to be an important factor for the conservation of predators in agro-ecosystems. However, scarcity of prey may prevent *C. septempunctata* from reproducing or initiate long distance migration. Therefore, prey availability in non-crop habitats may play a significant part in the conservation of lady beetles and the related biological control agents in agro-ecosystems. Predation of *C. septempunctata* on *Myzus persicae* was quantitatively investigated in the laboratory. The predation selectivity experiment reveald that adult *C. septempunctata* preferred *M. persicae* among three preys *i.e*., *M. persicae,* eggs and larvae of *Helicoverpa assaulta* (Maolin and Fang Hao, 2004). A laboratory experiment was conducted to determine the feeding potential of *C. septempunctata, Menochilus sexmaculatus, Cheilomenes sexmaculata,* and *Brumoides suturalis* on mustard aphid *L. erysimi,* but the adult of *C. septempunctata* consumed more mustard aphids (Soni *et al.,* 2004).

The ever-increasing demand for large number of laboratory-reared insects has necessitated the development of more efficient and economical methods of their mass production. The shifting emphasis in insects control utilizing biological entities, such as predatory insects has also created a

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demand for constantly reliable sources of supply for such insects. The present study for that reason was undertaken for obtaining information on the biology of this predator under local sets of condition by making use of natural prey and artificial diets. Such information would be helpful in mass culturing of this predator under laboratory conditions using different rearing media.

MATERIALS AND METHODS

These experiments were conducted in the Research Laboratory, Department of Entomology, at Sindh Agriculture University, Tandojam. To obtain eggs and larvae, the newly emerged adult ladybird beetle *Coccinella septempunctata* were collected from the mustard fields and released in pairs and confined inside glass bowls (7 cm X 2.5 cm) at suitable temperature 26±0.5°C, 72±5% R. H. and 16 L: 8 D hours. Each bowl was covered with muslin cloth. These conceded out tests were recurred five times. The adults accumulated were fed on natural and different artificial diets to determine suitable and appropriate nutrients combinations for the development of adult and larval stages. The rearing of both adults and larvae was carried out individually on the same aphids and artificial diets as specified underneath:

Natural diet

The mustard aphid *Lipaphis erysimi* infested twigs were kept in each bowl to serve as food for the adult predator and endowed with water soaked cotton. The larvae and adults in all replicates were provided with uncounted aphids per day. Adults were provided with small droplets of glucose and water on a piece of wet cotton wool for their continuous supply.

Artificial diets

All the nutritional ingredients for both diets were procured from the market. The composition of the food media was as follows:

Diet 1

Used yolk 25 g, 2 g sucrose, 4 g honey, 2 g casein, 1 g protein hydrolyzate were mixed thoroughly to form a uniform mixture. This larval and adult diet was prepared in diet mixing kettle.

Diet 2

Agar 1.3 g, cane sugar 16 g, honey 6 g and protein hydrolyzate 1 g were dissolved in 100 ml of hot water and cooled to 35-38°C. To above 20 ml mixture 4.5g of royal jelly was added and stirred constantly until a homogenous white emulsion was obtained. The two mixtures were combined to which 0.5 g of alfalfa flour yeast and 2 g pulverized dry aphid was added, stirred vigorously and cooled to 5°C for its storage.

To record the observations on behaviour, duration of mating, pre-oviposition, oviposition and post-oviposition periods, adults were allowed for oviposition on paper placed inside each bowl. The paper with egg masses of *C. septempunctata* were cut with scissors. The eggs deposited by the females on the surface of container were removed with camel hairbrush. The eggs were counted and kept on sterilized blotting paper in small Petri dishes to record hatching. The Petri dishes bearing the known numbers of eggs were kept at laboratory temperature and relative humidity for studying different parameters. The observations on hatching of eggs were recorded twice a day. To avoid cannibalism, the eggs were checked twice every day and the emerging predatory larvae were removed instantaneously with fine brush, kept in Petri dishes, and 5 g dietary media of artificial diet was kept in each Petri dishes. Regularly, larvae were checked for instar position and then the pupal emergence recorded daily. The observations pertaining to obvious morphological changes and moulting were also recorded daily. The number of eggs laid, incubation period of eggs, larval and pupal periods were determined on different rearing medias. The total number of eggs laid (fecundity) by each female during its lifetime, the longevity of male and female adults and their sex ratio were also recorded. The matured larvae were observed by their behaviour for pupation, number of survived larvae and mortality were also recorded. Pupal developmental, their duration (days) survival and mortality were determined. Pupae were reared by the same method as applied for all treatments. The male and female sexes, their weight and mortality were recorded as well. Three generations of test predator was reared on natural and artificial diets. The observations were terminated and were not considered for evaluation

when the insect fully matured or died. The statistical interpretation were undertaken to correlate the different observations and mean values were compared to work out suitable parameters with single factor ANOVA at alpha 0.05.

RESULTS AND DISCUSSION

The results from the current study revealed that all the diets (natural and artificial) significantly affected the development of seven-spotted beetle, *Coccinella septempunctata.* The natural diet comprising aphids host proved significantly superior to the artificial diets.

Table I shows the survival and biology of *Coccinella septempunctata* on natural prey and artificial diets. From the current investigations, it can be seen that the lady beetle reared on aphids as host gave significantly the uppermost results for all the parameters under consideration as compared to both artificial diets. The progeny obtained on natural host was of the higher quality and most efficient in their behaviour. Amongst the artificial diets, diet 1 comprising yolk, sucrose and honey was found inferior to the diet 2 containing agar, honey, protein hydrolyzate and alfalfa flour yeast. Hence, the diet composing aphid as natural host proved excellent for rearing of adult coccinellids, but if this diet is supplemented with artificial diet, development will become faster and the lady beetle can be reared more successfully. In case the aphid is scanty or it is out of season, lady beetle mass production can be carried out only on the artificial diet. Bashir (1973) reported optimum eggs production due to inclusion of vitamin E in the larval diet. Singh and Malhotra (1979) studied the bionomics of this lady beetle using aphids as natural diet. Alamgeer *et al.* (1999) showed that when prey density increased, the predatory efficiency, which was greatest for mustard aphid *Lipaphis erysimi* was also increased. Gour and Pareek (2003) found that predatory *C. septempunctata* preferred to prey upon *L. erysimi* than *Brevicoryne brassicae.* Omkar *et al.* (2003) observed the *C. septempunctata* with highest rapid larval development as 14.2 days and greatest daily consumption of mustard aphid at the rate of 45.3 aphids/day. Kalushkov and Hodek (2004) tested the response of aphidophagous *C. septempunctata* towards thirteen species of aphids (Sternorrhyncha: Aphididae). All aphid species studied were found suitable food according to the rate of larval development, larval mortality and adult fresh weight.

The study demonstrated that diet comprising aphid as natural host proved excellent for rearing of coccinellids, but if artificial diet and aphid was given simultaneously, development becomes faster and lady beetle could be reared more successfully. Natural hosts and supplementary artificial diets used simultaneously or jointly have been successfully reported from some other laboratories. Richards and Evans (1998) fed coccinellids on a variety of prey in addition to preferred aphids. These alternative foods served only to maintain the predator but did not permit immature growth or adult reproduction; females produced very few eggs, and held eggs of very small size in their ovaries, when provided only sucrose (15%). When however, provided with both weevils and sucrose, females of both species laid eggs in modest numbers. Evans *et al.* (1999) compared eggs produced by two aphidophagous lady beetles, provided with diets of aphids (essential prey) and weevils (alternative prey). As predicted, female predators produced greater number of eggs when a diet of pea aphids in limited number was supplemented by alfalfa weevil.

Amongst the artificial diets, diet comprising yolk, sucrose and honey proved inferior to the diet containing agar, honey, protein hydrolyzate and alfalfa flour yeast in its performance. Sun and Fang (1999) reviewed the highest egg productivity (3000 or more per female) achieved by feeding adults on *Trichogramma* sp., pupae improved by the addition of a mixture of 0.1 % olive oil and 5% cane sugar or on *Trichogramma* adults alone. Singh and Singh (1994) compiled life fecundity table for females of *C. septempunctata* preying on *L. erysimi* and found that the net reproductive rate and mean length of generation under laboratory and field conditions were 95.88 and 54.18, and 28.88 and 28.68 days, respectively. Akram *et al.* (1996) reported that egg stage and larval instars of *C. septempunctata* occupied a total of 9.91 days. The pupal stage lasted for 4.66 days and the adults survived for 6-8 days. Sato and Dixon (2004) studied survival and development of hatchling larvae of three

Table I.- Survival and biology of seven spotted ladybird beetle *Coccinella septempunctata* on natural prey and artificial diet.

Parameters	Treatment			
	Natural diet (aphid)	Artificial diet-1	Artificial diet-2	LSD
Pre-copulation period (Days)	6.00 C	11.60 C	10.20 AB	3.277
Copulation period (Minutes)	56.00 A	34.40 B	35.40 B	8.496
Pre-oviposition period (Days)	6.4 B	12.2 A	11.40 AB	5.221
Oviposition period (Days)	15.40 A	6.00 C	9.20 B	2.989
Post-oviposition period (Days)	3.40 A	1.80 B	1.80 B	1.530
Number of eggs laid	255.0 A	11.0 B	18.00 B	25.06
Number of eggs hatched	150.6 A	2.00 B	4.00 B	11.49
Percent hatching	59.50 A	17.62 B	22.48 B	7.518
Incubation period	3.4 B	4.6 A	4.6 A	0.883
Larval survival (%)	80.48 A	0.0 B	75.32 A	13.81
Total larval period	13.0 B	0.00	17.0 A	1.975
Number of pupae observed	90.00 A	0.00	2.00 B	11.40
Pupation (%)	74.70 A	0.00	64.98 A	20.73
Pupal duration (Days)	4.00 B	0.00	6.20 A	0.564
Adults emerged (Male)	10.00 A	0.00	0.00	1.331
Adults emerged (Female)	7.00 A	0.00	0.20 B	4.331
Adult percent emergence	89.60 A	0.00	6.66 B	15.15
Weight of 4^{th} instar larvae	31.14 A	0.00	4.30 B	8.127
Pupal weight	28.00 A	0.00	3.50 B	6.906
Male weight	34.68 A	0.00	0.00	1.310
Female weight	56.82 A	0.00	8.90 B	16.31
Duration from egg to adult	20.60 B	0.00	29.00 A	1.277
Male longevity	38.80 A	0.00	0.00	3.641
Female longevity	50.80 A	0.00	8.90 B	18.01

aphidophagous ladybirds, when fed their own and the other species eggs. In all three species, the larvae survived when fed co-specific eggs. In general, larvae were reluctant to eat the eggs of other species. From the present study, it can be concluded that the lady beetle reared on aphids as host gave significantly more efficient results compared to artificial diet. Artificial foods can however be a good substitute results of natural prey for rearing this predator.

REFERENCES

AKRAM, W., AKBAR, S. AND MAHMOOD, M., 1996. Studies on the biology and predatory efficiency of *Coccinella septempunctata* with special reference to cabbage aphid. *Pak. Entomol.*, **18**: 104-106.

ALAMGEER, S., KUMAR, A., KUMAR, N, AND TRIPATHI, C.P.M., 1999. Prey predator relationship between *L. erysimi* Kalt. and *C. septempunctata* Linn. III effect of host plants on the searching strategy, mutual interference and killing power of the predator. *Biol. Agric. Hort.,* **35**: 11-17.

BASHIR, M.O., 1973. *Effect of nutrition on development and reproduction of aphidophagous coccinellids with special reference to* Olla abdominalis *(Say).* Ph.D. dissertation, Univ. of California, Berkeley, 300 pp.

BIANCHI, F.J.J.A., WERF, W.V.D., DER, W.W.V. AND VAN, D.W., 2004. Model evaluation of the function of prey in non-crop habitats for biological control by ladybeetles in agricultural landscapes. *Ecol. Model*, **38**: 177-193.

EVANS, E.W., STEVENSON, A.T. AND RICHARDS, D.R., 1999. Essential versus alternative foods of insect predators: benefits of a mixed diet. *Oecologia*, **39**: 107-112.

GOUR, S. AND PAREEK, B.L., 2003. Biology and predation potential of *C. septempunctata* on mustard aphid, *Lipaphis erysimi. Annl. Biol.,* **19**: 225-229.

KALUSHKOV, P. AND HODEK, I., 2004. The effects of thirteen species of aphids on some life history parameters of the ladybird *Coccinella septempunctata. Biol. Contr.*, **36**: 21-32.

MAOLIN, H. AND FANG HAO, W., 2004. Predation of *M. persicae* by adults of *C. septempunctata. Ent. Known*, **41**: 347-350.

MATHUR, K.C., 1983. Aphids of agricultural importance and

their natural enemies of Jullunder Punjab. In: *The aphids* (ed. B.K. Behura). The Zoological Society of Orissa, Utkal University, Bhubneshwar, India, pp. 229-233

OMKAR, SHEFALI, S. AND SRIVASTAVA, S., 2003. Influence of six aphid prey species on development and reproduction of a ladybird beetle, *C. septempunctata. Biol. Contr.*, **43**: 379-393.

RICHARDS, D.R. AND EVANS, E. W., 1998. Reproductive responses of aphidophagous lady beetles (Coleoptera: Coccinellidae) to non-aphid diets: an example from alfalfa. *Annl. entomol. Soc. Am.*, **29**: 632-640.

RIZVI, N.H., HUSSAIN, T., ALI, S. S., RAJPUT, M.R., AHMED, M. AND SHAKOORI, A. R., 1994. Comparative predatory behaviour of larvae and adults of *Coccinella septempunctata* L. *Proc. Pakistan Congr. Zool.*, **12:** 285-289.

SATO, S. AND DIXON, A.F.G., 2004. Effect of intraguild predation on the survival and development of three species of aphidophagous ladybirds: consequences for invasive species. *Agric. Forest Ent.*, **22**: 21-24.

SINGH, H. S. AND SINGH, R., 1994. Life fecundity table of *Coccinella septempunctata* Linn. Predating on mustard aphid *(Lipaphis erysimi* Kalt.) under laboratory and field conditions. *J. ent. Res.*, **1**: 297-303.

SINGH, N.N., PANDEY, R., RAI, S., PANDEY, R. AND RAI, S., 2003. Relative abundance of effective natural enemies of mustard aphid, *Lipaphis erysimi* (Kalt.). *J. appl. Zool. Res.*, **10**: 209-211.

SINGH, R. AND MALHOTRA, R. K., 1979. Bionomics of *Coccinella septempunctata* Linn. *Indian J. Ent.*, **41**: 244-249.

SONI, R., DEOL, G. S. AND BRAR, K. S., 2004. Feeding potential of coccinellids on mustard aphid, *L. erysimi* K. *Insect Environ.*, **10**: 15-16.

SUN, Y.I. AND FANG, H. W., 1999. Mass rearing *Coccinella septempunctata* L. (Col: Coccinellidae) with artificial diets: problems and substitute diets. *Chinese J. bioI. Contr.*, **48**: 169-173.

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