Pakistan Entomologist

Journal homepage: www.pakentomol.com

REARING OF *COCCINELLA SEPTEMPUNCTATA* L. (COLEOPTERA: COCCINELLIDAE) ON NATURAL AND ARTIFICIAL DIETS

Muhammad Sufyan*, Muhammad Jalal Arif, Inzamam-ul-Haq, Muhammad Dildar Gogi, Muhammad Arshad and Ahmad Nawaz

Department of Entomology, University of Agriculture Faisalabad

ARTICLE INFORMATION

Received: July 18, 2016

Received in revised form: October 05, 2016

Accepted: November 25, 2016

***Corresponding Author**:

Muhammad Sufyan

E-mail: muhammad.sufyan@uaf.edu.pk

ABSTRACT

Seven-spotted ladybird beetle *Coccinella septempunctata* L., is a natural enemy of aphids and was reared on five different natural and alternative artificial foods under laboratory conditions. Results showed that maximum egg laying (194.2 eggs) was found on natural diet (*Sitobion avenae*). When compared with artificial diets, only 8.2 eggs were found on diet 4 (casein protein + water + honey). Male and female sex ratio was not significantly different on all natural and artificial diets. Larval, pupal and adult emergence on artificial diet was also not significantly different on diet 2 (casein protein + protein hydrozylate + honey + water) and diet 4 (casein protein + water + honey). Maximum duration of larvae was found on diet 4 (casein protein+ water+ honey) 12.8 days which is longer than natural diet (*Sitobion avenae*) where it was 8.2 days. Pupal duration was found maximum on artificial diet 4 (casein protein+ protein hydrozylate+ honey+ water) 14.4 days which is longer than natural diet (*Sitobion avenae*) where it was 10 days and maximum adult duration was found on artificial diet 2 (casein protein + protein hydrozylate + honey + water) 18.4 days which is longer as compared to natural diet (*Sitobion avenae*) where it was 13.2 days.

Keywords: *Coccinella septempunctata*, Predator, Artificial diet, Natural diet.

INTRODUCTION

Different types of pests are found in nature affecting life and yield of natural and cultivated crops of agro-forestry. Researchers are trying to develop and apply different techniques to control and reduce loss of these pests on agriculture, forest and garden products. Chemical control method (CCM) is frequently applied as it is easy and prompt way to directly kill or repel the pests from crops and fruit tree (Katsarou *et al.,* 2005). But it is reported in many experiments that CCM has not only hazardous effects on human life by increasing pollution but also it has indirect impact by disturbing ecosystems. For example, in the developing world, over 250,000 people die each year from suicide and deliberate self-harm using insecticides and other pesticides (Gunnell *et al.*, 2007). The effects of chronic exposure to residual chemical pesticides, however, remain controversial (Pimentel, 2005). There are also possible links between chronic pesticide exposure and congenital defects (Eriksson, 1997), preterm birth (Longnecker *et al.,* 2001), Parkinson's disease (Semchuk *et al.,* 1992; Gorell *et al.*, 1998; Betarbet *et al.*, 2000; Priyadarshi *et al.*, 2000) and neuropsychological dysfunctions. Adverse environmental effects are also of concern. Due to the indiscriminate actions of some agrochemical insecticides, beneficial insects, birds, aquatic invertebrates and fish can also succumb to the toxic effects of these agents (Pain *et al.*, 2004). The use of agrochemicals with so few targets has promoted the evolution of resistance to a number of insecticide families (Feyereisen, 1995; Brogdon and McAllister, 1998).

These problems indicate the need to identify new and safe insecticidal lead compounds, validate novel insecticidal targets and develop alternate methods of effective insect control. Recently, it is reported that biological control method (BCM) is better technique to control the pest of different types (Habeck *et al.,* 1990). Biological control is a bio effector-method of controlling pests (including insects, mites, weeds and plant diseases) using other living organisms. It relies on predation, parasitism, herbivores, or other natural mechanisms, but typically also involves an active human management role. It can be an important component of integrated pest management (IPM) programs. Natural enemies of insect pests, also known as biological control agents, include predators, parasitoids and pathogens.

Cite this article as: Sufyan, M., M.J. Arif, Inzamam-ul-Haq, M.D. Gogi, M. Arshad and A. Nawaz, 2017. Rearing of *Coccinella septempunctata* L. (Coleoptera: Coccinellidae) on natural and artificial diets. Pak. Entomol., 38(2):129-133.

Predators are mainly free-living species that directly consume a large number of prey during their whole lifetime. *Coccinella* spp. is a potential bio control agent in suppressing aphid populations in the field. It belongs to family Coccinellidae of order Coleopteran. It is demonstrated in previous studies that CSL responds to olfactory cues from their aphid prey and can even distinguish between aphid species on volatiles (Sengonca, 1994).

Coccinella septempunctata L is considered to be an important bio-control agent for soft-bodied insects such as aphids, white flies, jassids and small lepidopterous larvae which were among the first to be used in this fashion. CSL can prove to be a good bio-control source for thrips and whiteflies in green house crops also (Deligeorgidis *et al.,* 2005). 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). Moreover, 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. 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. Rearing coccinellids on natural food, i.e. living aphids, is difficult and uneconomical (Ohkada and Matsuka, 1973). This requires a lot of resources such as space, time, and labor for aphid mass rearing in order to secure continuous and reliable supply of aphids. Those obstacles can be overcome by rearing the predator on an artificial diet. Artificial diets for insects generally must contain the following components: proteins but sometimes free amino acids, lipids, carbohydrates, vitamins and minerals (Cohen, 2005). Nutrient intake of adult insects influences their longevity and fecundity. The shifting emphasis in insects control utilizing biological entities, such as predatory insects has also created a demand for constantly reliable sources of supply for such insects.

Keeping in view, the present study was undertaken 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.

Lady bird beetles are very important predator of soft bodied insects such as aphids. However it is very difficult to make sure of its availability throughout the year. So it is important to make its rearing on some artificial diets.

MATERIALS AND METHODS

The experiment was conducted in the Bio-control lab, Entomological Research Institute, Ayub Agricultural Research Institute, Faisalabad. To obtain eggs and larvae, the newly emerged adult ladybird beetle *C. septempunctata* were collected from the wheat fields and released in pairs (male and female) and confined inside plastic petridishes (one pair inside each petri dish) at suitable temperature 26±0.5°C, 76±5% R. H. and 12 L: 12 D hours. 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.

Treatments

Following five treatments were used with five replicates.

T_1= *S. avenae*

T_2= Casein Protein+ Protein Hydrozylate+ Honey+ Water

T_3 = Sugar+ Yeast+ Water

T_4 = Casein Protein+ Water+ Honey

T_5 = Water

Adults were allowed for oviposition on paper placed inside each petri-dish. 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 hair brush. The eggs were counted and kept on sterilized blotting paper in small petri dishes to record hatching. The observations on hatching of eggs were recorded daily. To avoid cannibalism, the eggs were checked daily and the emerging predatory larvae were removed instantaneously with fine brush, kept in petri dishes. Artificial diets were provided with the help of cotton swab soaked with respected diet. 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. Analysis of variance and LSD was computed with Statistix 8.1 @ 0.05.

RESULTS

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

Fig.1 showed that lady beetle reared on aphids as host gave significantly the uppermost results for all the parameters under consideration as compared to artificial diets. The results obtained about fecundity are shown in Fig.1. This shows that predators fed on Diet 1 (natural prey) laid higher number of eggs 194.2 as compared to artificial diets Diet 2, Diet 4 where only 8.4 and 8.2 eggs were laid. While on Diet 3 and Diet 5 no egg laying occur. Male and female sex ratio is also shown in Fig.1. Male female sex ratio is almost similar on natural and artificial diets.

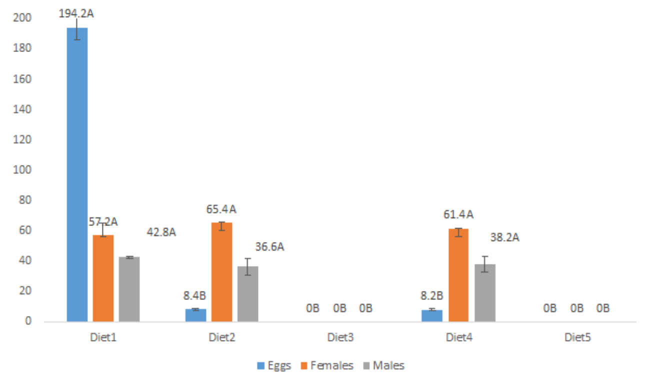

Fig. 1

Fecundity and sex ratio of *C. septempunctata* on natural prey and artificial diets.

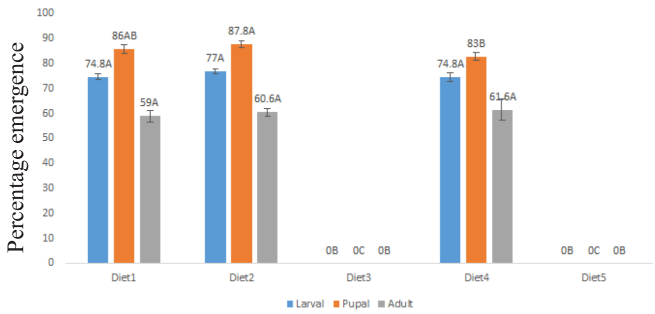

Fig. 2

Percentage emergence of larvae pupae and adults of *C. septempunctata.*

Percentage larval emergence was not significantly different on Diet 1 (natural prey) and artificial diets (Diet 2 and Diet 4) which was 74.8, 77 and 74.8 respectively. Similarly percentage pupal emergence on Diet 1 and Diet 2 was greater than Diet 4. Percentage adult emergence on Diet 1, Diet 2 and Diet 4 was 59, 60.6 and 61.6 respectively. On Diet 3 and Diet 5, there was no larval, pupal or adult emergence because no egg laying occurred on these Diets (Fig. 2).
Duration of eggs was greater on artificial diets [Diet 2 (6.2days) and Diet 4 (5.8 days)] as compared to natural diet 1 (4.2 days). Similarly larval duration was greater on artificial diet [Diet 4 (12.8 days)] as compared to natural diet [Diet 1 (8.2 days)]. Duration of larvae on Diet 2 was 12.4 days. Result show that pupal duration was also longer on artificial diets as compared to natural diet. Pupal duration on Diet 1, Diet 2 and Diet 4 was 10 days, 14 days and 14.4 days, respectively. Adult duration on artificial diets was also longer than natural diet. On Diet 1, it was 13.2 days which was shorter than Diet 2 (18.4 days) and Diet 4 (18.2 days). Results show that on Diet 3 and Diet 5, there was maximum adult duration. On these diets no egg laying occurred but adults kept on egg laying and remained alive for a longer period which was 65.6 days on Diet 3 and 65.2 days on Diet 1 (Fig. 3).

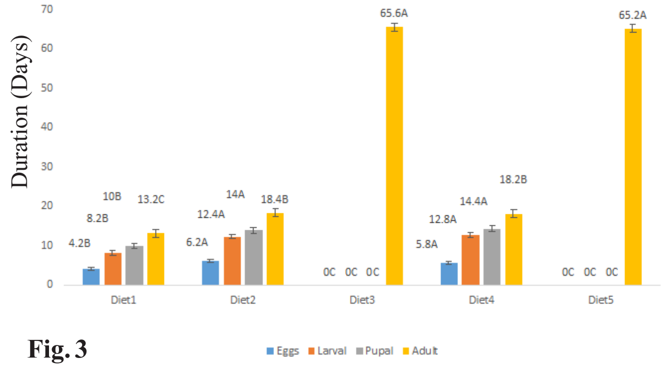

Fig. 3

Egg, larval, pupal and adult duration on different diets.

DISCUSSION

Results of this study showed that predator fed on aphid pray have maximum egg laying and that fed on artificial diets have minimum or no egg laying. Results of this study are in accordance with Evans *et al.* (1999), who fed coccinellids on a variety of prey but 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.
Results of this experiment showed that mean length of generation on natural prey was 35.6 days. It showed that these results are in contrast with Singh and Singh (1994), who 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.. This difference may be due to nature of food or other environmental factors. Laboratory conditions may be different.
Results of this experiment showed that egg laying on natural prey was 194.2. So there is difference between results of this experiment and Rajamohan (1973), who reported that *Menochilus sexmaculatus* had the highest fecundity when reared on *Ahpis craccivora* (1107 eggs), followed by *Aphis gossypii* (718 eggs*), Rhopalosiphum maidis* (522 eggs) and *Aphis umbrella* (276 eggs), respectively. This may be due to difference in nature of food. Because prey used in their research is different than this experiment.
Results showed that predator completed its development from egg to adulthood in 35.6 days on aphid prey and in 51.2 days, when fed on artificial diets. But these results are in contrast with Sarwar and Saqib (2010), who reported that 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. This difference may be due to nature of food or other environmental factors. Laboratory conditions may be different.
In the current study CSL showed longevity of 65.2 days when fed on plane water. So there is difference between results of this experiment and findings of Ashraf *et al.* (2010), who

reported that CSL reared under artificial diet showed more longevity 41.6 days on plain water. These difference may be due to environmental factors.

Results of this experiment showed that CSL has longevity more than 50 days on artificial diets. So there is difference in the results of this experiment with Samalo (1976), who reported that *M. sexmaculatus* adult could live for 28 days on sugar syrup and water alone. These difference may be due to environmental factors or nature of food.

Results of this experiment showed that maximum egg laying on artificial diet was only 8.2 eggs and when predator was supplied with water, no egg laying occur. So there is a difference in the results of this experiment and Agus *et al*. (2013), who reported that highest number of eggs (323.7 eggs) was found when the adult was presented with the drink of sugar solution in the sponge. When the predator was supplied with the water in a sponge, the lowest number of individual eggs were laid, 65.00 eggs. So there is contrast in the results. He further reported that adult predators fed with artificial diet only and honey solution had longevities of 14 and 29 - 30 days, respectively. But the results of this experiment showed that longevity of predator on artificial diets was 51.2 days. There is difference in the results of these experiments. This difference may be due to nature of food or other environmental factors.

Findings of this experiment predict that there is a profound reliability among various parameters such as food type and temperature; which affect the relationship among predators (CLS) or preys i.e. aphids and other insects. The life form study of CSL and aphids in different climates can lead us to discover the ways and means to overcome the damages caused by different insects to various crops that is congruently favouring the biocontrol mechanism. So, this technique can be used as bio-control technique for avoiding loss in yield of various cash crops and this is also studied in past years. This will be not only a boosting step for our economy by enhancing per hectare yield but also cost effect and affordable method for layman and farmers at broad level.

CONCLUSION

It is concluded that all the diets significantly affected the growth and development of *C. septempunctata*. CSL laid more eggs when fed on natural diet but has shorter life cycle on this. CSL has longer life cycle on artificial diets but laid a few number of eggs. Among artificial diets on Diet 3 and Diet 5, CSL laid no eggs but remained alive for 65.6 and 65.2 days respectively. So these diets prolong the life cycle of adult CSL. So these diets can be used to keep adults alive in the absence of natural prey. Their population can be maintained on these diets and this population can be transferred in the fields for the control of pests.

REFERENCES

Agus, N. 2013. Oviposition and longevity of *Coccinella* sp. (Coleoptera: Coccinellidae) on artificial diets. J. Asian Sci. Res., 3: 693-697.

Ashraf, M., M. Ishtiaq, M. Asif, M. Adrees and M.N. Ayub, 2010. A study on laboratory rearing of lady bird beetle (*Coccinella septempunctata*) to observe its fecundity and longevity on natural and artificial diets. Int. J. Biol., 2: 165-173.

Betarbet, R., T.B. Sherer, G. MacKenzie, M. Garcia-Osuna, A. VPanov and J.T. Greenamyre, 2000. Chronic systemic pesticide exposure reproduces features of Parkinson's disease. Nat. Neurosci., 3: 1301-1306.

Bianchi, F.J.J.A., W.V.D. Werf, W.W.V. Der and D.W. Van, 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.

Brogdon, W.G. and J.C. McAllister, 1998. Insecticide resistance and vector control. Emerg. Infect. Dis., 4: 605-613.

Cohen, A.C. 2005. Insect diets: Science and technology. Boca Raton London New York Washington, D.C: CRC PRESS.

Deligeorgidis, P. N., I.M. Vaiopoulou, G. Kaltsoudas and G. Sidiropoulos, 2005. Predatory effect of *Coccinella septempunctata* on *Thrips tabaci* and *Trialeurodes vaporariorum*. J.E.N., 129: 246-249. doi:10.1111/j.1439-0418.2005.00959.246–249.

Eriksson, P. 1997. Developmental neurotoxicity of environmental agents in the neonate. Neurotox., 18: 719-726.

Evans, E.W., A.T. Stevenson and D.R. Richards, 1999. Essential versus alternative foods of insect predators: benefits of a mixed diet. Oecologia, 39: 107-112.

Feyereisen, R., 1995. Molecular biology of insecticide resistance. Toxicol. Lett., pp. 82-90.

Gorell, J.M., C.C. Johnson, B.A. Rybicki, E.L. Peterson and R.J. Richardson, 1998. The risk of Parkinson's disease with exposure to pesticides, farming, well water, and rural living. Neurol., 50: 1346-1350.

Gunnell, D., M. Eddles, M.R. Phillips and F. Konradsen, 2007. The global distribution of fatal pesticide self-poisoning: systematic review. BMC Public Health, 7: 357.

Habeck, D.H., F.D. Bennett and J.H. Frank, 1990. Classical Biological Control in the Southern United States. Southern Cooperative Series Bulletin No. 355, IFAS Editorial, University of Florida, Gainesville, FL. pp. 197.

Katsarou, I., J.T. Margaritopoulos, J.A. Tsitsipis, D.C. Perdikis and K.D. Zarpas, 2005. Effect of temperature on development, growth and feeding of *Coccinella septempunctata* and *Hippodamia convergens* reared on the tobacco aphid*, Myzus persicae* nicotianae. BioContr., 50: 565-588.

Longnecker, M.P., M.A. Klebanoff, H. Zhou and J.W. Brock, 2001. Association between maternal serum concentration of the DDT metabolite DDE and preterm and small-for-gestational-age babies at birth. The Lancet, 358: 110-114.

Ohkada, and M. Matsuka, 1973. Artificial rearing of *Hormonia oxyridis* on pulverized drone honeybee brood. Environ. Entomol., 2: 301-302.

Pain, D.J., R. Gargi, A.A. Cunningham, A. Jones and V. Prakash, 2004. Mortality of globally threatened Sarus cranes Grus antigon from monocrotophos poisoning in India. Sci. Total Environ,. 326: 55-61.

Pimentel, D. 2005. Environmental and economic costs of the application of pesticides primarily in the United States. Environ. Dev. Sustain., 7: 229-252.

Priyadarshi, A., S.A. Khuder, E.A. Schaub and S. Shrivastava, 2000. A meta-analysis of Parkinson's disease and exposure to pesticides. Neurotoxicol., 21: 435-440.

Rajamohan, N.A.S.J. 1973. Studies on the reproduction of coccinellid *Menochilus sexmaculatus* (F.) on four species of aphids. Zeitschrift fur Angewandte Entomol., 74: 388-393.

Rizvi, N.H., T. Hussain, S.S. Ali, M.R. Rajput, M. Ahmed and A.R. Shakoori, 1994. Comparative predatory behaviour of larvae and adults of *Coccinella septempunctata* L. Proc. Pakistan Congr. Zool., 12: 285-289.

Samalo, A.P.A.M.P. 1976. Effect of Various Food Substances on Longevity and Fecundity of some Ladybird Beetles. Ind. J. Entomol., 39: 190-192.

Sarwar, M. and S.M. Saqib, 2010. Rearing of predatory seven spotted ladybird beetle *Coccinella septempunctata* L. (Coleoptera: Coccinellidae) on natural and artificial diets under laboratory conditions. Pak. J. Zool., 42: 47-51.

Semchuk, K.M., E.J. Love and R.G. Lee, 1992. Parkinson's disease and exposure to agricultural work and pesticide chemicals. Neurol., 42: 1328-1335.

Sengonca, C.L.B.Z. 1994. Responses of the different instar predator, *Coccinella septempunctata* L. (Coleoptera: Coccinellidae), to the kairomone produced by the prey and non-prey insects as well as the predator itself. *Pflanzenk Pflanzen,* 101: 173-177.

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

Soni, R., G.S. Deol and K.S. Brar, 2004. Feeding potential of coccinellids on mustard aphid, *L. erysimi* K. Insect Environ., 10: 15-16.