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.

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 + water + honey) 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.
Ladybird 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.

Coccinella septempunctata L is considered to be an important bio-control agent for soft-bodied insects such as aphids, whiteflies, jassids and small lepidopterous larvae which were among the first to be used in this fashion. 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, whiteflies, jassids and small lepidopterous larvae which were among the first to be used in this fashion. CSL responds to olfactory cues from their aphid prey and can even distinguish between aphid species on volatiles (Sengonca, 1994).

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.

- **T1** = S. avenae
- **T2** = Casein Protein+ Protein Hydrolyzate+ Honey+ Water
- **T3** = Sugar+ Yeast+ Water
- **T4** = Casein Protein+ Water+ Honey
- **T5** = 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. 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 (6.2 days) 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).

Results of this study showed that predator fed on aphid prey 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.

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

DISCUSSION

Results of this study showed that egg laying on natural prey was 194.2. So there is difference between results of this experiment and Sarwar and Saqib (2010), who reported that Menochilus sexmaculatus had the highest fecundity when reared on Aphis pisorum (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

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