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Performance of *Coccinella Undecimpunctata* L. On Three Species of Aphids under Laboratory Conditions

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Abstract:

Study was carried out on the biology of 11- spotted beetle, Coccinella undecimpunctata L on Aphis gossypii, Rhopalosiphum maidis and Therioaphis musculata in laboratory from September 2011 to March 2012. Observations on the oviposition, fecundity, adult emergence, fertility, longevity and mortality were recorded. The results indicated that average pre-copulation period was 4.23± 0.45 days on A. gossypii, 5.14±0.76 on R.maidis, and 3.11±0.15 on T. musculata. Copulation period was 48.69±1.26 minutes on A. gossypii, 38.36±1.11 on R. maidis and 34.87±0.85 on T. musculata. Post-copulation period was 3.39±0.25 days on A. gossypii 3.80±0.25 on R. maidis and on 2.36±0.12 on T. musculata. Oviposition period was 42.60±1.14 days on A. gossypii, 36.15±1.08 on R. maidis and 31.10±0.65 days on T. musculata and post oviposition periods were 5.05±0.71 days on A. gossypii, 4.24±0.45 on R. maidis and 3.16±0.16 days on T. musculata. The mean fecundity/female was 388.26±11.35 on A. gossypii, 339.89±10.25 on R. maidis and 312.61±9.92 eggs on T. musculata. Whereas, the maximum incubation period was 3.22±0.08 days on A. gossypii, 3.36±0.14 on R. maidis and 3.74±0.22 days on T. musculata. The maximum total larval duration was observed 13.76 ± 1.86 day on A. gossypii, 15.66 ±2.23 on R. maidis and 15.17 ± 2.21 on T. musculata. The results further revealed that the percent male

emergence of C.undecimpunctata was 40 % on A. gossypii, 30% on R. Maidis and 36 % on T. musculata and female emergence was 60 % on A. gossypii, 70 % on R. maidis and 64% on T. musculata. The average consumption of female was more as compared to male adults. Whereas, 3rd and 4th instars were found more voracious than larval instars.

Key words: Coccinellid beetle, aphids, biology, feeding potential & laboratory

Introduction

Insect pests have always been a threat to agricultural productivity, in result the crop productivity per unit area in Pakistan is far less than the potential crop yields or when comparison is made with the yields achieved by agriculturally advanced countries of the world. Thus for controlling these harmful insects, different chemicals are applied against different insect pests (Rajesh *et al*., 2004). The farmers spray toxic chemicals on cotton, vegetables, oilseeds and fruit crops in order to avoid the pest infestation. Due to the intensive and indiscriminate use of many pesticides' poison, people suffer from many diseases, and some of these are chronic for human beings. Use of pesticides has resulted in the environmental pollution on large scale. Besides contaminating food and food products, pesticides have been accumulating in the soil, air and water to a critical stage. This calls for a safe and cheap control method of these insect pests; and which can only be achieved by the practice of Integrated Pest Management (IPM); a pest control management which ensures environmental safety (Solangi, 2004). Biological control is the use of an organism to reduce the population density of another organism and thus includes the control of pests, weeds and diseases. Firstly, in nature, most organisms are consumed by predators, which in many cases leads to drastic reductions in the population of the prey species; in biological control, man exploits this 'natural

control' to suppress the numbers of pest species. Secondly, biological control reduces rather than eradicates pests, such that the pest and natural enemy remain in the agro-ecosystem at low densities (Bale *et al.* 2008). Coccinellid beetles are entomophagous arthropods that devour soft bodied insects in general and aphids in particular (Dixon, 2000). There are probably as many as 4000 species of lady beetles found worldwide, they consist many important predators and parasitoids (Rai and Ramamurthy, 2002).

The 11-spotted ladybird beetle *Coccinella undecimpunctata* L. is most common predatory insect. It feeds on jassids nymphs and coccids particularly aphid species. These soft body insects are found on oil seed crop and green vegetable crops. These coccinellid beetles have been reported as bio-control agents against mustard aphids at Tandojam, Sindh (Ali *et al.* 2005, and Rizvi *et al.* 1995). The 11-spotted ladybird beetle is widely distributed in the world and commonly feed on Aphid species and other soft bodied arthropods. The beetle completes its life cycle in 15-20 days (Daliwari and Dhaliwal, 1989). Among several coccinellids *C. undecimpunctata* L. is a generalist predator on a large number of soft bodied insects including ground nuts aphids, coffee green bug, sugarcane leaf hopper, alfalfa aphid, castor white flies, sorghum shoot fly and maize aphid (Chaudhry *et al.* 1983).

Aphids are very serious insect pests in agriculture everywhere in the world. These are small homopteran plant sap-sucking insects infesting both aerial and sub- aerial parts of plants. As a result of their attack the plants show various symptoms of damage. Aphids being obligatory parasites of plants will naturally include plants of economic importance as their food source and there is hardly any plant that is spared by the one or other aphid species (Anand, 1983). In view of the significance of 11-spotted ladybird beetle in biological control of aphids, the study was planned for the preference by 11- spotted beetles on three different species of aphids will be tested to

evaluate the development and efficiency of beetle on the favorable aphid diet specie in laboratory conditions.

Materials and Methods

1. Biology: Experiment on behavioural studies of 11-spotted beetles on cotton aphid, *Aphis gossypii* (Glov.), alfalfa aphid, *Therioaphis maculate* (Buckton) and corn leaf aphid, *Rhopalosiphum maidis* (Fitch) under laboratory conditions was conducted during 2012 in the laboratory, Department of Entomology, Faculty of Crop Protection, Sindh Agriculture University, Tandojam.

1.1 Culture development: Adult beetles of coccinellid predator, *C. undeciumpunctata* and aphid species were collected from maize, cotton, corn, alfalfa, berseem and other crops. The adult beetles were brought to laboratory and confined in cubicular plastic cage (25″×10″×15″cm). The side of cages were secured by wire gauze and front of each cage had an operator/observer hole guarded by muslin cloth sleeve to provide food for predators. The fresh young leaves of respective hosts containing the aphids (prey) were provided daily to the adult beetles.

1.2 Development of life cycle:

i. Eggs: The eggs deposited mainly on host plant leaves were removed daily with the help of camel hair brush and kept in paired Petri dishes (9 cm.dia.) having a filter paper spread over bottom. The number of eggs laid per female in each Petri dish was counted under binocular microscope. This procedure was repeated till the death of the ovipositing females. Each experiment was replicated ten times. The laboratory temperature of 25 ± 2^0C and at 60 to 70% R.H was made.

ii. Larval instars: After hatching of eggs, the duration of larval stages were determined by placing each larva in Petri dish provided with aphids and replicated 10 times. The observations pertaining to obvious morphological changes and molting were recorded daily up to last larval instar.

iii. Pupal and adult stages: The pupal stages were observed by placing 4th instars larva in Petri dishes (9.0×1.5 cm). The duration of pupation was observed two times daily, until the pupae were ecdyced and the adults emerged. The newly emerged adults were sexed and replaced in Petri dishes by placing a male and female pair in each Petri dish and replicated 10 times. Adults were provided with counted aphids on fresh leaves of mustard the percent emergence of male and female adults, their longevity and sex ratio were determined. The pupal and adult mortality was recorded daily by counting the dead pupae and adults.

1.3 Mating behaviour of adult coccinellid beetle: Newly emerged adults (male and female) were released in glass bowls (7 cm ×2.5 cm) in pairs to record the observation on mating behavior, duration of mating, pre-oviposition, oviposition and post oviposition periods. The number of eggs (fecundity) laid by each female during her life time, incubation period of eggs, hatching percentage of eggs and mortality were recorded.

2. Feeding preference of *C. undeciumpunctata*in laboratory.

2.1 Larval (grub) instars: After hatching from eggs, the first instar larvae of *C. undeciumpunctata* were transferred into Petri dishes (9 cm. dia.) by camel hair brush. For feeding potential the aphids were provided 30, 80, 130 and 250, along with the leaves of cotton crop on replicated five times. This was repeated in 1st, 2nd ,3rd and 4th instar larvae. The aphid

consumption of each larval instar of each predator was observed after 24 hrs daily until the larvae entered into next development stage. The experiment was continued until pupation.

2.2 Adults: Newly emerged adults of each coccinellid beetle *C. undeciumpunctata* were collected from pupal culture at random. Male and female adults were kept separate in Petri dishes and same experiment was repeated by providing 2840 and 3170 aphids to each adult beetle. The consumption of aphids was recorded after 24 hours daily by counting the number of alive aphids. The experiment was repeated five times.

Results

1. Biology of 11-spotted beetle, *Coccinella undecimpunctata L.*

i. Pre-copulation period: In this study (Table 1) it was observed that the pre- copulation (latent) period (duration of males stand still between genital contact and first bout of body shaking) in male of *C. undecimpunctata* was maximum 5.14±0.45 days (the period before first mating) on *A. gossypii*. This was followed by 4.23±0.45 days on *R. maidis* and 3.11±0.15 minutes on *T. musculata*. Prior to copulation the excited male beetle approached females beetle from behind, just to make sure if she was ready. In case if the female was not ready (reludant), female beetle ran away, otherwise the female beetle accepted the male for mating. For receptive females, the male from behind mounted on her back and hold her firmly with the help of his fore and middle legs. Thereafter, the male bend his abdomen at an angle of about 60 to receive the female genitalia.

ii. Copulation period: The data inTable-1 shows that the maximum mean copulation period of a pair of C. undecimpunctata was an average of 48.69±5.26 minutes on Aphis gossypii followed by 38.36±3.91 minutes on R. maidis, and 34.87±3.85 minutes on T. musculata. During copulation the aedaegus (penis) of male is protruded out from the extended tip of the abdomens and enters the genital opening of the female. The female remains quite during copulation and she holds firmly the leaf or branch of plant or sides of cage or Petri dish. The male have forward and back movement of the abdomen at intervals until the mating is completed.

iii. Post-copulation period: Table-1 also indicates the post copulation period of *C. undecimpunctata.* The maximum mean post-copulation period was 3.80±0.75 days on *R. maidis* followed by 3.39±0.25 days on *A. gossypii* and 2.36±0.12days on *T. musculata.*

iv. Oviposition period: The data in Table-1 indicated that maximum mean oviposition period of 42.60±4.14 days on *A. gossypii* followed by 36.15±3.98 days on *R. maidis* and 31.10±3.65 days on *T. musculata* aphids.

v. Post-oviposition period: The results in Table-1 showed that maximum mean post-oviposition period of 5.05±0.71 days on *A. gossypii* followed by 4.24±0.45 days on *R. maidis* and 3.16±0.16 days on *T. musculata* aphids.

vi. Fecundity rate and incubation period of eggs: The data inTable-2 shows that total number of eggs laid by females of *C. undecimpunctata* (fecundity) during her life time was maximum mean number of 388.26±11.35 eggs when reared on *A. gossypii* followed by 339.89±10.25 eggs on *R. maidis* and 312.61±9.92 eggs on *T.musculata.* The results thus indicate that the maximum fecundity was recorded in the females

reared on *A. gossypii* and *R. maidis* aphids. However, lowest fecundity was on *T.musculata* aphid. The data in Table-2 further indicates that the incubation period of eggs was maximum mean 3.74 days) on *T. musculata.* Followed by 3.36 days on *R. maidis* and 3.22 days on *A. gossypii.*

vii. Hatching rate: The data inTable-2 further revealed that the hatching rate of eggs was maximum mean (64%) on *A. gossypii*, followed by 50% on *R. maidis and* 44% on *T. musculata* recorded in laboratory.

viii. Larval (grub) duration: The result of data in table -3 show that larval duration of 1st to 4th instars of *C. undecimpuntata* at temperature 25±2 ^{0}C, R.H. 55±5% in laboratory. Perusal of data indicates that larvae passed through four instars on all prey hosts. The maximum mean duration of first, second, third, in fourth instar larvae on corn aphid *R. maidis* were 3.10±0.40, 3.98±0.82, 4.12±0.93 and 4.46±0.98 days respectively, followed by on *T. musculata* were 2.80±0.40, 3.36±0.27, 3.87±0.42, and 5.14±1.15 days respectively. Similarly, on *A. gossypii* the mean duration was 2.60±0.35, 3.11±0.15, 3.69±0.37 and 4.36±0.87 days respectively. The total larval duration of all instars of greater on *R. maidis* (15.66±2.23 days) followed by *T. musculata* (15.17±2.21 days) and *R. maidis* (13.76±1.86 days).

ix. Pupal duration: As indicated in table- 3 the mean of *C. undecimpunctata* at 25±2^{0}C, R.H. 55.5% was maximum on *A. gossypii* (4.37±0.49 days), followed by *R. maidis* (4.01±0.33 days), and *T. musculata* (3.29±0.28 days).

x. Immature stages duration: The result in table- 3 indicates the total immature stages (Larval + Pupal) duration of *C. undecimpunctata* of greater on *R. maidis* (19.66±2.87

days), followed by *T. musculata* (18.46±2.62 days) and *R. maidis* (18.13±3.32 days).

xi. Pupation rate and Cannibalism percent: Results in Table-4 reveal that highest pupation percentage was observed in larvae of *C. undecimpunctata reared* on *A. gossypii* (80.0%). This was followed by *R. maidis* (60.0%) and *T. musculata* (70%). The data in Table-4 further indicates that cannibalism was normal among the larvae of *C. undecimpunctata* reared on different host species. The highest percent cannibalism rate was observed on *R. maidis* aphid (40%). It was followed by on *T. musculata* (30%) and *A. gossypii* (20%). Cannibalism is a wide spread phenomenon found in many arthropods. It is generally considered that this behavior is shown by coccinellids during the shortage of natural prey but during present study it was observed that fourth instar larvae of *C. undecimpunctata* cannibalism some percentage of younger larvae even in the presence of aphid preys.

xii. Adult emergence: The results in Table-5 indicated that the total percent emergence of male and female adults was 40% and 60% *A. gossypii*, 30% and 70% on *R. maidis* 36% and 64% on *T. musculata* respectively. Similarly, the result thus indicate that emergence of female adults was higher than male adults. However there was no significant difference in the emergence of both sexes (P>0.05).

xiii. Adult longevity*:* Table-6 indicates the longevity of male and female adults of *C. undecimpunctata* reared on different aphid species. The longevity in females was higher as compared to males on three host species. The mated male adults survived for 40.12±3.12 days on *A. gossypii,* 32.25±2.79 days on R. maidis and 28.69±2.59 days on *T. musculata.* Similarly the female adult longevity was 45.41±4.15 days on A. gossypii, 38.56±3.63 days on R. Maidis and 33.78±3.87 days on

T. musculata. The result thus suggested that maximum longevity in both male and female adults was higher when reared on *A. gossypii* followed by *R. maidis* and T. musculata.

Table-1 Behaviour and duration of copulation of *C. undecimpunctata L.* reared on different host species in laboratory. (Mean temper: 25 ± 2^{0}C, R.H. 55 ± 5%).

Prey host species	Pre-oviposition period			Oviposition Period	
	Pre-copulation (days)	Copulation (minutes)	Post-copulation (days)	Oviposition (days)	Post-oviposition (days)
cotton aphid (*Aphis gossypii*)	4.23±0.45	48.69±5.26	3.39±0.25	42.60±4.14	5.05±0.71
Corn aphid (*Rhopalosiphum maidis*)	5.14±0.76	38.36±3.91	3.80±0.75	36.15±3.78	4.24±0.45
Alfalfa aphid (*Therioaphis musculata)*	3.11±0.15	34.87±3.85	2.36±0.12	31.10±3.65	3.16±0.16

Table-2 Effect of host species on the fecundity and percentage hatching eggs of *C. undecimpunctata L.* in laboratory condition. (Mean temper: 25 ± 2^{0}C, R.H. 55 ± 5%).

Prey host species	Fecundity per female	No. of eggs kept for hatching	Incubation period (days)	No. of eggs hatch	Hatching Rate (%)
Cotton aphid (*Aphis gossypii*)	388.26±11.35	50	3.22±0.08	32.11±0.73	64
Corn aphid (*Rhopalosiphum maidis*)	339.89±10.25	50	3.36±0.14	25.07±0.56	50
Alfalfa aphid (*Therioaphis musculata)*	312.61±9.92	50	3.74±0.22	22.02±0.43	44

Table-3 Duration (Days) of larval and pupal stages of *C. undecimpunctata* L. reared on different prey host species in laboratory. (Mean temper: 25 ± 2⁰C, R.H. 55 ± 5%).

Prey host species	Duration of larval instars (days) (X ± S.E)				Total larval duration period (days) (X ± S.E)	Total Pupal period (X ± S.E)	Total duration Immature stages (larval + Pupal)
	1st Instar	2nd instar	3rd instar	4th instar			
cotton aphid (*A. gossypii*)	2.60±0.35	3. 11±0.15	3.69±0.37	4.36±0.87	13.76±1.86	4.37±0.49	18.13±2.32
Corn aphid (*Rhopalosiphum maidis*)	3.10±0.13	3.98±0.82	4.12±0.93	4.46±0.98	15.66±2.23	4.00±0.33	19.66±2.87
Alfalfa aphid (*Therioaphis musculata)*	2.80±0.40	3.36±0.27	3.87±0.42	5.14±1.15	15.17±2.21	3.29±0.28	18.46±2.62

Table-4 Pupation and larval cannibalism in *C. undecimpunctata* L. reared on different host species in laboratory. (Mean temper: 25 ± 2⁰C, R.H. 55 ± 5%).

Prey host species	No. Larvae observed	No. Pupal (emerged)	Pupation rate (%)	Cannibalism %
Cotton aphid (*Aphis gossypii*)	50	40	80	20
Corn aphid (*Rhopalosiphum maidis*)	50	30	60	40
Alfalfa aphid (*Therioaphis musculata)*	50	35	70	30

Table-5 Adult emergence rate of male and female adults of *C. undecimpunctata* L. reared on different host species in laboratory. (Mean temper: 25 ± 2⁰C, R.H. 55 ± 5%).

Prey host species	No. of pupae observed	Adult emergence			
		Males		*Females*	
		Emerged	%age	Emerged	%age
Cotton aphid (*A. gossypii*)	50	20	40	30	60
Corn aphid (*Rhopalosiphum maidis*)	50	15	30	35	70
Alfalfa aphid (*Therioaphis musculata)*	50	18	36	32	64

Table-6 Adult male and female longevity of *C. undecimpunctata* L. reared on different host species. (Mean temper: 25 ± 2⁰C, R.H. 55 ± 5%).

Prey host species	Male	Female
Cotton aphid (*A. gossypii*)	40.12±3.12	45.41±4.15
Corn aphid (*Rhopalosiphum maidis*)	32.25±2.79	38.56±3.63
Alfalfa aphid (*Therioaphis musculata)*	28.69±2.59	33.78±3.87

2.0 Feeding potential (1st, 2nd, 3rd and 4th larval instars) of *C. undecimpunctata* L. (during 24 hours) on different prey aphid species.

The data in Table-7 shows the feeding potential of larval instars of *C. undecimpunctata during* (24 hours) on different aphid species. The results presented in table-7 indicated that the mean prey consumption of first instar larvae of *C. undecimpunctata* during (24 hours) period was 9.28 aphids when larva fed on *A. gossypii.* Similarly on *R. maidis* the feeding rate was 7.56 aphids, on *T. musculata 5*.28 aphids. The mean highest consumption of aphids was recorded on *A. gossypii,* and lowest on *T.musculata.* Similarly in the second instar larva the mean highest consumption rate during 24 hours was recorded on 6 hours was recorded on *R. maidis.* (19.39 aphids / larva), followed by *A. gossypii (*15.21 aphids) *T. musculata* (14.36 aphids).

Similarly in the third instar larva the maximum mean feeding was noted on) *T. musculata* (35.36 aphids/larva), followed by *R. maidis* (31.15) *A. gossypii* (21.26 aphids). Similarly in fourth instar larva of *C. undecimpunctata* the maximum mean feeding rate was observed on *T. musculata* (52.85 aphids) followed by *A. gossypii.* (42.69 aphids), *R. maidis* (39.64 aphids).

The results thus suggested that highest feeding rate of aphid species was recorded in the fourth instar larva, followed by third instar, second instar and first instar larva of *C.*

undecimpunctata. The fourth instar larvae were more voracious feeders and devoured significantly highest number of aphids then other instars.

Table-7 Total mean aphid consumption of 1st, 2nd, 3rd, & 4th instar larvae of *C .undecimpunctata L.* on different prey (aphid) species

Aphid species	Aphid consumption per (24 hours) (Mean ± S.E)			
	1st instar	2nd instar	3rd instar	4th instar
Cotton aphid (*A. gossypii*)	9.28±1.47	15.21±1.97	21.26±2.06	42.69±3.89
Corn aphid (*Rhopalosiphum maidis*)	7.56±1.05	19.39±2.82	31.15±2.45	39.64±3.02
Alfalfa aphid (*Therioaphis musculata)*	5.28±0.98	14.36±1.89	35.36±3.82	52.85±5.56

Feeding potential adults (male and female) of *C. undecimpunctata* L. (during 6 hours) on different prey aphid species.

i. **Male adults:** The data mentioned in table-8 reveals that the mean feeding rate of male adults of *C. undecimpunctata on* different host species varied with the age of male adults. The results show that male life span on *A. gossypii was* 28 days and it devoured mean 46.17 aphids per day. On *R. maidis* the longevity of male adult was 30 days and aphid consumption per day was 42.89 Similarly on *T. musculata* the life span of male adult was 36 days and it devoured 60.56 aphids / day. The data reveals that *T. musculata was* most preferred food and *R. maidis* was least preferred prey for male adults of *C. undecimpunctata.*

ii. **Female adults:** The results in table-8 indicated that female adults lived longer on *A. gossypii* (39 days) followed by *R. maidis* (36 days), *T. musculata* (34 days). The mean aphid consumption by female adults was more on *A. gossypii* (55.34 aphids / day) followed by *R. Maidis* (42.89 aphids), *T. musculata* (70.89 aphids/day). The

overall data shows that female adults lived longer and consumed more number of aphids than male adults of *C. undecimpunctata*. However, there is no significant difference between both sexes.

Table-8 Total age and mean aphid consumption of adult male of *C. undecimpunctata L.* on different prey (Aphid) species.

Aphid species	Aphid consumption per (24 hours) (Mean ± S.E)	
	Male	Female
Cotton aphid (*Aphis. gossypii*)	46.17±4.67	55.34±5.33
Corn aphid (*Rhopalosiphum maidis*)	42.89±4.12	47.23±4.93
Alfalfa aphid (*Therioaphis musculata)*	60.56±6.26	70.89±7.19

Discussion

The present experiment was conducted to study the biology of 11-spotted beetle *Coccinella undecimpunctata* L. reared on aphid species under laboratory conditions during the year 2012. Aphid species are the sucking pests which damage the plants by sucking the saps. For the management of these aphid species biological control is the best way, so the biology of 11- spotted beetles was necessary to know the breeding information of predators on studied aphid species. It was observed from the results of the present studies that pre-copulation, copulation duration, post copulation days, oviposition days as well as post oviposition days varied to a considerable extent within the replications/pairs of ladybird beetles. Similar was the situation for fecundity and fertility, and within ladybird beetle pairs deviation was considerable. The incubation period, 1st , 2nd, 3rd and 4th instar durations were relatively similar, while duration was greater for the pupal stage. Adult emergence was greater in female 11-spotted ladybird beetles as compared to male beetles and thus the sex ratio was higher in females as

compared to males. The longevity was comparably higher in case of female ladybird beetles than male beetles.

The present study agree with those of Bhadauria *et al.,* (2001) studied biological and feeding of *Menochilus sexmaculatus* on the five aphid species, *Lipaphis erysimi* (Kalt.). *Aphis craccivora* (Koch.). *Hayadaphis coriandri* (DAS), *Aphis nerri* (BLF) and *Uroleucon compositae* (Theobald). *U. compositae* hindered the larval development of the predator and adults transformed from the larvae fed on *U. compositae* failed to lay nymphs. *A. nerri* was the most suitable host. The fecundity was higher when fed on adults than nymphs. The consumption of nymphs on *H. coriandri* was maximum during larval development and lowest of *U. compositae*.

The present study also partially agree with the Ali *et al.* (2005) evaluated the predatory potential of *Coccinella undecimpunctata* on cotton aphid (*Aphis gossypii*) under laboratory conditions. Larvae of the 1st, 2nd, 3rd and 4th instars, and adults were provided with aphids on cotton leaves. Predatory potential and aphid mortality due to injury by larvae significantly varied among the larval instars except the 2nd and 3rd instars, for which both parameters did not significantly vary. He number of aphids consumed per larva increased with the larval age, and the 4th-insar larvae recorded the greatest predatory potential (21.28 aphids per grub) and feeding percentage (85.12%). Aphid mortality due to injury caused by larvae, which decreased with the increased in larval age, was highest for 1st-instar larvae (15.87%). Daily feeding increased with the age of the beetle, reached the peak on the 17th day of the male (42.67 aphids per beetle) and female (60.33 aphids per day) beetle, then decreased towards the end of the physiological age. The feeding potential of females was greater than that of males.

The present study also in agreement with those of Solangi *et al.* (2007b) studied the biology of 11-spotted beetle *Coccinella undecimpunctata* L. on mustard aphid during

the year 2006. The oviposition, fecundity, adult emergence, fertility percentage, sex ratio, longevity and mortality were studied in the laboratory on 10 separately reared pairs of beetles. The results indicated that average pre-copulation period was 4.1±1.28 days post copulation period 3.6±1.26 days, oviposition period, 37.7±6.88 days and post oviposition period 4.0±1.63 days. The mean fecundity was 593.4±86.5 eggs, fertile eggs were 531.80±76.16 with the fertility percentage of 89.63±3.44. the incubation was 3.1±1.19 and 3.1±0.94 days while 1st and 2ndinstar larva period was 3.1±1.19 and 3.1±0.87 days and for 3rd and 4th instar larvae averaged 3.5±1.26 and 3.3±0.94 days, respectively whereas the total larval period was 12.9±1.28 days and pupal period 5.6±0.96 days. The average number of pupae observed was 19.9±6.69, while the male emergence was 7.4±2.63 (38.50±13.12%) and the female emergence was 8.9±3.66 (43.48±8.24%). The sex ratio (male: female) averaged 1:1.25±1: 0.45. Thus the total male + female emergence was 81.99±13.37 per beetle pair. The mortality recorded was 3.7±3.43 beetles showing an averaged mortality of 17.57±14.51%. Longevity of the male was 36.5±4.17 days and the female longevity of 46.0±9.14 days. It was recorded that longevity period was significantly greater in case of female ladybird beetles as compared to their males. Adult emergence was greater in females of 11-spotted beetles as compared to males and thus the sex ratio was higher in females as compared to males. The longevity was comparably higher in case of females than in male beetles.

Conclusion

- In *C. undecimpunctata beetle* the duration of pre-copulation, copulation and post copulation, oviposition and post oviposition days varied on aphid species.
- Similar was the situation for fecundity and fertility, and within different pairs of ladybird beetle pairs deviation was considerable.

- The egg incubation period and duration of 1st, 2nd, 3rd and 4th instars also different on different species.
- Adult emergence was greater in female beetles as compared to males and thus the sex ratio was higher in females as compared to males on different aphid species.
- 3rd and 4th instars are voracious feeders as compared to 1st and 2nd instars.
- Adult female consumed more number of aphid as compared to males.

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