Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2016; 4(4): 1306-1310

Received: 20-05-2016
Accepted: 21-06-2016

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Biological parameters and preferential feeding response of *Coccinella undecimpunctata* L. on three aphid species

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Abstract
Laboratory study was carried out in the department of Entomology, Sindh Agriculture University, Tando Jam Pakistan during winter season from December 2009 to March 2010, to investigate the Biological parameters and preferential feeding response of *Coccinella undecimpunctata* (L) against aphid species. For this purpose fully matured *Coccinella undecimpunctata* (L) was reared on three aphids species such as maize aphid, *Rhopalosiphum maidis* (F), alfalfa, *Therioaphis trifolii* and mustard aphid, *Lipaphis erysimi* (K). Results revealed that both adult and grubs of *C. undecimpunctata* (L) had significant feeding potential on all aphid species but highest feeding potential was recorded on alfalfa aphid than mustard and maize aphids respectively period under studied, because of its higher survivorship comparatively than on other aphid species.

Keywords: Biology, feeding response, aphids, 11-spotted beetle

1. Introduction
Insect predators are normally considered as effective control of insect pest populations [1]. Ladybird beetles have very distinctive shape and can be easily identified [2]. Larval and adult stages are very good predators of aphids and other small insects and mites [3]. Beetles act as bio-control agent that feed very rapidly on aphids. When there is fine excess of aphids fed to beetles they always lay little or vast bunches of eggs [4]. The insects of Coccinellidae family are very gracious and valuable. These are predators of many other insects that help farmers in controlling the crop damaging insects below threshold level [5]. As an outcome, the role of biological control stands as a gainful alternative to the use of chemicals in the agro-ecosystem [6]. Coccinellids have got attention of researchers as biological control agents, due to their ability to feed on a large number of preys [7]. 11-spotted (*Coccinella undecimpunctata* L) both adult and larvae are considered potential predators of a wide range of prey, as well as aphids [8]. 11-spotted (*Coccinella undecimpunctata* L) is very effective in keeping alfalfa's aphids below the economic threshold level [9]. In Pakistan, the mustard is attacked by a number of aphids and 11-spotted beetle is frequently found in Mustard crops [10]. Reported the maize aphid *Rhopalosiphum maidis* is one of the major pests infesting maize crop [11].
Information pertaining to the biological parameters and feeding preference of predatory beetle on three aphid species is essential for assessing the potential rate of increase for a population and his predation for the use as biological control agent against these host species.
Such work uncover prey-predator abundance, allowing forecasting the suitability of a predator as a biological control agent. This work aimed to investigate the suitability of *C. undecimpunctata* as a biological control agent for the maize aphid, *Rhopalosiphum maidis* F, alfalfa aphid, *Therioaphis trifolii* and mustard aphid, *Lipaphis erysimi* K (Hemiptera: Aphididae) which are important pests in Pakistan.

2. Material and Methods
2.1 Biological Parameters
The 11-spotted *Coccinella undecimpunctata* L. beetle and their hosts (aphids) required for the study were collected from fields of Maize, Alfalfa and Mustard and were brought in to laboratory and reared at 20±2 ºC during winter season from December 2009 to March 2010 in the laboratory of department of Entomology, Sindh Agriculture University, Tando Jam Pakistan.

The adults were paired and reared on maize aphid, *Rhopalosiphum maidis* F, alfalfa aphid, *Therioaphis trifolii* and mustard aphid, *Lipaphis erysimi* K, while plant leaves were offered as oviposition substrate and as a food for aphids in wide mouth, plastic jars secured by muslin cloth. Fresh stocks of leaves with aphids were provided daily. The eggs laid by female beetles on aphid host leaves were transferred to Petri- dishes (9 cm dia.) having a circular paper sheets spread over the bottom for egg developmental study. Percent egg hatch was recorded daily. The beetle larvae obtained were used to determine larval stage and were reared singly in Petri dishes. The same procedure for the pupal period was applied. Oviposition and post-oviposition periods, fecundity, fertility and longevity of adults were also recorded. Each treatment had 10 replications.

2.2 Predatory efficiency

After hatching, the young larvae were transferred individually in Petri-dishes (6.0 × 1.0 cm). The bottoms of the Petri-dishes were covered with a moistened filter paper. The pre-determined aphids were supplied every morning at the rate of 90, 80, 70 and 60 in number for 1st, 2nd, 3rd and 4th instar, respectively. The preys were supplied on leaf and the base of the leaf. The food was changed within 24 hours. The number of aphids consumed within 24 hours and duration of each instar were recorded. For determining the predation efficiency of adult beetle, the newly emerged adults were transferred individually in Petri-dishes (6.0 × 1.0 cm). Aphids were supplied everyday at the rate of 100 for an adult on bean leaf. The base of the leaf was covered as described earlier. The number of aphids consumed by an adult beetle were recorded every 24 hours and continued until the death.

The results were analyzed by ANOVA and Multiple Range test (DMR) using Statisix 8.1 computer software**.**

3. Results

The results from the current study revealed that the pre-oviposition period of the predatory beetle was 4.02, 3.51 and 3.91 days, for oviposition period it was 24.22, 25.41 and 23.62 and for post-oviposition period in days was 4.66, 4.50 and 3.99 for maize, alfalfa and mustard aphid, respectively. Table-1

The mean number of eggs 621, 616, and 601 were recorded when reared on maize, alfalfa, and mustard aphids and these values are highly significant. The hatch percent of eggs was 70.21, 68.11, and 66.03 when reared on maize, alfalfa, and mustard aphids under laboratory conditions and values are non-significant. The mean incubation period of *C. undecimpunctata* L. eggs laid by females reared on maize, alfalfa, and mustard aphids were 6.5, 8.20, and 7.0 days respectively with non- significant chi-square vale (0.039) at 0.05 level. (Table–1)

The data in Table-1 depicts that the grubs passed through four instars to reach the pupal stage. Feeding on different host aphids did not significantly influence the duration of various life stages of *C. undecimpunctata.* The duration values in days for first, second, third and fourth instars ranged between 6.50, 5.60, 7.90 and 8.01, respectively for maize aphid. For alfalfa aphid it was ranged between 5.25, 6.0, 6.10 and 7.80, respectively. The duration ranged between 5.23, 5.66, 5.91 and 8.50, respectively for mustard aphid. Female adult beetle life span under present study was 35, 50.00, and 40.00 days and for male adult it was 30.00, 42.00 and 32.00 days on maize, alfalfa and mustard aphids, respectively (Table-1).

Table 1: Biological parameters of *Coccinella undecimpunctata* Linn. reared on three host aphids.

Parameter	Maize Aphid	Alfalfa aphid	Mustard aphid
Pre-oviposition Period – Days	4.02	3.51	3.91
Oviposition Period – Days	24.22	25.41	23.62
Post – Oviposition Period – Days	4.66	4.50	3.99
Fecundity (No. of eggs)	621	616	601
Percent hatch	70.21	68.11	66.03
Incubation period – (Days)	6.50	8.20	7.00
First instar – Days	6.50	5.25	5.23
Second instar – Days	5.60	6.0	5.66
Third instar – Days	7.90	6.10	5.91
Fourth instar – Days	8.01	7.80	8.50
Pupal Period – Days	4.01	4.59	4.30
Adult (female) life – Days	35.00	50.00	40.90
Adult (male)	30.00	42.00	32.00

3.1 Preferential feeding response of larval instars per day

Fig-1 indicates that all four instars of predatory beetle were voracious feeder of all aphid species. The 1st instar of predatory beetle devoured 5.50, 10.95 and 6.5 maize, alfalfa and mustard aphids, respectively, 2nd instar devoured 20.01, 36.11 and 25.5, the preferential feeding response of 3rd instar larvae was 30.12, 46.5 and 36.5 and 4th instar larvae devoured 41.25,57.12 and 46.11 maize, alfalfa and mustard aphids, respectively. The statistical analysis showed highly significant difference between predatory efficiency of the instars (F=123.15 df =3, P<0.05). Multiple Range (DMR) test indicated that the 4th instar was various predator than others. However, ANOVA results further showed highly significant difference in different aphids species (F=25.81 df =2, P<0.05) devoured by larval instars. Multiple Range (DMR) test further indicated that the predator preferred alfalfa aphid against mustard and maize, respectively.

The data in Fig-2 indicate the exploitation rate of male adult *C. undecimpunctata* on all aphid species tested increased with the age of 13th and 14th day for maize aphid (37.0), on 19th and 20th day for alfalfa aphids (46.0) and on 12th and 13th day with maximum (45.0) for mustard aphid. The feeding rate decreased after mid age in case of each host-aphid species. The mean feeding rate throughout adult life was 74.64, 74.37 and 73.96 for maize, alfalfa, and mustard aphids respectively. The statistical analysis showed highly significant in preference feeding response (male adult) between different aphids species (F=7.80 df =2, P<0.01). However, ANOVA results further showed highly significant difference between the days (F=6.76 df =29, P<0.05) aphid

species devoured by male beetle. Multiple Range (DMR) test indicated that the predator preferred alfalfa aphid against mustard and maize, respectively.

The data in Fig-3 depicted that the preferential feeding rate of female adult *C. undecimpunctata* on different aphid species shown that it increased with the age of 17th day for maize aphid (41.0), it was (54.0) on 28th day for alfalfa aphids and on 14th day with maximum (37.0) for mustard aphid. The feeding rate decreased after mid age in case of each host-aphid species. The statistical analysis showed highly significant in preference feeding response (female adult) between different aphids species ($F=10.09$ df $=2$, $P<0.01$). However, ANOVA results further showed highly significant difference between the days ($F=1.84$ df $=34$, $P<0.05$) aphid species devoured by female beetle. Multiple Range (DMR) test indicated that the predator preferred alfalfa aphid against mustard and maize, respectively.

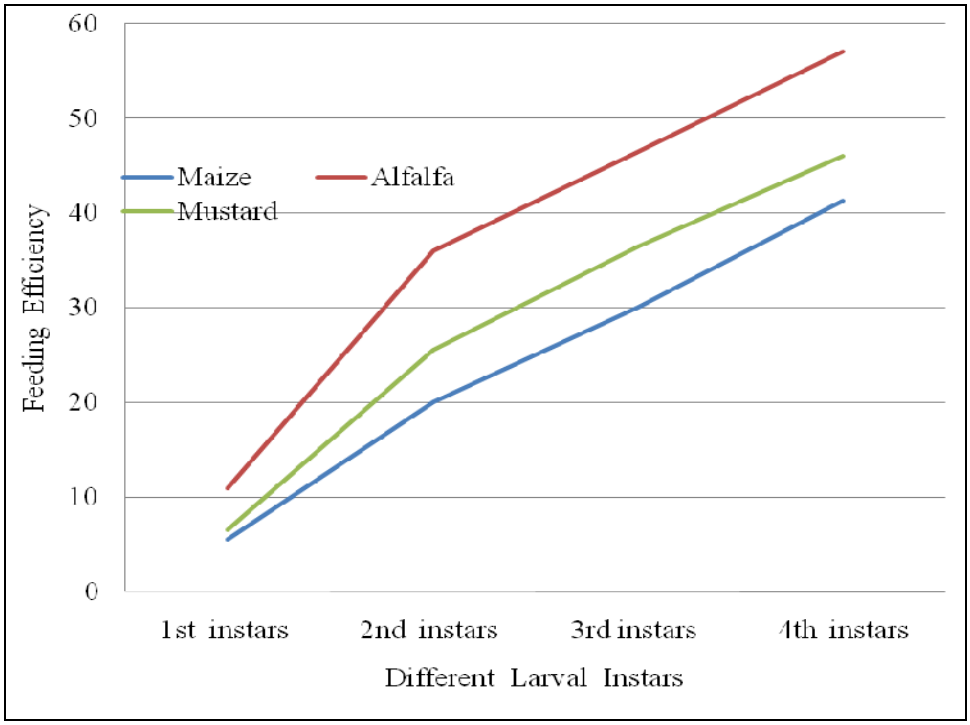

Fig 1: Feeding potential of different larval instars of *Coccinella undecimpunctata* on three aphid species.

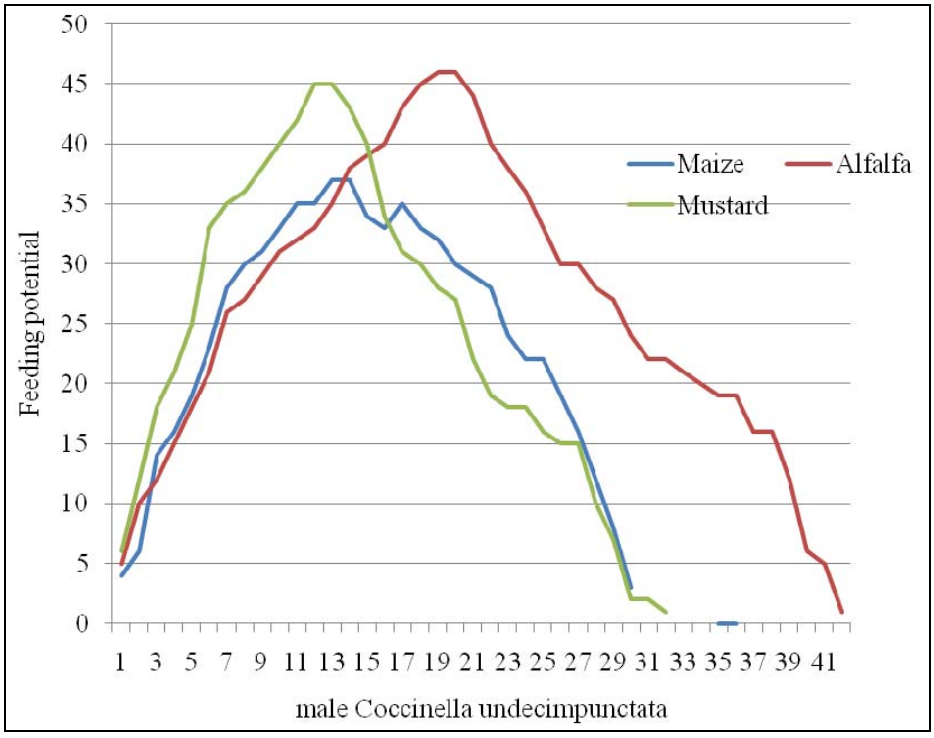

Fig 2: Feeding potential of adult male *Coccinella undecimpunctata* on three aphid species.

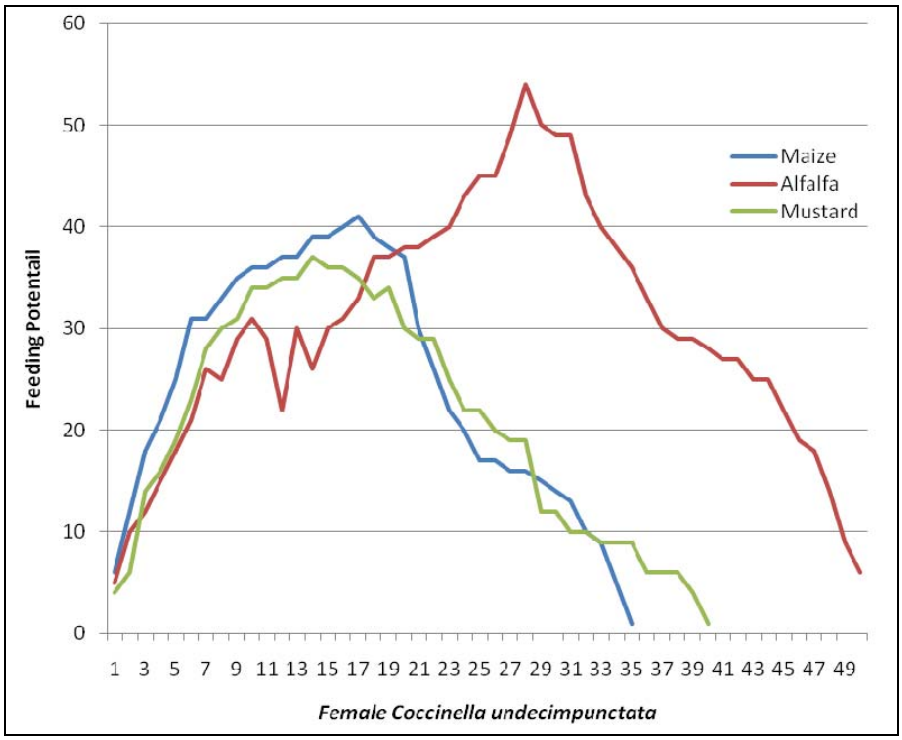

Fig 3: Feeding potential of adult female *Coccinella undecimpunctata* on three aphids species.

4. Discussion

During present studies the results shows that Pre-oviposition period of the predatory beetle was 4.02, 3.51 and 3.91 days, and for oviposition period it was 24.22, 25.41 and 23.62, respectively. Post-ovisition period in days was 4.66, 4.50 and 3.99 for maize, alfalfa and mustard aphid, respectively (Table–1).

The mean number of eggs per female recorded was 621, 616, and 601 when reared on maize, alfalfa, and mustard aphids respectively and these values are highly significant. Change in prey may influence the number of eggs per female as [12] reported 1391 eggs per female when *C. undecimpunctata* was fed *Aphis gossypii*. The hatch percent of eggs was 70.21, 68.11, and 66.03 when reared on maize, alfalfa, and mustard aphids under laboratory conditions (Table-1) and these values are non-significant. Saha (1987) [12] also reported that 48. 9-54. 80% hatch of the eggs when *C. undecimpunctata* females were reared on cotton leaves. The mean incubation period of *C. undecimpunctata* L. eggs laid by females reared on maize, alfalfa, and mustard aphids were 6.5, 8.20, and 7.0 days respectively with non- significant chi-square vale (0.039) at 0.05 level. Similarly [13] reported that incubation period of the eggs of *C. septempunctata* was about a week.

The data in (Table-1) depicts that the grubs passed through four instars to reach the pupal stage. Feeding of different host aphids did not significantly influence the duration of various life stages of *C. undecimpunctata.* The duration values in days for first, second, third and fourth instars ranged between 6.50, 5.60, 7.90 and 8.01 days, respectively for maize aphid. For alfalfa aphid it was ranged between 5.25, 6.0, 6.10 and 7.80 days, respectively. The duration ranged between 5.23, 5.66, 5.91 and 8.50 days, respectively for mustard aphid. Similarly [14] reported that at about 25 ^{0}C under laboratory conditions *C. undecimpunctata* required 17 days to reach adult stage and 18 ^{0}C it needed 23.6 days.

Pupal period in this study ranged between 4.01, 4.59 for maize, alfalfa and mustard aphid, respectively. [15] was reported in his study that pupal period ranged from 4 to 6 days with an average of 4.7 days *Coccinella septempunctata.* Adult female life span of the beetle under present study was 35.00, 50.00 and 40.90 days and for male adult it was 30, 42 and 32 days for for maize, alfalfa and mustard aphid, respectively. [14] reported that the adults lived 16-49 days when fed on aphids. [16] reported that females and males of *C. septempunctata* live an average of 47.6 and 46.9 days, respectively, at 20 °C. [17] reported an average longevity of 52.8 6 3.8 days for *Hippodamia convergens* Guerin Meneville, where females and males lived an average of 50.2 6 5.1 and 56.1 6 5.8 days, respectively. *A. variegata,* another species of Hippodamian, lived an average of 71.8 6 3.3 days, a slightly longer period, than that reported for *H. convergens,* perhaps due to differences in holding conditions and diets offered.

The data in (Fig-1) indicates that all the instars were found voracious feeders of all the aphid species tested. Similarly [18] were reported that mustard aphid is least preferred by *C. septempunctata* grubs. Adults devoured more mustard followed by maize and alfalfa aphid. During the studies, the results indicates that an average daily aphid consumption rate by *C. undecimpunctata* grubs was 24.51, 52.11, and 28.63 for maize, alfalfa, and mustard aphid and these values were highly significant. Similarly [19] reported that *C. undecimpunctata* grubs can consume 79 *Aphis craccivora* in a day.

In the present study it was observed that (Fig-2) the exploitation rate of adult *C. undecimpunctata* on all aphid species tested increased with the age, the maximum feeding rate on 13th and 14th day for maize aphid (37.0), on 19th and 20th day for alfalfa aphids (46.0) and on 12th and 13th day with maximum (45.0) for mustard aphid. The feeding rate decreased after mid age in case of each host-aphid species. The mean feeding rate throughout adult life was 74.64, 74.37 and 73.96 for maize, alfalfa, and mustard aphids respectively. [20] Reported that the adults of *M. sexmaculatus* consumed a mean of 30 *Myzus persicae* in a day.

5. Conclusion

It was concluded that *C. undecimpunctata* grubs and adults were voracious feed on all aphid species period under studied. But alfalfa aphid was most preferred as compared to mustard and maize aphids; respectively. This beetle has great potential and can be used as biological control agent against of these three aphid species to get significant results. Further studies on predatory efficiency of *C. undecimpunctata* may be conducted with other important aphid pests such as cotton, corn leaf and chickpea aphids which will be helpful for controlling aphid species in future.

6. Acknowledgments

The authors acknowledge The National Natural Foundation Project No. (31471822) Anhui Agricultural University Hefei China, for technical support and continuous encouragement. The authors would like to extend their thanks to editors and reviewers for their constructive comments on the manuscripts, including suggestions for improvement. This was a valuable contribution towards seeing the proceedings to completion of this research article.

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