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Predatory Efficiency of *Menochilus sexmaculatus* Fab. and *Coccinella undecimpunctata* Lin., (Coccinellidae: Coleoptera) on Alfalfa Aphid, *Therioaphis trifolii* (Monell.)

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Abstract: To evaluate predatory efficiency of *Menochilus sexmaculatus* Fab. and *Coccinella undecimpunctata* Lin.,(Coccinellidae: Coloptera) on alfalfa aphid *Therioaphis trifolii* (Monell) a laboratory experiment was conducted during winter 2000-2001 at Sindh Agriculture University, TandoJam, Sindh, Pakistan. The per day predatory efficiency of the zigzag beetle against 1st, 2nd, 3rd and 4th instars was worked out as 11.8, 26.8, 43.4 and 141.5, respectively and that of 11-spotted as 10.6, 18.4, 38.1 and 52.6 aphids. The per day efficiency for males of both zigzag and 11-spotted was 73.00 and 51.8, respectively; and that of the females it was 80.00 and 56.00 per day, respectively. The feeding rate per life stage of the zigzag beetle for all four instars was 86.5, 115.2, 164.9 and 948.1, respectively; and for the 11-spotted it was 55.10, 81.00, 175.20 and 278.80, respectively. The per stage for males of both these beetles rate was 2548.20 and 2930.00 respectively. And for the females it was 2800.00 and 3080.00 alfalfa aphids, respectively. Both the males of zigzag and 11-spotted beetles consumed 88.2 and 70 on 18th and 15th day and 60.5 and 58.3 aphids on 30th days of their age. Both the females consumed 99.21 and 77.4 on 18th and 21st day, respectively and 61.90 and 53.30 aphids, respectively on 30th day of their age. The voracity of both the beetles fluctuated as per aphid densities. The zigzag beetle: aphid ratio was 8.4: 10, 10.6:15, 11.2:20, 14.4:25, 17.0:30, 18.4:35, 23.8:40, 25:50 and 28:60 and that of 11-spotted it was 7.8:10, 9.2:15, 10.73:20, 12.4:25, 14.22:30, 16.6:35, 20.18:40, 21.93:50 and 24.26:60. The total consumption rate each of zigzag and 11-spotted was 19.49 and 15.30 aphids, respectively. The aphid population in control was worked out at zero predator that increased as 6.4, 7.2, 8.3, 9.4, 12, 12.8, 13.9, 14.68 and 14.8%.

Key words: Zigzag beetle, 11-spotted beetle, alfalfa aphid, efficiency

INTRODUCTION

In balanced ecosystems, insect pests are kept in check by their natural enemies (predators and parasitoids). These agents are beneficial in agricultural systems Nirmala[1].

Coccinellid predators play an important role in keeping aphid densities low in alfalfa and other field crops. Frazer[2], Rice and Wilde[3], Poswal *et al.*[4], Mulder and Ber-beret[5], Subhash and Chander[6], Khanand and Suhail[7], reported that coccinellids prey on aphids efficiently in alfalfa fields.

Spotted alfalfa aphid, *Therioaphis trifolii* is smaller ($^1/_{10}$ inch long) and an agile pest. It is pale green or yellow; has 4 to 6 rows of dark green spots on the upper abdomen, which is tipped with short hairs.

The aphid reproduces parthenogenetically (asexually). No males have been reported in Sindh[8]. Development of the aphid is optimal between 10 and 20°C. Besides drawing photosynthetic material from host plant, this species injects a toxic substance into the plant, Lohar[9]. The aphid causes yield loss to clover pastures in western and south-eastern Australia, Milne[10]. It is a menace in Pakistan[8]. Since no work on predatory efficiency of both *M. sexmaculatus* and *C. undecimpunctata* has been reported in Pakistan. Hence the present study was therefore conducted to evaluate predatory efficiency of *Menochilus sexmaculatus* Fab. and *Coccinella undecimpunctata* Lin.,(Coccinellidae: Coloptera) on alfalfa aphid *Therioaphis trifolii* (Monell).

MATERIALS AND METHODS

Comparative efficiency of the grubs: The comparative efficiency of zigzag and 11 spotted beetles was worked out by releasing grubs (instars) into predetermined aphids placed into Petri dishes with respective aphid-host leaves. 1st 2nd 3rd and 4th instars were obtained from the culture maintained in laboratory. Predation was recorded daily by counting consumed and left-over alfalfa aphids. Counting continued till the grubs metamorphosed.

Comparative efficiency of male and female adult: The one-day old adults of both beetles was collected at

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random from culture and confined without food into Petri-dishes for two days. After two days the male and female were replicated together five times and provided with 150 aphids in each Petri dish. Feeding rate of the beetles was recorded daily by counting unconsumed and dead aphids. The laboratory test was carried out at 20±2°C. The data were analyzed using regression analyses and analysis of variance (ANOVA).

Comparative efficiency of adults in field: Cages (2x2x4 ft L.W.H) were placed in the field, as suggested by Tenhumberg[11], at Integrated Pest Management, ARI, Tando Jam from December 1999 to February 2000. Predetermined number of aphids was kept in the cages along with one-day old adults of zigzag and 11-sptted beetles from the laboratory. The beetles were released into the cages at 24 h feeding intervals.

During the first week the aphid: predator ratio was 10:1, which was increased every weeks as 15:1, 20:1, 25:1, 30:1, 35:1, 40:1, 50:1 and 60:1, respectively. Each treatment had five replications. Control cages were used to determine aphid development without the test coccinellids.

At each observation, counting of consumed and alive aphids was made in each cage. Again the same number of beetles was released as fresh food for the next 24 h. Aphid consumption rate was estimated by comparing growth rate of aphid in the Control cages at a 24 h interval.

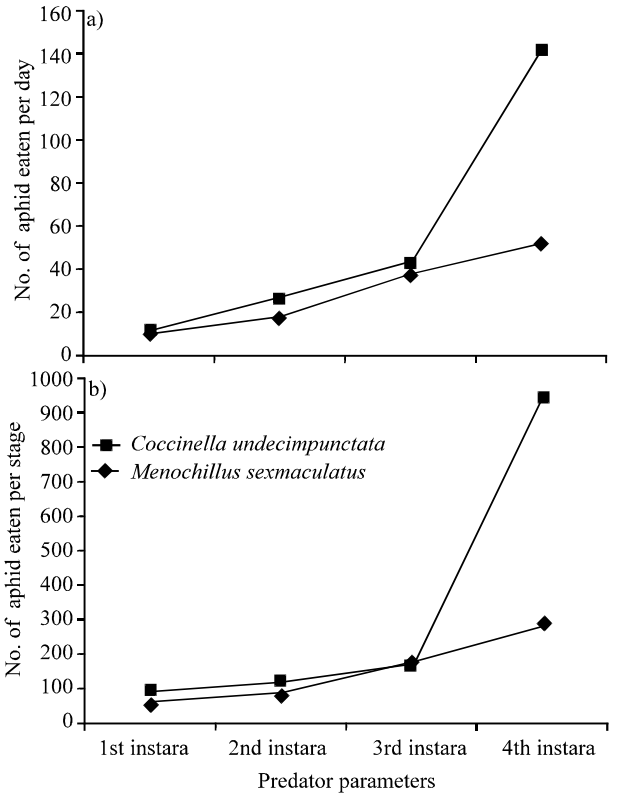

Fig. 1: Comparative efficiency of *M. sexmaculatus* and *C. undecimpunctata* (grubs) on alfalfa aphid. (a) efficiency rate per day (b) efficiency rate per day

RESULTS AND DISCUSSION

Comparative efficiency of zigzag grubs

Efficiency rate per day: All four instars of the zigzag beetle were found to be voracious feeders. The instars of the zigzag beetle devoured 11.8, 26.8, 43.4 and 141.5 aphids per day, respectively (Fig. 1). The feeding rate fitted the logistic model with the following equation:

$$= \ln. 1.635+0.793X\ n = 4\ r = 0.98\ s = 0.208\ f = 72.61 \quad (1)$$

The fourth instar (grub) feeding indicates that the fourth instar grub consumed most aphids (Eq. 1). Mannan[12] maintains that larval efficiency increased with age and that it reduced the aphid population down to 67.65%.

Efficiency rate per stage: The feeding rate per life stage of the zigzag beetle for all four instars (grubs) was 86.5, 115.2, 164.9 and 948.1 alfalfa aphids, respectively (Fig. 1b). That is, the rate was directly proportional to aphid population. There is a significant direct cor-relation between larval age and aphid. That is:

$$\ln. 3.40+0.753X\ n=4\ r = 0.90\ s = 0.558\ f = 91.17 \quad (2)$$

The predation was highly significant at 0.05 level per stage.

Comparative efficiency of 11-spotted grubs

Efficiency rate per day: Feeding rate of all four instar larval (grub) of 11-spotted beetle was 10.6, 18.4, 38.1 and 52.6 aphids per day, respectively (Fig. 1a). It is given as:

$$\ln. 1.83+0.553 \text{ aphids eaten } n= 4\ r = 0.99\ s = 0.124\ f = 99.53 \quad (3)$$

The predation was highly significant at 0.05 level per day.

These results are in agreement with those of Mahmood and Mohammad[13], Rajput [14], Buriro [8], Lekha and Jat[15]. All of them reported that aphid consumption increased as the larval growth of 11-spotted beetle and varied according to their instars.

Efficiency rate per stag: The aphid feeding efficiency rate per stage of 11-spotted for all four instars was 55.10, 81.00, 175.20 and 278.80, respectively (Fig. 1b).
The equation thus follows as:

$$\ln. 3.39+0.56X\ n = 4\ r = 0.99\ s = 0.113\ f = 122.91 \quad (4)$$

There is a highly significant and positive correlation between instars and prey.

Predatory efficiency of zigzag and 11-spotted beetles

Efficiency rate per day: The feeding efficiency of males of both the zigzag and the 11-spotted beetles was 73.00 and 51.8 and for females it was 80.00 and 56.00 alfalfa aphids, respectively. The analysis showed highly significant difference between both the predators (predator = 85.6 with 1 df for each case) (Fig. 2a).

The feeding of male and female of zigzag beetle was 73.00 and 80.00 and that of 11-spotted it was 51.80 and 56.00, respectively. The analysis showed highly significant difference (F-statistics for sex = 99.90 with 1 df for each case at 0.05 level).

Efficiency rate per stage: The per stage feeding rate for males of both beetles was 2548.20 and 2930.00, respectively. For females it was 2800.00 and 3080.00 aphids, respectively. The difference was highly significant (predator = 85.6 with 1 df for each case). The male and female of zigzag devoured 2548.20 and 2800.00 and that of 11-spotted beetles, 2930.00 and 3080.00 aphids, respectively. There was a highly significant difference between sexes and devouring of aphids (135. 07 with 1 df for each case) (Fig. 2b).

The zigzag beetle is more voracious than 11-spotted beetle. However, it was more voracious than the former per stage due to its longevity. The females of both the species consumed more aphids than their males. This could be due to the fact that the females lay eggs and need more proteins.

Feeding efficiency male and female: The predatory potential males of zigzag and 11-spotted beetles varied as their development. The former beetle consumed 88.2 and the latter 70 aphids on 18th and 15th days of their age, respectively. Both the 30-day, respectively old beetles consumed 60.5 and 58.3 aphids.

The female zigzag beetle and 11-spotted consumed (99.21 and 77.4 aphids) on 18th and 21st days of their age, respectively. The response of both beetle species in consuming the aphids exhibited significant trend till their respective mid ages. Thereafter, their predatory potential

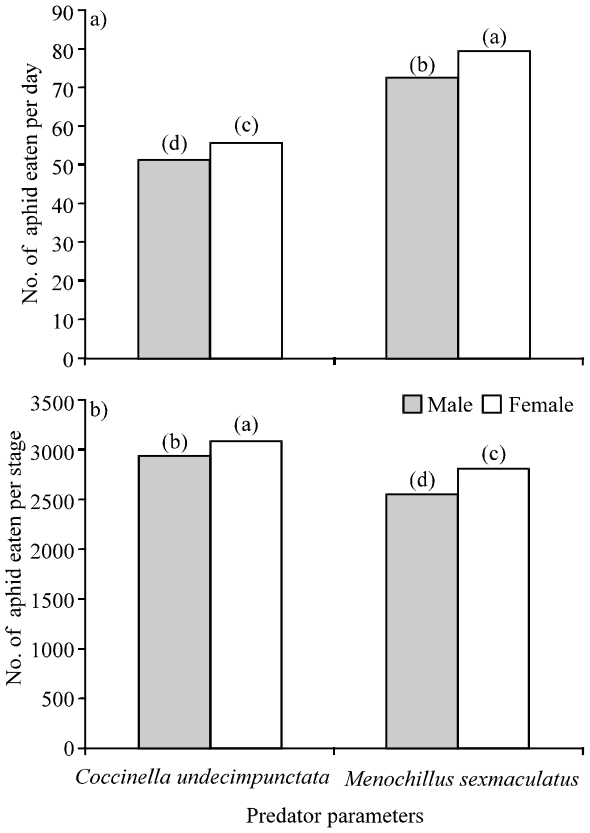

Fig. 2: Comparative efficiency of *M. sexmaculatus* and *C. undecimpunctata.* (male and female) on alfalfa aphid (a) efficiency rate per day (b) efficiency rate per day

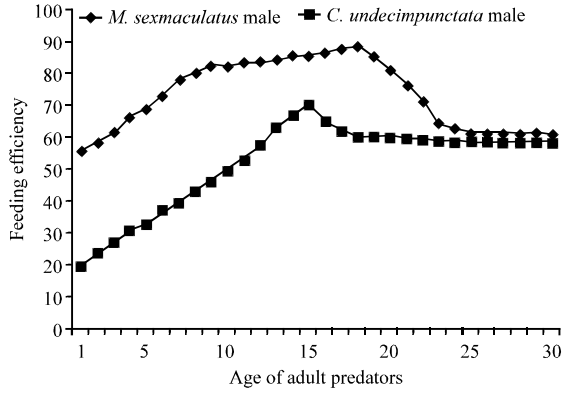

Fig. 3: Comparative feeding potential of male adult beetles under laboratory conditions

decreased rapidly. Minimum aphid consumption with long duration in both females species was as (61.90 and 53.30), respectively when both were 30 days old (Fig. 3 and 4).

Our data are in agreement with Dixon and Agarwala[16] who reported that efficiency of three species of ladybird

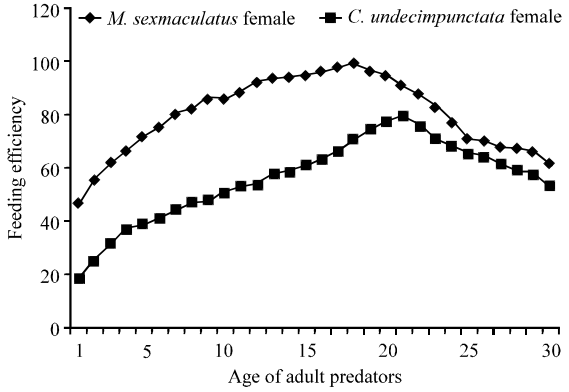

Fig. 4: Comparative feeding potential of female adult beetles under laboratory conditions

beetles declined with age. The overall results (Fig. 3 and 4) show that the feeding percent of male and female beetles of both species varied significantly. The females of zigzag and 11-spotted were more voracious feeders than their males.

The consumption percentage of zigzag was significantly higher than that of 11-spotted in the case of males and females. It is concluded that zigzag is more voracious and can be used as a bio-control agent of aphids.

These findings are in agreement with those of Singh and Marwaha[17] who maintain that zigzag and 7-spotted beetles are efficient bio-control agents against maize aphids *Rhopalosiphum maidis*.

Comparative efficiency of adult beetles in field: The voracity of both the predators fluctuated as aphid densities. The zigzag beetle : aphid ratio was 8.4: 10, 10.6:15, 11.2:20, 14.4:25, 17.0:30, 18.4:35, 23.8:40, 25:50 and 28:60 and that of 11-spotted it was 7.8:10, 9.2:15, 10.73:20, 12.4:25, 14.22:30, 16.6:35, 20.18:40, 21.93:50 and 24.26:60 (Fig. 5a and b). Rahim[18] reported that zigzag and 11-spotted beetles suppressed aphid of wheat in field. Tenhumberg[11] suggested that the predatory efficiency of coccinellid beetles was directly proportional to aphid population.

The predator-prey ratio fitted as:

	n	r	s	f
a) Zigzag beetle				
Prey ratio = 9.004+0.331 aphids devoured	9	0.99	0.781	385.75
b) 11-spotted beetle				
Prey ratio = 3.095+0.358 aphids devoured	9	0.99	0.785	448.53

A positive linear relationship in both species was r = 0.99. Ofuya and Akingbohungbe[19] reported that the feeding rates of *C. lunata* were correlated with the

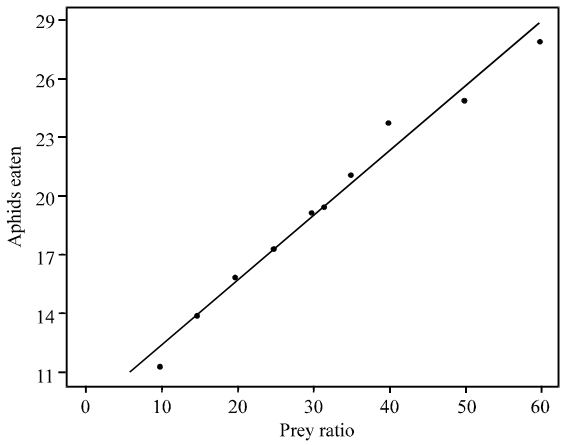

Fig. 5a: Regression analysis plot of prey ratio vs number of alfalfa aphids eaten by zigzag adult beetle

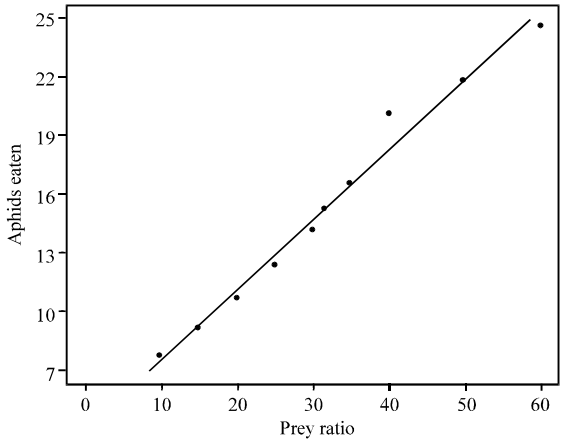

Fig. 5b: Regression analysis plot of prey ratio vs number of alfalfa aphids eaten by 11-spotted adult beetle

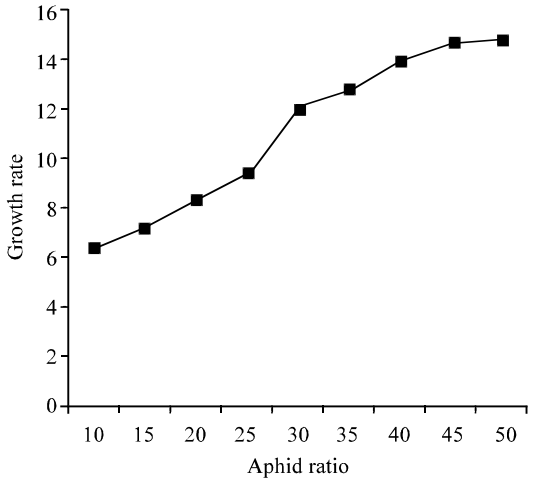

Fig. 6: Population growth of aphid under field condition

population density of the prey. The comparative predator-prey ratio of zigzag is higher than that of 11-spotted. The total mean consumption rate of each was 19.49 and 15.30 aphids, respectively. Kencinaiah[20] observed that aphids were completely controlled by 5-10 larvae of zigzag beetle. The total consumption rate of each was 19.49 and 15.30 aphids (Fig. 5 a and b).

The aphid population in control as zero predator increased as 6.4, 7.2, 8.3, 9.4, 12, 12.8, 13.9, 14.68 and 14.8% (Fig. 6). The aphid growth rate fitted logistic model with the following equation:

Aphid growth rate =
ln. 1.782+0.018X n = 8 r = 0.93 s = 0.124 f = 46. 29 (5)

There was a highly significant correlation between growth rate of alfalfa aphid in the absence of its predator, but the absence was counted as in other treatments.

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