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Interrelationship between zigzag beetle (*Menochilus sexmaculatus*) and sucking insect pests on chili crop

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Abstract
The present study was carried out to investigate the Interrelationship between zigzag beetle (*Menochilus sexmaculatus*) and sucking insect pests on chili crop. The results indicated that over all mean population of whitefly was highest (9.89) followed by thrips (6.71), aphid (6.10), jassid (4.65) and mealy (2.08) per leaf. The all pest population steadly increased to the seasonal peak. More predators migrated toward the crop as pest population increased. It was observed that zigzag beetle is the potential predator of sucking insect pests in chilli crop. Its maximum population was recorded in the last week of August when there was highest insect pest population.

Keywords: Zigzag beetle, sucking pest, chili and ecosystem

1. Introduction
The zigzag (*Menochilus sexmaculatus*) beetle is widely distributed and common aphid feeding species in India, Pakistan, Borneo, Jawa Indonesia, U. K. Philippines, Islands of Bali, France, Sumatra and South Africa [1]. Biological control measures are successfully established, because they are permanent in their effect and have efficient capability of predation on insect pests. These control methods are primarily preventive but not corrective [2]. *M. sexmaculatus* is an efficient predator of many aphid species, e.g. The population of the mustard aphid, *Lipaphis erysimi* Kalt. is considerably suppressed in field by this beetle [3].
Coccinellids are used as a natural enemy for sucking insect pests [4]. The understanding of the behaviour and foraging by coccinellids in the field in relation to the crop and different prey and abundance could give knowledge about their role as a biological control agent. It could also guide for better techniques for predicting their choice and impact on prey infestations in the field. A large number of experiments on coccinellid foraging behaviour on prey have been reported. But, they were conducted in the laboratory [5].
Predatory efficiency studies on insect predators in laboratory arenas may highlight important factors involved in the predator–prey interaction but cannot be expected to provide an adequate understanding of field interactions [5].
The objective of this study was to determine the effects of presence of different preys on adult coccinellid activity and efficiency in chili fields. Specifically, we sought to determine the influence of crop growth stage, and prey density and choice of prey by zigzag beetle in the field ecosystem. The predation by zigzag on five sucking insect pests, jassid, whitefly, thrips, aphid and mealy bug. A second objective was to observe predator relationship with different preys.

2. Materials and Methods
Study was carried out to record the interrelationship between zigzag beetle (*Menochilus sexmaculatus*) and sucking insect pests on chilli crop during the year 2013, in Dhonkaie farm at Kunri. Population growth of insect pests and predator was recorded from 25 randomly selected and tagged plants. Three leaves, one each from top middle and bottom portion of each selected plants were examined carefully at weekly intervals from 1st week of germination till the crop maturity. Population growth was analyzed by simple logistic model as given in equation 1.
$Nt_i = Nt_0 eRT$---- (1). Nt_i = number of pests and predators at time interval i, Nt_0, number of pests and predators at time interval zero. e the base of natural logarithm R the rate of increase, T the

time elapsed in days. $\ln Nt_i = \ln Nt_0 + RT\ n\ r\ s\ F$ -- (2)
Nt_i = natural log of pests and predator at time interval i, Nt_0 the intercept of y on natural log pests and predators population, R the slope of curve and T the time in days, n the observations used in calculation, r the correlation coefficient, s standard deviation from regression and F – statistics. The regression equations were computed using Statgraphics and the data transformed in log. This holds true for single species model with Deeveys type II population growth responses.

3. Results

The results indicated that jassid appeared with the population of 1.6 individuals per leaf on 8th May steadily increasing population reached seasonal peak 7.96 individuals per leaf on 25th July. After that, gradually decreasing trend was evident from data (Table-1). The data seemed to indicate that whitefly appeared with the population 0.28 on 20th May and steadily increased in numbers until the later part of August 20.2 individuals per leaf. The thrips appeared in the later part of May with population 0.28 individuals per leaf increases in numbers 17.08 were noted until around the first part of September, and then gradually declines were evident. First time aphid appeared one month later than other pests with a lower number (0.08) per leaf, increases in number was very slow until beginning of the August and then a rapid increase toward higher population was observed till the harvesting. The mealy bug appeared on 20th May with the population of (0.16) per leaf, linearly increasing population reached their highest (8.4) per leaf on 18th August. The population remained considerably lower throughout the season as compared to others.

4. Disscussion

The zigzag appeared in crop with population 0.16 per leaf on 20th May and it increased and reached their highest (3.58) per leaf until the last part of August. Similar result were reported by [6] who carried out studies on population abundance of predators in alfalfa and cotton fields at the experimental field of Integrated Pest Management (IPM), Agriculture Research Institute (ARI) Tandojam. They showed that the maximum population of zigzag beetle was from June to September. Results also agree with [7] who conducted research on Cotton Mealybug, *Phenacoccus solenopsis* (Pseudococcidae: Homoptera), and its Natural Enemies in Punjab, Pakistan and reported that the *Menochilus sexmaculatus* and other predator associated with mealybug round the year. Similar finding were recorded by [8]who done work on Within-field distribution of *Aphis gossypii* and aphidophagous lady beetles on chili, *Capsicum annuum*. And recorded *Menochilus sexmaculatus* (Fabricius) as predator of chilli aphids.

Data from Table-1 also indicate lady beetles steadily increased in numbers until the late part of August then began a steady decline toward very low populations. No appreciable increases were noted throughout the remaining season. In the same time the population of insect pest seemed towards declining. It indicted that due to maturity of the crop the insect pest migrated to another crops. It is in agreement with that of [9] who reported that behavior and performance of sucking insect pests vary with growth conditions, nutrient, water availability and temperature. Owing to absence of prey, predator also migrated from the crop. It is in concurrence with [10] and [11] who reported that the population of predators increased proportionately with that of sucking insect pests.

The results revealed that over all mean population of whitefly was highest (9.89) followed by thrips (6.71), aphid (6.10), jassid (4.65) and mealy bug (2.08). The statistical analysis indicated that there was highly significant differences between pest population ($F=8.12$ df $=5$, $P< 0.01$).

4.1 Predator pest relationship

The predator pest relationship indicated that there were 0.16 predators against 0.64 pests. After that, more predators migrated as pest population increased. The fitted regression logistic growth model for defining the relationship between predator and pest population revealed that the predator population increased linearly as their prey population increased and reached 3.66 predators against 11.44 pests.

In the last observation the variation between predator and pest populations increased. The regression equation showed that the slope rate of predator population increase was 0.58X, which reflected that due to one unit change in pest population, about 0.58 units in the population of predator was estimated. Quite a large R-square (0.80) was reported by the model which indicated that about 80% variation in predator population depends upon consolidated pest population.

Table 1: Weekly mean population of predator (Zigzag beetle) and insect pest population of chilli crop.

Date	Zigzag	Jassids	Whitefly	Thrips	Aphids	Mealy bug	Consolidated Pest
8/5	0	1.6	0	0	0	0	0.32
14/5	0	2.76	0	0	0	0	0.55
20/5	0.16	3.44	0.28	0	0	0	0.64
26/5	0.24	3.68	0.84	0.28	0	0.16	0.99
1/6	0.2	3.8	0.84	0.52	0.08	0.16	0.93
7/6	0.28	3.84	1.24	1.12	0.12	0.28	1.14
13/6	0.24	4.01	2.24	1.44	0.12	0.32	1.39
19/6	0.24	4.12	3	2.2	0.16	0.88	1.76
25/6	0.28	4.2	3.04	3.04	0.16	0.96	1.94
1/7	0.56	4.28	3.2	3.44	0.2	1.04	2.12
7/7	0.6	5.08	6.56	4	0.24	1.24	2.95
13/7	0.76	6.36	12.8	4.52	0.52	1.48	5.13
19/7	0.88	7.44	14.12	5.04	1.12	1.76	5.89
25/7	0.72	7.96	16.56	5.6	1.88	3.04	5.96
31/7	1.12	6.8	16.36	7.64	3	3.76	6.44
6/8,	2.44	5.6	18.2	9.68	4.08	3.88	8.28
12/8	3.28	5.68	18.28	12.32	5.36	6.94	9.71
18/8	3.32	5.44	18.44	13.56	6.72	8.4	10.51
24/8	3.42	5.12	19.2	14.48	8.44	7.32	10.912
30/8	3.58	5	20.16	15.48	11.08	2.48	10.84

5/9	2.96	4.72	16.12	17.08	12.52	1.24	10.33
11/9	2.44	4.44	13.36	13.36	20.28	1.52	10.59
17/9	2.96	4.44	13.16	13.28	21.72	1.08	10.73
23/9	1.32	4.2	11.82	13.28	25.56	0.6	11.09
29/9	0.6	3.2	9.52	6.4	29.36	0.6	9.81
Total	32.6	117.21	239.34	167.76	152.72	49.14	140.952
Mean	1.232	4.659	9.893	6.71	6.108	2.085	5.63808

5. Conclusions

It is concluded that zigzag beetle is the potential predator of sucking insect pests on chilli crop. Its population was maximum in the months when there was an increase in insect pest population.

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