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Testing of the food consumption by different instars of grubs and adults of Mexican beetle, *Zygogramma bicolorata* on *Parthenium hysterophorus* L. in Raipur, Chhattisgarh

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Abstract
Testing of the food consumption by different instars of grubs and adults of Mexican beetle, *Zygogramma bicolorata* Pallister, for the biological control of the *Parthenium* weed, *Parthenium hysterophorus* L was explored in the Biocontrol laboratory, Department of Entomology, IGKV, Raipur, Chhattisgarh, during 2018-19 and 2019-20. *Z. bicolorata* P. is considered as a safe biocontrol agent but till now it is not well established and spread in Chhattisgarh. Both grubs and adults of *Z. bicolorata* feed on the leaves and help in defoliation of the weed. Therefore, the present study was carried out to investigate the feeding efficiency of the Mexican beetle, *Z. bicolorata*, by releasing adults and different instars of grubs of beetles on *Parthenium* leaf. Overall data of two years indicated that food consumption of *Z. bicolorata* was maximum (12.58mg) in 3rd instar grubs followed by 4th instar (8.75mg) and minimum by male beetle (1.25mg).

Keywords: *Parthenium hysterophorus*, mexican beetle, *Zygogramma bicolorata*, feeding efficiency, defoliation

Introduction
Parthenium hysterophorus (Linnaeus), well known in India as 'carrot grass' or 'congress grass' and 'gajar ghans' or 'chatak chandni' in hindi, belongs to family Asteraceae. It is native of tropical and sub-tropical South and North America and found to invade into Africa, Australia and Asia. It is an herb of geotropical origin which has now spread in too many parts of the world [1], and has become one of the main weeds in almost all types of agricultural lands besides infesting wasteland, community land, road and railway track sides including forests [19,8]. It has achieved the status of major weed in India and Australia [3]. It is an aggressive weed posing a serious threat to the environment and biodiversity [13]. Young plants of *Parthenium* form a rosette of leaves close to the soil surface. As it matures, the plant develops many branches on its upper half, and may eventually grow up to two meters [17]. With good rainfall and warm temperature, *Parthenium* has the ability to germinate and establish at any time of the year [19, 23]. Flowering usually commences 6–8 weeks after germination and soil moisture seems to be the major contributing factor for flowering [19]. Pollination is primarily governed by wind [16]. *Parthenium* inhibits germination and growth of the other plant by allelopathic effects [21] and according to Kumari *et. al.*, 2014 [15], cell survival and chlorophyll content of crop plants were markedly reduced when *Parthenium* extracts were directly sprayed on them. In artificial feeding tests on live stock, majority of buffaloes, bulls and calves developed severe dermatitis and died with 8-30 days [18]. The Mexican beetle, *Zygogramma bicolorata* Pallister (Coleoptera: Chrysomelidae) was imported into India in 1983 for the biological control of the noxious *Parthenium* weed, *P. hysterophorus* L. Grubs and adult beetles feed voraciously on the foliage and inflorescence and remains confined to congress weed [2, 9]. The bio-ecology [7] and *in vitro* rearing of the beetle on *Parthenium* has been well documented [11, 14]. Although the insect established readily, population build-up was noticed only in 1988 and by 1994, it had spread over 200000 sq km area in and around Bangalore from the epicenter [10]. The beetle is known to occur throughout the year but the insect diapauses over an extended period of time in nature [12] resulting in extensive proliferation of the weed in its absence. Biological control of *Parthenium* weed is considered to be the most cost effective, environmentally safe and

ecologically viable method [6]. It was documented to control *Parthenium* worth of Rs 10 million in terms of herbicide cost after initial release of bioagent, *Z. bicolorata* P. at Jabalpur, India [22] and it was estimated that this bioagent had checked the spread of *Parthenium* in about eight million hectares of land since its release in India. In an attempt of biological control and search for suitable bioagent, the Mexican beetle was found to be effective bio-control agent of *P. hysterophorus*, introduced from Mexico to Bangalore in 1983 with field releases of the beetles were initiated at Bangalore in 1984. The aim of study to minimize the chemical herbicide load.

Materials and Methods

Experimental details

a. Location of study: The studies on feeding potential of Mexican beetle, *Zygogramma bicolorata* P. were conducted in the Bio-control laboratory, Department of Entomology, IGKV, Raipur, Chhattisgarh, India (Plate 1).

b. Collection and Rearing of *Zygogramma bicolorata* P: Adult beetles of *Z. bicolorata* were collected from *Parthenium* plants at Raipur in the range of 2.0 km around Indira Gandhi Krishi Vishwavidyalaya, University campus, during 2018 from June - July, as the beetles emerged after diapuase during these months. The collected beetles were reared under net house as well as in the Biocontrol laboratory.

Beetles were placed in plastic basins. The basins were filled with soil up to 10 cms. Three fresh *Parthenium* plants of an average height of 24.60cms having flowers was planted in the basins for feeding of beetles. Plastic net covers were used for covering basins. Egg laying, both on plastic net and leaves (both upper and lower side) were observed. Mated pairs of beetles were selected and transferred to new plastic basins of the same size with *Parthenium* plant. The basins were replenished with fresh *Parthenium* plant till the female beetle survived. Temperature was maintained at an average of 25±5 °C during the experimental period.

Food consumption by adult and grubs of Mexican beetle, *Z. bicolorata* P.

c. Observations recorded: For determining the food consumption of Mexican beetle, *Z. bicolorata* P, experiment was conducted in the Bio-control laboratory, Department of Entomology, IGKV, Raipur, Chhattisgarh at a temperature range of 25-30°C and 60 ± 5% RH,. Newly hatched different instars of grubs were taken for food utilization study. Grubs from different instars were maintained separately as stock culture and were used for the study. The newly emerged different stages of beetles *i.e.* 1st, 2nd, 3rd, and 4th instars and adults were released on to previously weighed leaf of host plant in different petriplates (10 cm. dia.) provided with moist filter paper and allowed to feed for 24 hrs. The experiment was replicated thrice (Plate 3). At the end of each day of the experiment, the filter paper was cleaned with a fine camel hair brush to collect the excrement. The weight of consumed food was calculated by subtracting the weight of remaining food after feeding for 24 hours. Similar experiment was conducted separately for male and female adults. Observations were recorded on the quantity of food eaten by different life stages of *Z. bicolorata* within 24 hrs. The data obtained from the experiment was transformed accordingly and analyzed statistically.

The amount of food consumption was estimated by the formula given below:-

Food consumption= Weight of total food given to grubs and adults– weight of leftover food by grubs and adults

Results and Discussion

Food consumption by adult and grubs of Mexican beetle, *Z. bicolorata* P.

As per the data presented in (Table 1), all treatments showed significant differences among each other. In 2018-19, food consumption of *Z. bicolorata* was maximum (12.83mg) by third instar grubs followed by fourth instar (8.33mg) and minimum food was consumed by adult male beetle (1.17mg).

The experiment was repeated in the next year *i.e.* 2019-20 also, on all larval (grub) instars, adult males and females. During 2019-2020, similar mode of feeding was observed, in which the highest amount of food consumption was observed by third instar grubs (12.33mg) followed by fourth instar (9.77mg) and minimum by adult male beetle (1.33mg). (Table 1 and Fig. 1)

Overall pooled data of two years indicated that, food consumption of *Z. bicolorata* was maximum (12.58mg) in third instar grubs followed by fourth instar (8.75mg) and minimum in adult male beetle (1.25mg). (Table 1)

The present findings are in line with Bhumannavar and Balasubramanian, 1998 [4], who also reported that consumption by the third instar grubs of *Z. bicolorata* of *Parthenium* leaf was 11.01 ± 5.81 mg per individual per day which is in close conformity with the present results.

The present findings are in agreement with Chandravanshi *et.al.*, 2018 [5] who also mentioned that, the food consumption of *Parthenium* was maximum (11.03mg) by 3rd instar grubs followed by 4th instars (7.94mg) and minimum in adult stage (0.74mg).

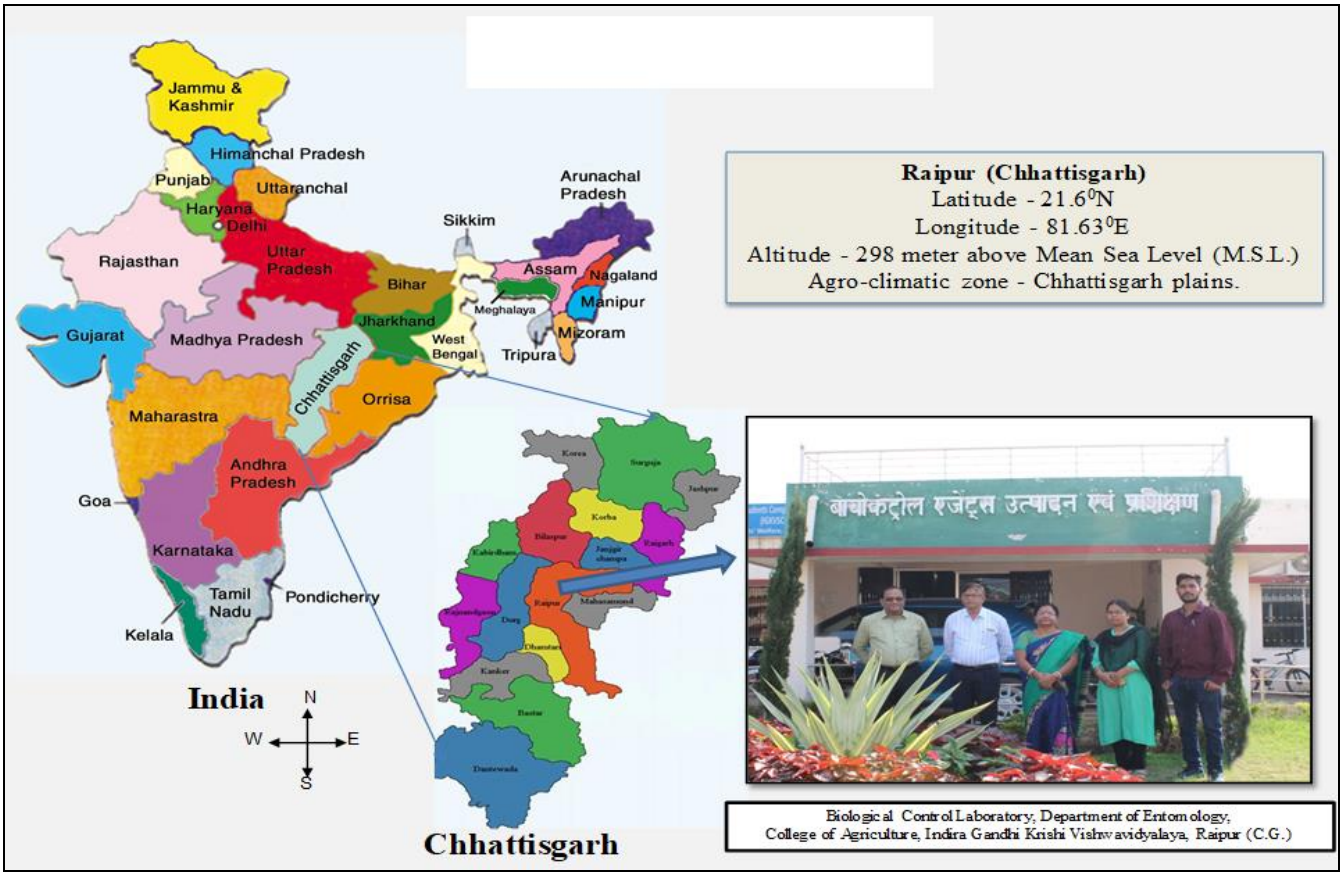


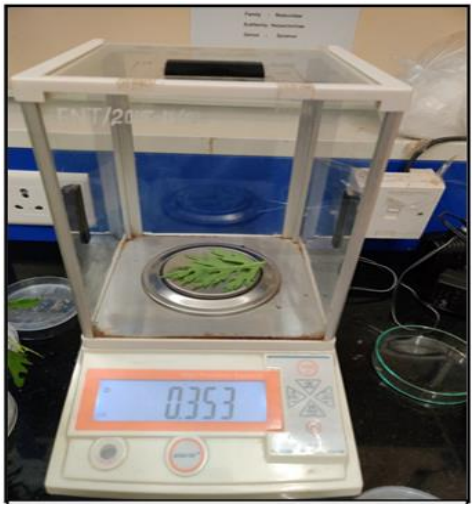
Plate 1: Site of Experiment

Grubs of Mexican beetle, *Z. bicolorata*: Pallister feeding on leaf m argin of Parthenium

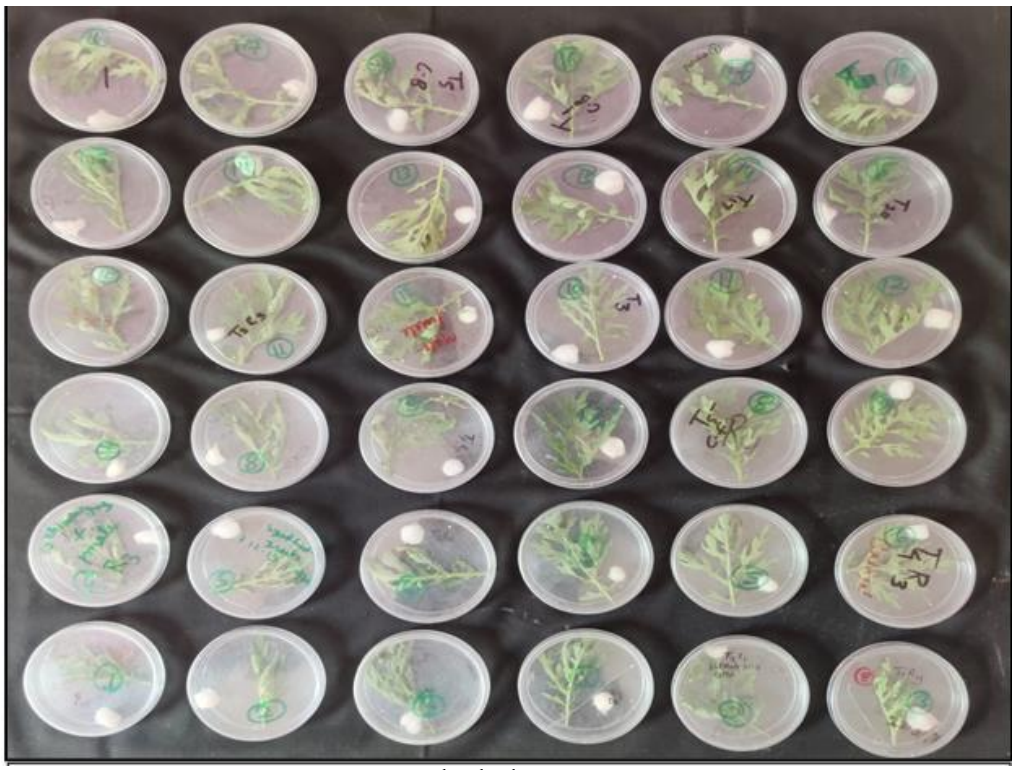
Adults of Mexican beetle, *Z. bicolorata* bicolorata feeding on leaf margin of Parthenium

Plate 2: Feeding of Mexican beetle, *Z. bicolorata* Pallister in Parthenium weeds during 2018-2019

Wt. of leaves before feeding by Z. bicolorata



Wt. of leaves after feeding by Z. bicolorata



Testing of feeding efficiency of different stages (1st, 2nd, 3rd, 4th, adult male and female of Z. bicolorata) replicated six times.

Plate 3: Weight of leaves fed recorded by electronic weighing balance for feeding efficiency studies

Table 1: Food consumption (in mg) by different stages of grubs and adults of *Z. bicolorata* within 24hrs under laboratory conditions during 2018- 2020

S. No.	Life stage	Food consumption by grubs and adults of *Z. bicolorata* within 24hrs (in mg)		
		2018-19	2019-2020	Mean
Grubs/larvae				
1	1st instar	2.33 (1.68)	2.17 (1.63)	2.25 (1.66)
2	2nd instar	5.67 (2.48)	5.83 (2.52)	5.75 (2.50)
3	3rd instar	12.83 (3.65)	12.33 (3.58)	12.58 (3.62)
4	4th instar	8.33 (2.97)	9.17 (3.11)	8.75 (3.04)
Adults				
5	Female	1.67 (1.47)	1.83 (1.53)	1.75 (1.50)
6	Male	1.17 (1.29)	1.33 (1.35)	1.25 (1.32)
	Total	13.55	13.72	13.64
	SEm±	0.077	0.082	
	CD @5%	0.222	0.239	
	CV(%)	7.893	8.393	

*The figures in parentheses represent square root transformed values

* The data shows mean of three replications

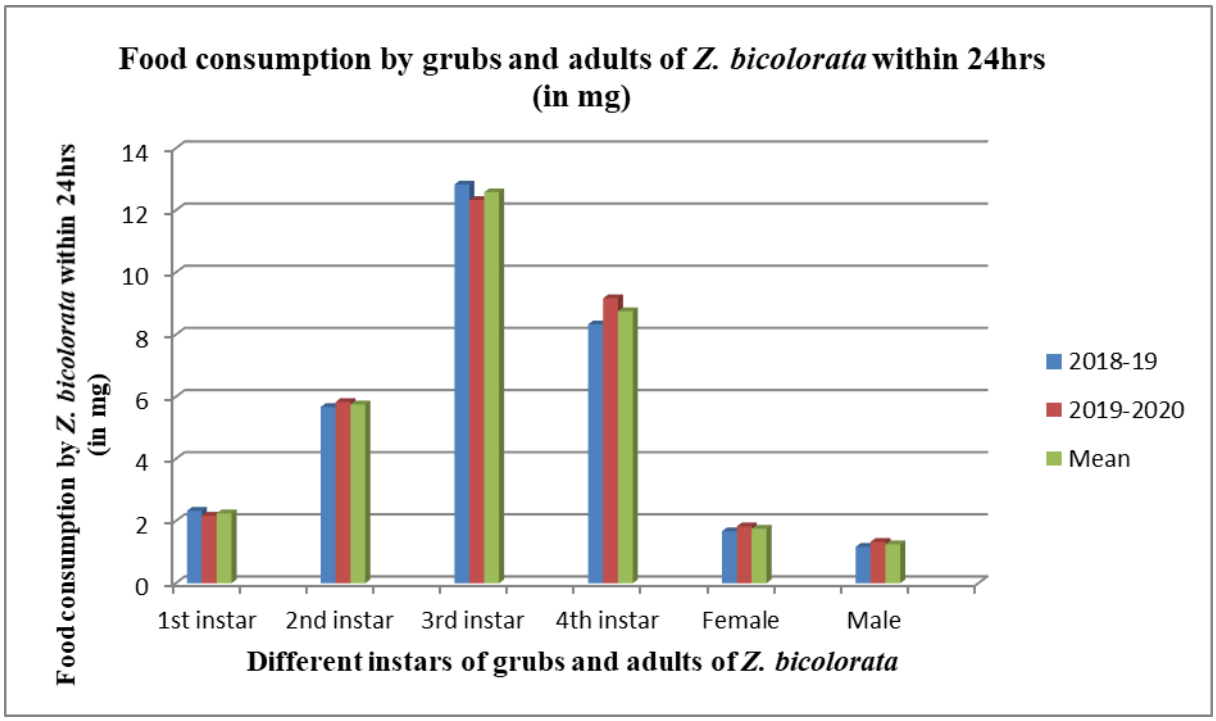


Fig 1: Food consumption by grubs and adults of *Z. bicolorata* within 24hrs (in mg)

Conclusion

Thus, on testing of the food consumption by grubs and adults of Mexican beetle, *Z. bicolorata*, grubs of different instars f,r two years, overall data indicated that food consumption of *Z. bicolorata* was maximum (12.58mg) in 3rd instar grubs followed by 4th instar (8.75mg) and minimum by male beetle (1.25mg).

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