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Evaluation of Feeding Potential of Mexican Beetle (*Zygogramma bicolorata*) on Carrot Grass (*Parthenium hysterophorus*) in Dehradun District, Uttarakhand, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Short Research Article

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ABSTRACT

Zygogramma bicolorata is an efficient natural control agent that can be used against *Parthenium hysterophorus*, a very common and allergic weed found in the Dehradun belt of Uttarakhand region. It is responsible for asthma, bronchitis, skin lesions, rashes, contact dermatitis, hay fever and various respiratory ailments. *Z. bicolorata* is a natural predator of this vicious weed. The feeding capacity of Mexican beetle, *Z. bicolorata* was studied under controlled conditions, at the Department

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of Zoology, S.G.R.R. University, Dehradun, Uttarakhand 2023. Ten different sites were chosen from the Dehradun district, considering the widespread availability of Parthenium weed in the region. It was detected that the feeding capacity of the adult stage of the beetle was maximum in site 3 and lowest in site 6. The result showed in site 3 that the adult consumed 3.7 g leaves of Parthenium at 20 °C whereas, the similar relevant statistics were 2.3 mg. The detriment caused by *Z. bicolorata* was more visible when it was used at a higher density and at the initial growing stages of Parthenium. The fully mature stages were preferred less in comparison to the younger ones. This technique can be highly useful if implemented wisely in the management of *Parthenium* weed and contributes towards achieving the goal of sustainable development.

Keywords: Mexican beetle; parthenium; feeding potential; defoliation; sustainable development.

1. INTRODUCTION

Zygogramma bicolorata is typically named as the Mexican Beetle or the Parthenium Beetle [1]. This insect belongs to the order Coleoptera and the family Chrysomelidae [2]. It is a small beetle comprising a brown colored head, yellow colored graduated pronotum, and yellow-colored elytra marks along with special long brown stripes which also happen to be its characteristic feature. It was first observed in Pune region of India around the 1950s by Professor Paranjape as a wild plant growing on garbage dumping sites and later Rao reported it as a new species that evolved in India [3]. With the widespread of this weed all across the globe, special efforts have been made by all the countries to get rid of this harmful weed through various methods, including biological, chemical, mechanical, allelopathy and manual control methodologies [4]. Despite so much effort, it has been difficult to eliminate this weed as every method employed has several disadvantages attached to it. Keeping in mind the concept of environment protection and sustainable development people are more inclined towards ecofriendly biological control methods such as the use of natural enemies, bioherbicides, insects, nematodes, snails and some competitive plants which could outcast this dangerous weed completely without deteriorating the quality of the natural environment. The beetle feeds on leaves and flowers of the weed and completely eradicates it within a short time span [5]. It will help in minimizing asthmatic disorders, bronchitis, dermatitis and various kind of allergies which are extremely prevalent in regions infected with Parthenium. The need of the hour is to serve mankind without causing any harm to our surroundings at a minimum cost [6].

It is important to implement an integrated approach along with biological methods to improve the management of this weed. Control

of Parthenium cannot be achieved by one single method keeping in mind the various agricultural, environmental and medical hazards of Parthenium [7].

This study can aid in examining the potential in the relevant subject. Increased usage of chemical control agents not only contributes to the deterioration of the environment quality but also possess hazardous impact to human health. Therefore, the usage of biocontrol agent can be a great initiative towards our ultimate goal of environmental conservation.

2. MATERIALS AND METHODS

2.1 Study Area

The area of Dehradun basically lies in Doon Valley and has a variation in height from 410m in Clement Town to above 600 m at Jakhan which is about 4 km from the region. However, the overall ascent is 450 m above sea level. A place named Jakhan is at the starting point of Lesser Himalayan Range that extends upto Mussoorie and areas beyond in Dehradun District at 3700m above the sea level. The hilly region of Mussoorie goes up to a height of 1870–2007 metres above sea level. The selected sites for research works are: Garhi Cantt, Kaulagarh, Raipur, Rajpur, Doiwala, Sahastradhara, PremNagar, Jamunwala, Anarwala and Jhajra.

2.2 Choice Test Experiment

The food consumption of parthenium beetle for choice was conducted in bio-control laboratory at the Department of Zoology, S.G.R.R. University at temperature range of 25 to 30°C and 60 ± 5% RH. The experiment conducted in laboratory on the basis of Jaiswal et al 2023 with minor modifications. Temperature and humidity were

maintained using air conditioner. A sample of parthenium beetle was collected from parthenium leaves and flowers. Samples were collected from ten different sites (GarhiCantt (Site1), Kaulagarh (Site2), Raipur (Site3), Rajpur (Site4), Doiwala (Site5), Sahastradhara (Site6), PremNagar (Site7), Jamunwala (Site8), Anarwala (Site9) and Jhajra (Site 10). For the selection of plant feeding study bowl (500 ml) was used. For the experiment 5 beetles were placed in each study bowl with 5 g of parthenium leaves and each test replicated three times (n=3) with the control. Weighing scale is used to take accurate and same quantity of Parthenium in every bowl. For the choice test parthenium leaves was placed

after 0, 24-, 48-, 72-, 96-, 120-, 144- and 168-hour's total weight of parthenium leaves was measured 5 g Parthenium weight is considered as its control weight for the experiment. Food was changed every third day.

2.3 Data Analysis

The feeding rate was calculated by comparing the weight of control against the total weight of leaves feeding by beetles.

Effect of feeding rate: Control Weight – Weight of leaves feeding by beetles.



(A) *Z. bicolorata*



(B) Feeding bowls from ten different sites



(C) Feeding bowls with *Z. bicolorata* from a site



(D) Parthenium damaged by *Z. bicolorata*

Fig. 1. Feeding rate estimation

Table 1. Result of feeding potential of Mexican beetle on carrot grass (Mean±SE)

Site/hours	0 hr	24 hr	48 hr	72 hr	96 hr	120 hr	144 hr	168 hr
GarhiCantt	5.00±0.00	4.13±0.08	2.63±0.10	1.70±0.07	2.53±0.12	1.33±0.05	0.00±0.00	2.67±0.14
Kaulagarh	5.00±0.00	3.50±0.06	2.63±0.08	1.57±0.08	3.90±0.07	2.70±0.07	0.00±0.00	3.00±0.03
Raipur	5.00±0.00	3.70±0.07	2.40±0.03	1.37±0.10	3.50±0.13	2.17±0.07	0.00±0.00	2.73±0.05
Rajpur	5.00±0.00	3.77±0.05	2.30±0.07	1.37±0.05	3.50±0.10	2.33±0.08	0.00±0.00	3.37±0.10
Doiwala	5.00±0.00	3.33±0.07	2.23±0.08	1.43±0.05	3.83±0.05	2.50±0.03	0.00±0.00	3.67±0.05
Sahastradhara	5.00±0.00	3.47±0.08	2.33±0.05	1.37±0.10	3.43±0.08	1.97±0.08	0.00±0.00	2.80±0.07
Prem Nagar	5.00±0.00	3.30±0.07	2.33±0.05	1.23±0.05	3.27±0.07	2.30±0.07	0.00±0.00	2.43±0.07
Jamunwala	5.00±0.00	3.47±0.07	2.30±0.07	1.47±0.07	3.47±0.08	2.50±0.07	0.00±0.00	2.67±0.07
Anarwala	5.00±0.00	3.47±0.10	2.40±0.03	1.33±0.05	3.87±0.05	2.30±0.09	0.00±0.00	3.10±0.03
Jhajra	5.00±0.00	3.37±0.05	2.43±0.08	1.37±0.05	3.77±0.05	2.40±0.07	0.00±0.00	2.97±0.05

3. RESULTS AND DISCUSSION

It was observed that the feeding potential of adult stage of the insect was highest in site 3 and lowest in site 6 (Table 1). The result showed in site 3 that the adult consumed 3.7gm parthenium leaves at 25°C. whereas, the corresponding in Fig. were 2.3 mg. The damage inflicted by *Z. bicolorata* was more pronounced when it was applied in higher density and at early growth stages of the weed. The work will not only help us to curb the growth of Parthenium using eco-friendly bio control method via Mexican beetle promoting the concept of sustainable development in our region with minimum environmental degradation [8]. Adult males consumed less in comparison to the females which may be attributed to the larger size and life span of the females. The males fed to the tune of 3.5 - 4.5 mg, whereas the females were found to be consuming more in comparison to the males and recorded 4-5mg [9,10]. The parthenium leaves consumed by first instar larvae at 25°C was in the range of 2-3 mg. and the second instar consumed at a higher rate and recorded 2-3mg [11,12]. The third instar larvae consumed more voraciously and at faster rate and the recorded consumed leaves by them was to the tune of 3-4mg. In the fourth instar, 4-5mg. This may be due to the approaching stoppage in the feeding as the larvae entered the pre-pupal stage.

4. CONCLUSIONS

The experiment shows that *Z. bicolorata* is a voracious feeder of Parthenium and could be used effectively in Parthenium management. Testing the feeding of Mexican beetle *Z. bicolorata* by releasing on host plant *P. hysterophorus*, the results revealed that beetles in 5 pairs take minimum time for defoliation of host plant.

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Competing interests

Authors have declared that no competing interests exist.

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