VOLUME 9 ISSUE 1 2023

ISSN 2454 – 3055

INTERNATIONAL JOURNAL OF ZOOLOGICAL INVESTIGATIONS

Forum for Biological and Environmental Sciences

Published by Saran Publications, India

International Journal of Zoological Investigations Vol. 9, No. 1, 332-338 (2023)

International Journal of Zoological Investigations

Contents available at Journals Home Page: www.ijzi.net

Editor-in-Chief: Prof. Ajai Kumar Srivastav

Published by: Saran Publications, Gorakhpur, India

ISSN: 2454-3055

Biocontrol Potential of *Zygogramma bicolorata* under the Influence of Probable Operating Factors in Two Physiographically Different Biotopes

Ganguly Nilanjan, Rajak Prem and Paramanik Manas*

Department of Animal Science, Kazi Nazrul University, Asansol, Paschim Bardhaman, West Bengal 713340, India

**Corresponding Author*

Received: 27th December, 2022; **Accepted:** 1st February, 2023; **Published online:** 19th February, 2023

https://doi.org/10.33745/ijzi.2023.v09i01.038

Abstract: Parthenium is an invasive weed that spreads rapidly and causes serious damage to the ecosystem and crop productivity besides health hazards to animals including humans. The Mexican beetle *Zygogramma bicolorata* is identified as one of the most prominent biocontrol agents of Parthenium. The present study was conducted to find the efficiency of *Z. bicolorata* in the biocontrol of Parthenium under the influence of the microenvironment due to the canopy of trees along the foothills of Biharinath in Bankura district, West Bengal, India for the first time. Two biotopes were selected for the study, Spot A without a forest cover, and Spot B with a densely forested area. A significant difference in the number of beetles was observed between the two spots in one year study. The average number of beetles per plant was 16.17 in Spot A as compared to 21.33 in Spot B. The yearly time of the peak in population density was also different in the two biotopes. In Spot A the peak was observed during October whereas it is during August in Spot B. The results suggest that the canopy of trees may be influencing the population density of the beetle. The forest covers are probably helpful in maintaining a microclimate with a temperature and humidity that benefits the survival and multiplication of Mexican beetles in Spot B. The more time required for the establishment of the highest number of beetles in a year may also be due to this microclimatic difference as the canopy of trees is scanty in Spot A. These findings may help in formulating a smart management strategy against Parthenium.

Keywords: Biharinath hill, Canopy cover, Tropical climate, *Zygogramma bicolorata*, Parthenium

Citation: Ganguly Nilanjan, Rajak Prem and Paramanik Manas: Biocontrol potential of *Zygogramma bicolorata* under the influence of probable operating factors in two physiographically different biotopes. Intern. J. Zool. Invest. 9(1): 332-338, 2023.

https://doi.org/10.33745/ijzi.2023.v09i01.038

Introduction

Parthenium hysterophorus L. (Asteraceae; Heliantheae), commonly called the Parthenium, is an annual, short-lived, herbaceous plant. It is a weed of global significance which causes losses in agriculture, has adverse effects on human and animal health, and degrades natural ecosystems (Kaur *et al.*, 2014). In fact, it is a weed of central and south America, that entered India from the

United States of America along with wheat imported into India in 1956 (Vertak, 1968) and naturalized itself. Now Parthenium is considered as the most devastating weed in agricultural and urban areas of Asia (Patel, 2011; Hasan and Ansari, 2016) and became a serious threat to biodiversity and crop productivity (Adkins and Shabbir, 2014; Sushilkumar, 2014) due to its invasive and dominating nature. This weed is a responsible factor for many health-related issues to humans and livestock which have now reached epidemic proportions (Mahadevappa, 1999; Patel, 2011). In humans, ill effects include dermatitis, allergic rhinitis, asthma, bronchitis, allergic responses, immunity loss, and so on. While livestock animals may suffer from rashes and inflammation around the mouth and nose, ulceration in the mouth and digestive tracts, fever, diarrhoea, kidney and liver disorder, and even death (Saini *et al.*, 2014).

Warm temperature with sufficient rainfall favours the germination and growth of Parthenium at any time of the year (Hasan and Ansari, 2015). Its effective management is very difficult due to its capacity to produce seeds in large quantities, adaptability to flourish well in any kind of habitat, and allelopathic potential (Sushilkumar and Saraswat, 1999; Patel, 2011). Looking at the multitude of harms caused by Parthenium, its management is necessary to prevent future problems.

Due to anthropogenic activities environment becoming polluted (Mukherjee and Paramanik, 2022; Roy and Paramanik, 2022) which imposes a harsh effect on various organisms (Mukherjee *et al.*, 2022). Management of harmful animals and plants using different types of biological agents is preferable to avoid the ill effect of synthetic agents on the environment (Pandey *et al.*, 1996; Paramanik, 2018; Paramanik *et al.*, 2022 a, b; Tomar and Thakur, 2022). Biological control using insects is one of the most important approaches in sustainable management. The beetle, *Zygogramma bicolorata*, a native of tropical America (around Mexico) commonly known as the Mexican beetle has been used in the biocontrol of Parthenium. Larva and adults feed on Parthenium resulting in skeletonization, defoliation, and reduction in flower and seed production. *Z. bicolorata* can cause 100% defoliation of Parthenium, resulting in reduced weed density, plant height, plant biomass, flower production, and soil seed bank (Dhileepan *et al.*, 2000).

The life cycle of *Z. bicolorata* is completed in 23-30 days with about 4 generations per year, depending on rainfall and food availability. Adults able to live up to 2 years, diapause within chambers 1-3 cm beneath the soil from autumn to winter influenced by short day length and low temperature. They resume their activity in response to rainfall with increased temperature and longer days in the spring season (McFadyen, 1992; Shushilkumar and Ray, 2011). Diapause in adults is regulated by complex interactions of temperature, moisture, photoperiod, host plant availability, diapause history, and other biological factors (Dhileepan, 2007; Gupta, 2008).

Biharinath hill (1449 ft high) of Bankura district has a tropical arid climatic condition and is a popular tourist spot. Summer temperature often rises over 38℃ whereas winter has a pleasant moderate temperature of around 23℃ during sampling (Table 1). Soil is laterite red and hard beds are covered with scrub jungle and Saal trees of various densities. One side of the Biharinath foothill is densely forested with thick canopy cover whereas the micro climatic condition of the other side differs significantly having a human settlement area and fewer canopies. The foothill area is infested with Parthenium weed and the Mexican beetle grows there naturally.

Scanty information is available regarding the *Z. bicolorata* population useful for biocontrol of Parthenium from Biharinath foothill areas. The present study was conducted to assess the density and effectiveness of the beetle in the biocontrol of the weed in two physiographically different biotopes on two sides of the hill.

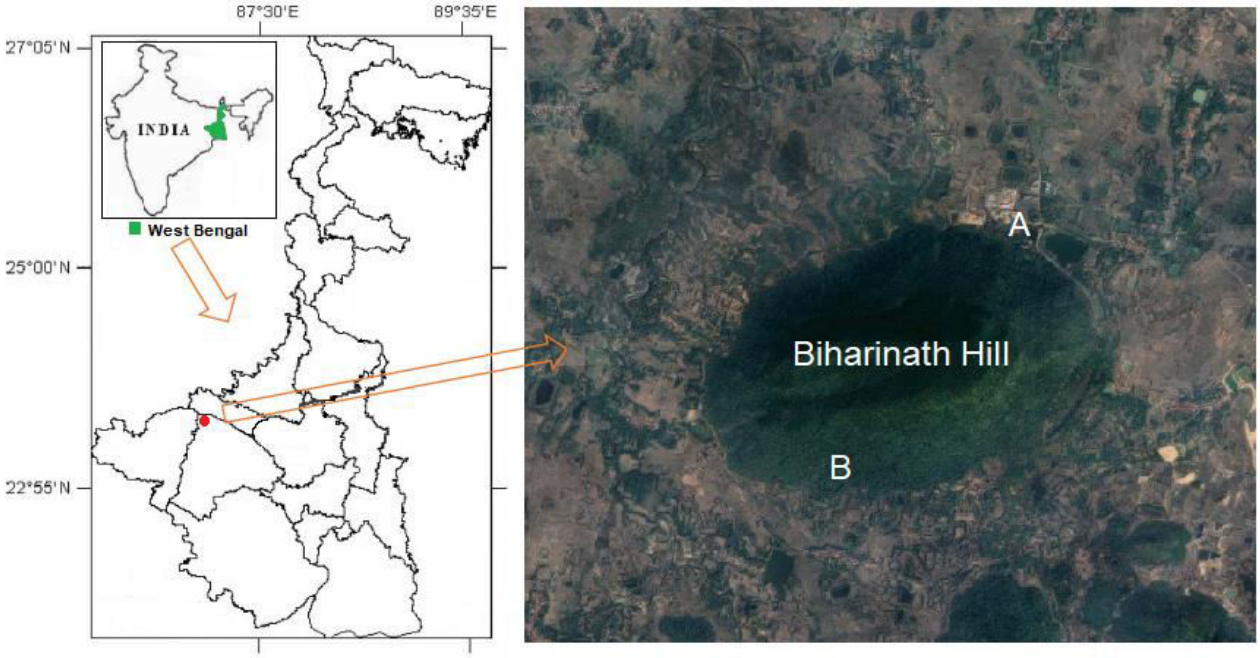

Fig. 1: The study area (retrieved from Google maps)

Fig. 2: The two selected study-area

Materials and Methods

Study area:

Biharinath hill is stretched between 22°38' to 23°38' north latitude and 86°36' to 87°46' east longitude in the Bankura district of West Bengal, India (Fig. 1). Two contrasting biotopes of the foothills were selected for the study.

Spot A: North-east side of the hill, along the roadside near the pond and temple premises. Some human settlements are present with less canopy of trees compared to that spot B.

Spot B: South-west side of the hill, along the forested area with a dense canopy of trees (Fig. 2).

Sampling:

The number of adult *Z. bicolorata* beetles was counted from twenty (20) randomly selected Parthenium plants of spot A and spot B, each. The observations were conducted every month during

1000 - 1200 hours from March 2020 to February 2021. Temperature, relative humidity, and rainfall (Table 1) were recorded on the days of the survey.

Results and Discussion

In one-year collections, the mean number of *Z. bicolorata* beetles per plant was recorded to be 16.17 in Spot A, whereas it is 21.33 in Spot B. In both spots, the lowest prevalence of the beetle was found during December to February (winter) months and then it increases gradually. The highest prevalence of beetles for Spot A was 58.00 noted in October (late summer) and in Spot B the highest prevalence was 70.95 noted in August (early summer) (Table 2).

A significant population of *Z. bicolorata* was noticed during the summer months at the foothills of Biharinath. The line graph of the data shows a typical J-shaped growth curve of the beetle. With the onset of favourable climatic conditions, the population of the Mexican beetle flourished. But there is a marked difference in the time of the peak in population density in the two biotopes (Fig. 3). The tropical climatic condition in both biotopes was basically similar, but there is an obvious difference in the microclimate. Being covered with a thick canopy of trees, lower temperatures, and higher humidity are encountered in Spot B. Therefore, the canopy of the forest assists in the early building of a healthy *Z. bicolorata* population. In Spot B, a dense population of Mexican beetle establishes early and the Parthenium weeds were almost completely skeletonized by their voracious appetite till August - September (Fig. 4). Whereas in Spot A, the beetles take more time to establish themself with a late defoliation process of the weed up to October - November, and the intensity of defoliation was also comparatively less.

Conclusion

Parthenium is a noxious, invasive weed of both agricultural and natural ecosystems having considerable impacts (Shrestha, 2019). *Z. bicolorata* is a natural enemy of Parthenium and is suggested as a biocontrol agent. But the fecundity, growth, and survivability of the beetle are greatly influenced by the climate especially the temperature - both low and high-temperature impact the biology of the beetle (Neven, 2000). During the present study, it was found that Spot A with patchy forested lands was highly infested with the differential growth of Parthenium weed for most of the month of the year; while in Spot B

Table 1: Metrological data of the study area during 2020-21

Month	Temperature (°C)	Relative Humidity (%)	Rainfall (cm)
March	23	74	2.0
April	38	42	3.2
May	36	56	10.0
June	32	74	23.3
July	29	85	29.3
August	31	72	25.3
September	33	64	22.3
October	33	64	8.8
November	24	56	1.0
December	18	55	0.8
January	20	50	1.2
February	28	52	2.2

Table 2: Monthly variation of beetles at two spots

Month	Spot A		Spot B	
	Average No./ Plant	%	Average No./ Plant	%
March	3.60	1.86	7.05	2.75
April	3.40	1.75	8.85	3.46
May	6.05	3.12	15.05	5.88
June	10.10	5.21	29.95	11.70
July	14.80	7.63	50.15	19.59
August	25.05	12.91	70.95	27.72
September	37.95	19.56	56.00	21.88
October	58.00	29.90	10.30	4.02
November	32.05	16.52	4.15	1.62
December	1.55	0.80	1.65	0.64
January	0.90	0.46	1.05	0.41
February	0.55	0.28	0.80	0.31
Average/ Total*	16.17	100*	21.33	100*

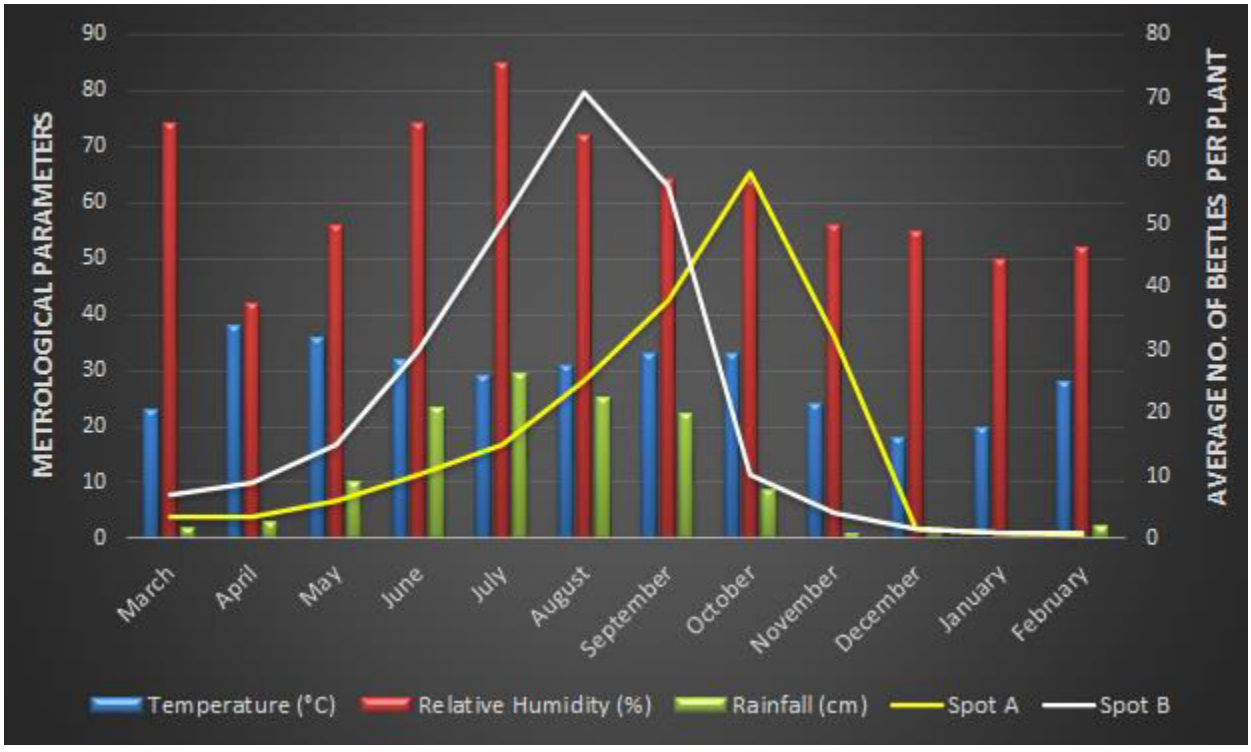

Fig. 3: Correlation between the climatic factors and growth of *Z. bicolorata* in two study spots

Fig. 4: (A) *Z. bicolorata* infested Parthenium, (B, C) Defoliated Parthenium.

with a densely forested canopy area, Parthenium growth is pointedly low. There is a significant difference ($P < 0.05$) in the population growth of the Mexican beetle *Z. bicolorata* in two physiographically contrasting biotopes along the foothills of Biharinath (Spot A and B) due to microclimatic differences and subsequently affect the Parthenium growth. The above findings suggest that the time of introduction of *Z. bicolorata* in the biocontrol strategy in any place may be crucial. As the microenvironment influences the growth and activity of the beetle, a smart adjustment in management strategy should be advantageous.

References

Adkins S and Shabbir A. (2014) Biology, ecology and management of the invasive Parthenium weed (*Parthenium hysterophorus* L.). Pest Manag Sci. 70: 1023-1029.

Dhileepan K. (2007) Biological control of Parthenium (*Parthenium hysterophorus*) in Australian rangeland translates to improved grass production. Weed Sci. 55(5): 497-501.

Dhileepan K, Sette SD and McFadyen RE. (2000) Impact of defoliation by the biocontrol agent *Zygogramma bicolorata* (Coleoptera: Chrysomelidae) on the weed *Parthenium hysterophorus* (Asteraceae) in Australia. BioControl 45: 501-512.

Gupta S. (2008) Diapause behaviour and impact assessment of *Zygogramma bicolorata* Pallister on *Parthenium hysterophorus* L. in Jammu. M. Sc. Thesis submitted to SKUST Jammu.

Hasan F and Ansari MS. (2015) Temperature-dependent development and demography of *Zygogramma bicolorata* Pallister (Coleoptera: Chrysomelidae) on *Parthenium hysterophorus* L. Ann Appl Biol. 168(1): 81-92.

Hasan F and Ansari MS. (2016) Ecotoxicological hazards of herbicides on biological attributes of *Zygogramma bicolorata* Pallister (Coleoptera: Chrysomelidae). Chemosphere 154: 398-407.

Kaur M, Aggarwal NK, Kumar V and Dhiman R. (2014) Effects and management of *Parthenium hysterophorus*: A weed of global significance. Int Sch Res Notices 14: 368647.

Mahadevappa M. (1999) Parthenium and its management. Publication Center, University of Agricultural Sciences, Dharwad (Karnataka), India, pp 1-132.

McFadyen RE. (1992) Biological control against parthenium weed in Australia. Crop Prot. 11(5): 400-407.

Mukherjee S and Paramanik M. (2022) Impact of Durga idol immersion on water bodies with early and late removal of idols in Asansol, West Bengal, India. Intern J Zool Invest. 8(1): 152-161.

Mukherjee S, Paramanik S and Paramanik M. (2022) The repercussion of a transformed environment on the diversity and abundance of common Avifauna in the Asansol - Burnpur industrial zone, West Bengal, India. Environ Ecol. 40(4B): 2499-2507.

Neven LG. (2000) Physiological responses of insects to heat. Postharvest Biol Technol. 21(1): 103-111.

Pandey AK, Mishra J, Rajak RC and Hasija SK. (1996) Potential of indigenous strains of *Sclerotium rolfsii* Sacc. for the management of *Parthenium hysterophorus* L.: A serious threat to biodiversity in India. In: Herbal Medicines, Biodiversity and Conservation Strategies, (eds.) Rajak R.C. and Rai M.K., International Book Distributors, Dehradun, pp 104-138.

Paramanik M. (2018) Bio efficiency of some medicinal plant's leaf powder against the stored grain pest *Sitophilus oryzae* L. Wesley J Res. 11(1): 4-8.

Paramanik M, Paramanik S, Mukherjee S, Kapuri R and Dasmodak S. (2022a) Larvicidal efficacy of the leaf and flower extracts of *Tropaeolum majus* L. (Tropaeolaceae) against the vector of lymphatic filariasis. Int J Mosq Res. 9(2): 26-29.

Paramanik S, Mukherjee S, Kapuri R, Dasmodak S and Paramanik M. (2022b) Evaluation of mosquito larvicidal potency of leaf and fruit extracts of *Olax scandens* Roxb. against the vectors of dengue and lymphatic filariasis. Int J Mosq Res. 9(6): 27-32.

Patel S. (2011) Harmful and beneficial aspects of *Parthenium hysterophorus*: an update. 3 Biotech. 1(1): 1-9.

Roy AN and Paramanik M. (2022) Assessment of Groundwater and Surface-Water Resources of Gushkara in Purba Bardhaman (West Bengal, India) using the Water Quality Index. Intern J Zool Invest. 8(2): 814-817.

Saini A, Aggarwal NK, Sharma A, Kaur M and Yadav A. (2014) Utility potential of *Parthenium hysterophorus* for its strategic management. Adv Agric. 14: 381859.

Shrestha BB. (2019) Management of invasive alien plants in Nepal : Current practices and future prospects. In: Tropical Ecosystems: Structure, Functions, and Challenges in the Face of Global Change, (eds.) Garkoti, S.C., Van Bloem S.J., Fulé P.Z. and Semwal R.L., Springer Singapore, pp. 45-68.

Sushilkumar (2014) Spread, menace and management of *Parthenium*. Indian J Weed Sci. 46(3): 205-219.

Sushilkumar and Ray P. (2011) Evaluation of augmentative release of *Zygogramma bicolorata* Pallister (Coleoptera: Chrysomelidae) for biological control of *Parthenium hysterophorus* L. Crop Prot. 30(6): 587-591.

Sushilkumar and Saraswat VN. (1999) Integrated management: the only solution to suppress *Parthenium hysterophorus*. In: Alien Weeds in Moist Tropical Zones: Banes and Benefits, (eds.) Shankaran K.V., Murphy S.T. and Evans H.C., Proceeding for the Workshop Held at KFRI, Peech, 2-4 Nov. 1999, pp 150-168.

Tomar P and Thakur N. (2022) Biocidal potential of indigenous isolates of Entomopathogenic Nematodes (EPNs) against tobacco cutworm, *Spodoptera litura* Fabricius (Lepidoptera: Noctuidae). Egypt J Biol Pest Control 32: 107.

Vartak VD. (1968) Weed that threatens crop and grasslands in Maharashtra. Indian Farming 18: 23-24.