GESA
GLOCAL ENVIRONMENT & SOCIAL ASSOCIATION

International Journal of Biological Innovations
http: //ijbi.org.in | http://www.gesa.org.in/journals.php
Doi: https://doi.org/10.46505/IJBI.2021.3209
IJBI 3(2): 306-311 **(2021)**
E-ISSN: 2582-1032

HOST SPECIFICITY ATTRIBUTES OF *ZYGOGRAMMA BICOLORATA* PALLISTER IN CHITRAKOOT REGION, INDIA

Preeti Tripathi and Ramesh Chandra Tripathi*

Department of Biological Sciences,
Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya,
Chitrakoot, Satna (M.P.), India

**Corresponding author*: rctmgcgv@gmail.com

Article Info:
Research article
Received
01.09.2021
Reviewed
20.09.2021
Accepted
25.09.2021

Abstract: The Mexican beetle, *Zygogramma bicolorata* is an effective bio-control insect of *Parthenium hysterophorus,* which was introduced in 1983 from Mexico to Bangalore. The adult and grub stages of *Zygogramma* act as bio-control agents for invasive and a very dangerous weed, *P. hysterophorus* (Gajar ghas). Various indigenous and economically important plants of different seasons were selected for choice and non-choice tests; food and oviposition preferences of the beetles were analysed. Host specificity tests in non-choice cases revealed that *Z. bicolorata* showed host specificity according to feeding and oviposition only towards *P. hysterophorus*. Feeding behaviour was seen only on *Parthenium* plants in choice tests. So it was found beneficial to release *Z. bicolorata* in field conditions for defoliation of carrot grass.

Keywords: Choice test, Feeding behaviour, Non-choice test, *Parthenium hysterophous.*

INTRODUCTION

Zygogramma bicolorata Pallister (Coleoptera) is a leaf feeder and belongs to family Chrysomelidae. This genus is represented by approx. 100 species, out of which 13 species are reported from Mexico. This beetle variously referred to as Mexican beetle. There are 4 life stages in the whole life cycle of Mexican beetle *namely* egg, larva, pupa and adult. This beetle belongs to Mexico and after then introduced to Australia and India. Both adult and grubs are capable to defoliate the leaves of carrot grass therefore check the growth of plant and flower production. *P. hysterophorus* was firstly introduced in Pune (Maharastra, India) in the year 1955. Tripathi and Chandra (2019) discussed the various indices of diversity of *P. hysterophorus* and associated weeds in Chitrakoot district. Singh (1997) suggested that competitive plants, insects and pathogens could be used for the management of the Carrot weed.

Zygogramma is a host specific Mexican beetle. Life table and bionomics of *Z. bicolorata* Pallister (Mexican Beetle) in Chitrakoot region was described by Chandra and Tripathi (2020). In order to examine the host specificity, the beetles were released almost all over the world including India, to check *Parthenium* infestations (Sheppard *et al.,* 2005). The findings of host specificity were proved very useful but quality works are still continued (Driesche *et al.,* 1999; McConnachie, 2015). Jayanth *et al.* (1998) explained that freshly emerged adults of *Z. bicolorata* for biological control trials against the noxious weed *Parthenium* were seen to feed and lay eggs on sunflower leaves under laboratory

conditions but no feeding behaviour was noticed on sunflower plant. Jaynath and Nagarkatti (1987) investigated the host specificity and damage potential of *Zygogramma bicolorata*. *Z. bicolorata* had a very narrow host range within the family Asteraceae and it is restricted to the sub family in which *Parthenium* occurs. *Parthenium* leaf feeding beetle *Z. bicolorata* was tested in two different assays involving differently ranked plants. First, beetles differing in their time-dependent level of responsiveness were in two choice assays with plants in the sub tribe Ambrossinae of the Heliantheae. Second, group of beetles were tested in no-choice sequential assays alternating exposure between the highest and lowest ranked plants. The data support the predictions that choice tests using insects in a non-deprived state and short duration sequential no-choice assays, will not adequately reveal the acceptability of lower ranked host plants.

Visalakshy *et al.* (2008) studied that *Z. bicolorata*, a biological control agent of *P. hysterophorus* was feeding leaves of *Helianthus annuus* in India, raising concerns of its host range. Based on the age grading technique, it was shown that the majority of *Z. bicolorata* on sunflower plants at any time were reproductively immature. This established that *Z. bicolorata* does not pose any risk to sunflower in India. Malkapure *et al.* (2012) studied the feeding preference of *Z. bicolorata*. There were different treatments or host plants tested for feeding preference, where *Parthenium* was found to be most preferred host and other may be stated as non-preferred hosts *e.g.* sunflower, *Chrysanthemum*, marigold, niger, gokhari leaves etc.

MATERIALS AND METHODS

The experiment was carried out in the field and laboratory of Biological Sciences, Faculty of Science and Environment, Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot, Satna. The study area is located on latitude 81°2'28.9"E to 81°8'27.534"E (lower), longitude 25°12'35.749"N to 25°14'30.537"N. Chitrakoot is a holistic place which is situated at 25^0 10' North latitude and 80^0 85' East longitudes. Three main cropping seasons in the Chitrakoot region is Kharif, Rabi and Zaid. The crops raised in Chitrakoot include wheat, paddy, maize, pulses and oilseeds. Main fruits grown are mango and guava.

Host specificity test in natural conditions

Indigenous and economically important plants like *Oryza sativa, Vigna radiata, Vigna mungo, Abelmoschus esculentus, Zea mays, Sorghum bicolor, Glycine max, Thevetia peruviana, Tagetes erecta, Helianthus petiolaris* and so many other important plants were grown in selected research fields.

Choice tests with *Parthenium*

The feeding and ovipositing behaviour of beetles on other host plants were also examined in the presence of *Parthenium*. For choice test, two separate fields were selected and in each field 10 plants of *P. hysterophorus* were grown with each indigenous and economically important plant species (10 plants in number) separately. Thus, 10 plants of *Parthenium* were grown with 10 plants of known species, covered with nylon net, to avoid Mexican beetle due to flying behavior. Before covering with net, 10 pairs of beetle *(Z. bicolorata)* were released to observe the feeding and oviposition behavior. In another field twenty 2nd instar larvae were placed near *Parthenium* plants and indigenous and economically important plant species to notice the feeding behavior.

Non-choice tests without *Parthenium*

Host specificity tests for non-choice were also conducted in the same manner as mentioned in the choice test, without taking *Parthenium* plant. During non-choice tests, only indigenous and economical plants were sown in the area where no *Parthenium* was implanted. After that 10 pairs of adult *Z. bicolorata* were released for observation of feeding and oviposition behavior of the beetle. In another field with indigenous plants without *Parthenium*, twenty 2nd instar larvae were released to notice the feeding behavior of grubs. The choice and non-choice tests for host specificity were set up for 48 hours. The equipment and materials used were digital balance, plastic containers of 11x14 cm (for 1st instars) and 15 x10 cm (for 2nd, 3rd, 4th instars)

with a lid having plastic mesh windows. 1st, 2nd, 3rd, 4th instars and adults (*Z. bicolorata*) were transferred to plastic containers in order to record the observations on feeding potential of *Z. bicolorata*. In five plastic containers ten numbers of different stages of *Zygogramma* were transferred in each container, offering fresh leaves (weight 1000 mg) of host to Mexican beetle.

RESULTS AND DISCUSSION

Feeding preference of *Z. bicolorata* on different hosts in laboratory conditions

The present investigation on the feeding preference of larvae and adults of *Z. bicolorata* on different hosts were carried out under laboratory conditions. *Oryza sativa, Vigna radita, Vigna mungo, Abelmoschus esculentus, Zea mays, Sorghum bicolor, Glycine max, Thevetia peruviana, Tagetes erecta, Helianthus petiolaris* and *Parthenium hysterophorus* as some host plants were taken for feeding preference of host insect. Host specificity experiment was done with 25 plant varieties belonging to ten families. Observations were taken to choice (*Parthenium* with indigenous and economically important plant species) and non-choice (indigenous and economically important plants without *Parthenium*) tests which had been executed during research work in field conditions. During observations in choice tests, it was observed that *Z. bicolorata* showed host specificity because of feeding and oviposition only towards *P. hysterophorus* and no other plant was fed or oviposited by Mexican beetle except that this leaf feeding beetle laid some eggs on *Helianthus petiolaris* but no feeding was noticed on this plant.

Other experiments were conducted for non-choice tests where Mexican beetle (*Z. bicolorata*) in the absence of *P. hysterophorus*, didn't feed on any other given plants but egg laying was found on *Glycine max*, *Tagetes erecta* and *Helianthus petiolaris* leaves but no feeding was found on these plants (table 1). During observation the different stages of *Z. bicolorata* fed voraciously on *Parthenium* and maximum consumption of food was observed by 3rd instars, which was followed by 4th instars and then feeding behaviour was shown by 2nd instars while the adults consumed the least food (fig. 1.)

Observations indicated that *Z. bicolorata* shows host specific behaviour towards the *Parthenium* plants only and specially its leaves.

Fig.1: Skeletonised *Parthenium* weeds during host specificity test of Mexican beetle.

For testing food preference of *Z. bicolorata* (adults and grubs) leaves of *Tagetes erecta, Oryza sativa, Sorghum bicolour, Zea mays, Pennisetum glaucum, Triticum astivum, Vigna radiata, Glycine max, Pisum sativum, Cajanus cajan, Phaseolus vulgaris, Cicer arietinum, Solanum melongena, Lycopersicon esculentum, Capsicum annum, Solanum tuberosum, Abelmoschus esculentus, Gossypium* sp., *Sesamum indicum, Brassica nigra, Ricinus communis, Rosa indica, Coriandrum sativum* and *P. hysterophorus* were offered to the *Z. bicolorata*. But in the observations feeding behaviour was found only on *P. hysterophorus* leaves by *Z. bicolorata* (adults and grubs) and no other host plant leaves were damaged by the beetle.

Observations were taken to choice and non-choice tests. During present investigations, it was

Table 1: Feeding behaviour of *Zygogramma* beetle on different plants.

Sl. No.	Host plant name/ Family	Common name	Choice test				Non-choice test	
			Feeding		Oviposition		Choice test	Oviposition
			Adult/ Grubs	Adult/ Grubs	Adult	Adult	Adult/ Grubs	Adult
			Host plants	*Parthenium*	Host plants	*Parthenium*	Host plants	Host plants
A.	**Asteraceae**							
1.	*Helianthus petiolaris*	Sunflower	No	No	Yes	Yes	No	Yes
2.	*Tagetes erecta*	Marigold	No	No	Yes	Yes	No	Yes
B.	**Poaceae**							
3.	*Oryza sativa*	Rice	No	Yes	No	Yes	No	No
4.	*Sorghum bicolor*	Jowar	No	Yes	No	Yes	No	No
5.	*Zea mays*	Maize	No	Yes	No	Yes	No	No
6.	*Pennisetum glaucum*	Bazra	No	Yes	No	Yes	No	No
7.	*Triticum astivum*	Wheat	No	Yes	No	Yes	No	No
C.	**Fabaceae**							
8.	*Vigna radiata*	Mung	No	Yes	No	Yes	No	No
9.	*Vigna mungo*	Urad	No	Yes	No	Yes	No	No
10.	*Glycine max*	Soybean	No	Yes	No	Yes	No	No
11.	*Pisum sativum*	Pea	No	Yes	No	Yes	No	No
12.	*Cajanus cajan*	Arhar	No	Yes	No	Yes	No	No
13.	*Phaseolus vulgaris*	Bean	No	Yes	No	Yes	No	No
14.	*Cicer arietinum*	Chana	No	Yes	No	Yes	No	No
D.	**Solanaceae**							
15.	*Solanum melongena*	Brinjal	No	Yes	No	Yes	No	Yes
16.	*Lycopersicon esculentum*	Tomato	No	Yes	No	Yes	No	No
17.	*Capsicum annum*	Chilly	No	Yes	No	Yes	No	No
18.	*Solanum tuberosum*	Potato	No	Yes	No	Yes	No	No
E.	**Malvaceae**							
19.	*Abelmoschus esculentus*	Ladies finger	No	Yes	No	Yes	No	No
20.	*Gossypium* sp.	Cotton	No	Yes	No	Yes	No	No
F.	**Pedaliaceae**							
21.	*Sesamum indicum*	Til	No	Yes	No	Yes	No	No
G.	**Brassicaceae**							
22.	*Brassica nigra*	Mustard	No	Yes	No	Yes	No	No
H.	**Euphorbiaceae**							
23.	*Ricinus communis*	Castor bean	No	Yes	No	Yes	No	No
I.	**Rosaceae**							
24.	*Rosa indica*	Rose	No	Yes	No	Yes	No	No
J.	**Apiaceae**							
25.	*Coriandrum sativum*	Coriander	No	Yes	No	Yes	No	No
	Probability		**0.00**	**1.00**	**0.08**	**1.00**	**0.00**	**0.12**

found that host plant *P. hysterophorus* was the most favoured host food of Mexican beetle in comparison to other plants. Observations indicated that *Z. bicolorata* show host specific behaviour towards the *Parthenium* plants only and specially its leaves. The maximum food (*Parthenium*) was consumed by 3rd instars (988.196 mg/ day/ 10 individuals) followed by 4th instars (961.889 mg/ day/ 10 individuals, 2nd instars (934.171 mg /day/ 10 individuals), 1st instars (918.088 mg/ day/ 10 individuals) and adults (880.07 mg/ day/ 10 individuals) respectively.

Jayanth *et al.* (1998) narrated that feeding did not occur on sunflower when it was presented in choice tests with *P. hysterophorus*. Choice tests are therefore useful for confirming that the target weeds is the most favoured host plant, but do not ascertain the relative acceptability of other hosts. Approximately similar finding was noticed in this research work in response to choice tests with *Parthenium*. No feeding behavior was noticed on *Helianthus petiolaris* (Sunflower) in the presence of *Parthenium* except a little oviposition (Probability= 0.1) in presence of *Parthenium*.

In given choice methods, the adults of Mexican beetle would neither feed nor lay eggs on any plant except *Parthenium* and ragweed. However, when given no choice, after one to two days adults will feed on most plants of the family Helianthaceae and to some extent, there was feeding and considerable damage. Few eggs of this beetle were seen on these plants and larvae did not feed or survive on them. But in latest study, no damage was found on the plants other than *Parthenium*. Further results have shown that little oviposition was reported on some plants like (*Glycine max*, *Tagetes erecta* and *Helianthus petiolaris*) leaves (Probability= 0.3) but no feeding was seen on any of these plants.

Towers and Subbha Rao (1992) studied host-specificity of *Zygogramma* taking 40 plant species representing 27 families, under quarantine conditions in India. They were satisfied that the beetle feeds and reproduces only on *Parthenium*. In the present experiment, after examining 25 plant varieties in non-choice tests for host-specificity with *Z. bicolorata*, no feeding behaviour was observed. Feeding behaviour was seen only on *Parthenium* plant in choice tests. So it was not harmful to release *Z. bicolorata* in field conditions for defoliation of carrot grass. The results of the present work revealed that *Z. bicolorata* showed host specificity with *Parthenium* as it feeds and oviposits mostly on *Parthenium*.

REFERENCES

1. **Chandra R. and Tripathi P.** (2020). Life table and Bionomics of *Zygogramma bicolorata* Pallister (Mexican Beetle) in Chitrakoot (MP). *Proceedings of the Zoological Society of India.* 19(2):79-82.
2. **Driesche R. V., Heard T., McClay A. and Reardon R.** (1999). Host Specificity Testing of Exotic Arthropod Biological Control Agents-The Biological Basis for Improvement in Safety. Proceeding: X International Symposium on Biological control of weeds. 1-100p.
3. **Jayanth K.P. and Nagarkatti S.** (1987). Investigations on the Host Specificity and Damage Potential of *Zygogramma bicolorata* Pallister (Coleoptera: Chrysomelidae) introduced into India for the Biological Control of *Parthenium hysterophorus*. *Entomon*. 12(2): 141-145.
4. **Jayanth K. P., Visalakshy P. N. G., Chaudhary M. and Ghosh S. K.** (1998). Age related feeding by the *Parthenium* beetle *Zygogramma bicolorata* on Sunflower and its effect on survival and reproduction. *Biocontrol Science and Technology*. 8(1): 117-123. 10.1080/09583159830487
5. **Malkapure A.P., Deotale R. O., Jiotode D.J., Dawane P. N. and Kakde A. T.** (2012). Feeding preference of *Zygogramma bicolorata* Pallister on different hosts. *Crop Res*. 44(3): 418-422.
6. **McConnachie A. J.** (2015). Host range and risk assessment of *Zygogramma bicolorata*, a defoliation agent released in South Africa for the biological control of *Parthenium hysterophorus*. *Biocontrol Science and*

Technology. 25(9): 975-991. 10.1080/ 09583157.2015.1023696

7. **Sheppard A. W., Klinken R. D. and Heard T. A.** (2005). Scientific advances in the analysis of direct risks of weed biological control agents to non-target plants. *Biological control*. 35(3):215-226. https://doi.org/ 10.1016/j. biocontrol.2005.05.010
8. **Singh S.P.** (1997). Perspectives in biological control of *Parthenium* in India. In (Eds. M. Mahadevappa and V.C. Patil). Proceedings of First International Conference on *Parthenium* held at Dharwad (Karnataka) from 6-8 October. I: 22-32.
9. **Towers G.H.N. and Subbha Rao P.V.** (1992). Impact of the pan-Tropical weed, *Parthenium hysterophorus* L. on human affairs. In: Richardson RG (ed). Proceedings of the First International Weed Control Congress, Melbourne, Australia. 134-138p.
10. **Tripathi P. and Chandra R.** (2019). Diversity of *Parthenium hysterophorus* and associated weeds in the Chitrakoot District. *International Journal of Biological Innovations.* 1 (2):51-55. https://doi.org/10.46505/IJBI.2019.1203
11. **Visalakshy P. N. G. and Jayanth K. P., Ghosh S.K. and Chaudhary M.** (2008). Post introduction risk assessment studies on *Zygogramma bicolorata* (Coleoptera: Chrysomelidae), a classical biological control agent of *Parthenium hysterophorus* (Asteraceae) in India. *Biocontrol Science and Technology*. 18(10): 1083-1086. https:// doi.org/10.1080/09583150802488808