AGRI MAGAZINE
(International E-Magazine for Agricultural Articles)
Volume: 03, Issue: 08 (August, 2026)
Available online at http://www.agrimagazine.in
©Agri Magazine, ISSN: 3048-8656

Parthenium Beetle, *Zygogramma bicolorata* Pallister (Coleoptera: Chrysomelidae): A Potential Classical Biological Control Agent of Parthenium Weed

*Tejpal Tetarwal[1], Rahul Nodal[1], Sachin Yadav[1] and M.K. Mahla[2]
[1]Ph.D. Scholar, Department of Entomology, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan-313001, India
[2]Professor, Department of Entomology, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan-313001, India
*Corresponding Author's email: tejpaltetarwal2001@gmail.com

Parthenium beetle is a host-specific leaf-feeding beetle used for classical biological control of Parthenium weed a major invasive weed. Larvae pass through four instars and completed duration in 16–28 days. Both larvae and adults feed heavily on parthenium, reducing plant biomass and seed production. The beetle completes 3–5 generations per year, peaks after the monsoon in India and survives unfavourable seasons mainly as diapausing adults or pupae with mortality influenced by predators and occasionally by parasitoids.

Introduction

Zygogramma bicolorata, a chrysomelid beetle native to Mexico and the southwestern United States was identified as a highly host-specific biocontrol agent following extensive host range testing conducted in Australia and India during the 1980 (Jayanth, 1987). The beetle was first released in India in 1984 and subsequently introduced in Australia and Ethiopia, demonstrating significant feeding damage to *P. hysterophorus* populations (Jayanth and Bali, 1994; Winston *et al*., 2014). Both grub and adult stages of the beetle are phytophagous, feeding primarily on the leaf lamina and their collective defoliation can substantially suppress weed biomass and seed production. *Parthenium hysterophorus* L., commonly known as parthenium weed or congress grass, is one of the world most problematic invasive alien plant species, classified among the top 10 most noxious weeds globally (McFadyen, 1992). Originated in tropical America, it has established highly destructive populations across Asia, Africa and Australia, causing significant agricultural crop losses, allelopathic suppression of native vegetation and severe human and livestock health problems (Adkins and Shabbir, 2014). Classical biological control using host-specific natural enemies has been identified as the most environmentally sustainable strategy to managing parthenium weed at landscape scales.

Taxonomy and morphology

Zygogramma bicolorata belongs to the order Coleoptera, family Chrysomelidae, subfamily Chrysomelinae. The adult beetle is approximately 5–7 mm in length, exhibiting a distinctly convex, ovoid body form with a characteristic bicolored pattern: the elytra are predominantly brown or reddish-brown with creamy-white longitudinal stripes. The mouthparts are of the mandibulate chewing type well adapted for foliar consumption. The larval stages are apodous, grub-like, with a pale yellowish-green body that darkens progressively through successive instars.

Life cycle

Egg: The eggs deposited by female in singly or in group of 2–5 eggs on the underside of leaf and on green stem up to 200 to 400 in numbers. Eggs are oval to elongate-elliptical in shape and pale yellowish-cream to orange in colour.

Larvae: Larval duration comprises four instars. First-instar larvae are small, pale yellowish-green and a dark brown head capsule with lasts 3–5 days. The fourth and last instar become conspicuously robust, exhibiting a darker dorsal coloration and a prominently sclerotized head capsule. The total larval period ranges from 16 to 28 days.

Pupa: Mature fourth-instar larvae exhibit negative phototaxis and positive geotaxis as pre-pupal behavioural cues, actively burrowing 2–5 cm into the soil substrate to construct earthen pupal cells. The pupa is pale cream to yellowish-white in colour. The pupal period typically lasts 7–12 days.

Adult: Adults exhibit soft, pale elytra that harden and acquire the characteristic bicolored pattern within 1–2 days post-eclosion. Adults are positively phototactic and immediately ascend host plants to commence feeding. Adult longevity ranges from 30 to 90 days under field conditions.

Nature of feeding damage

Both larvae and adult are damaging stages of beetle. Adult are obligate feeders on *P. hysterophorus* consuming both foliar and floral tissue. Adult feeding causes characteristic circular to irregular window panning damage on leaves, differing from larval skeletonizing damage.

Seasonal Population Dynamics

Zygogramma bicolorata is multivoltine in tropical and subtropical environment, completing 3–5 generations per year depending on climatic conditions and host plant phenology. In India, peak population densities coincide with the post-monsoon flush of *P. hysterophorus* growth (August–November) during which all life stages may be simultaneously observed in the field. During the dry season and winter months, the beetle survives primarily as diapausing adults sheltering in soil litter or as diapausing pupae in deeper soil layers.

Natural Enemies

Mortality across developmental stages of beetle has been attributed to several biotic factors. Egg predation by generalist predators including ants and mirid bugs has been documented in Indian field populations. Larval mortality due to parasitoid wasps (Braconidae and Ichneumonidae) has been reported sporadically, though parasitism rates remain generally low.

Conclusion

The life cycle of *Zygogramma bicolorata* is well-adapted to exploit the rapid growth phenology of *Parthenium hysterophorus* with each developmental stage exhibiting specific behavioural and physiological characteristics that maximize herbivorous impact on the host weed. The life cycle completed in 30–45 days under optimal conditions. Multivoltinism enables substantial population buildup during host plant growing seasons, amplifying the suppressive impact on *P. hysterophorus* populations.

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