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Diversity and Population Dynamics of Beneficial Insects in Rabi Cropping Systems of Dhod Tehsil, Sikar, Rajasthan

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Abstract

The present study investigates the diversity, abundance, and functional roles of beneficial insects associated with major Rabi crops in Dhod tehsil of Sikar district, Rajasthan, during two consecutive seasons (2021–2023). Insect sampling was conducted across six sites representing different ecological conditions, using pitfall traps, sweep nets, and sticky traps. A total of 46 species belonging to eight orders and 25 families were recorded. Hymenoptera emerged as the most dominant order, followed by Coleoptera, Diptera, and Lepidoptera. Functional categorization revealed 22 predator species, 22 pollinators, 7 parasitoids, and 6 soil builders. The Shannon–Wiener diversity index and Simpson's index indicated high community stability and species evenness. Among the sites, Harsh (Site 5) exhibited maximum species richness. The predominance of pollinators and predators underscores their critical ecological roles in enhancing pollination efficiency, natural pest control, and soil health in semi-arid agro ecosystems. The study highlights the need for conserving beneficial insect diversity through sustainable agricultural practices, reduced pesticide use, and maintenance of flowering field margins to strengthen ecosystem services and agro ecological resilience in Rajasthan's Rabi cropping systems.

Keywords

Beneficial insects; biodiversity; Rabi crops; pollinators; predators; parasitoids; soil builders; Dhod tehsil; Sikar district; agro ecosystem; integrated pest management (IPM); ecological intensification

1. Introduction

Agriculture is foundational to human societies, providing food, fiber, and livelihoods worldwide. In India, agriculture contributes substantially to GDP and sustains rural livelihoods (Kumar et al., 2016; Pal & Tripp, 1998). Sustaining productivity amidst challenges like climate variability and pest pressure requires integration of ecological services. Beneficial insects play vital roles in pollination, pest regulation, and soil fertility (Losey & Vaughan, 2006; Bianchi, Booij, & Tscharntke, 2006).

Rajasthan's semi-arid agroecosystems, particularly the Shekhawati region, face low rainfall and extreme temperatures (Rawal, 2017). Rabi crops such as wheat, mustard, gram, and barley dominate agriculture, depending largely on winter rainfall. Beneficial insects, including bees, beetles, ants, and wasps, enhance crop productivity and ecosystem stability through pollination and biological control (Dainese et al., 2019). However, habitat loss and pesticide use threaten these communities. This study investigates the diversity, distribution, and ecological roles of beneficial insects associated with Rabi crops in Dhod tehsil, Sikar, to promote sustainable pest management.

Beneficial insects can be broadly classified into pollinators, predators, parasitoids, and decomposers (Rondon et al., 2008). Pollinators such as bees and butterflies are essential for the reproductive success of flowering plants and directly enhance crop yields. Predators like ladybird beetles and mantids regulate pest populations by feeding on aphids, caterpillars, and hoppers (Getanjaly et al., 2015). Parasitoids, mainly from the Hymenoptera and Diptera, attack pest larvae and pupae, while soil-builders like ants and beetles contribute to nutrient recycling and soil fertility. The functional diversity of these insects ensures agro ecosystem stability and resilience against disturbances such as pest outbreaks and climatic fluctuations (Macfadyen et al., 2015). The promotion of beneficial insects as natural allies in crop production is increasingly recognized as a key element in achieving sustainable intensification (Bhattacharyya et al., 2015).

Given the ecological and economic significance of beneficial insects, this study was undertaken to assess their diversity, abundance, and functional roles in the Rabi cropping systems of Dhod tehsil, Sikar district. Understanding these interactions provides a foundation for developing sustainable pest management strategies that integrate biodiversity conservation with agricultural productivity.

2. Materials and Methods

2.1 Study Area

The study was carried out in Dhod tehsil of Sikar district (27.64°N, 75.38°E) in Rajasthan's semi-arid zone. Six villages—Kudan, Dhod, Jana, Shahpura, Harsh, and Kanwarpura—were selected to represent variations in soil texture, cropping intensity, and irrigation access. The area receives 350–500 mm annual rainfall, with sandy loam soils and temperature extremes from 4°C to 48°C (Sharma & Ghosh, 2013).

2.2 Insect Sampling and Study Duration

Sampling was conducted across two Rabi seasons (October–March 2021–22 and 2022–23). Sampling was done biweekly during morning hours to capture insect activity across crop growth stages—vegetative, flowering, and fruiting. Each site was monitored to ensure coverage of local agro ecosystem variation.

2.3 Collection Methods

Standard entomological methods were used to collect insects: (i) hand picking and forceps for visible species, (ii) sweep netting for canopy dwellers, (iii) brushing/beating for concealed species, (iv) pitfall traps for ground insects, and (v) sticky traps for flying species. These techniques targeted different insect strata and behaviors.

2.4 Identification of Insects

Collected insects were euthanized with ethyl acetate and preserved in 70% ethanol or pinned for dry preservation. Identification was done using standard keys (Arnett, 2000; Borror, Triplehorn, & Johnson, 1989) and expert consultation. Specimens were identified to family or species level where possible.

2.5 Diversity Indices

Biodiversity was assessed using Dominance (D), Simpson (1-D), Shannon-Wiener (H'), and Evenness (E) indices (Magurran, 2013). These metrics provide insights into community structure, richness, and balance.

2.6 Data Analysis

Data were compiled across six sites and two years. Species composition, abundance, and functional guild structure were analyzed using PAST and Microsoft Excel software. Guilds were grouped as pollinators, predators, parasitoids, or soil builders. Indices were compared across sites to identify diversity trends.

3. Results and Discussion

Table.1.Order-Wise Composition and ecological role of beneficial insects collected during the study period from study sites.

Order	**No. of Families**	**No. of Species**	**Ecological Role**
Hemiptera	1	1	Predators (Assassin bugs)
Hymenoptera	5	17	Parasitoids & Pollinators (Wasps, Ants, Bees)
Coleoptera	5	10	Predators (Ladybirds, Ground beetles, Dung beetles, Rove beetles)
Odonata	2	3	Predators (Dragonflies, Damselflies)
Neuroptera	2	2	Predators (Lacewings, Owlfly)
Dictyoptera	1	1	Predators (Praying mantis)
Diptera	2	6	Pollinators & Predators (Hoverflies, Drone flies)
Lepidoptera	2	6	Pollinators (Butterflies)

A total of forty-six species of beneficial insects belonging to eight orders—Hemiptera, Coleoptera, Hymenoptera, Odonata, Neuroptera, Dictyoptera, Diptera, and Lepidoptera—and twenty families were recorded during the Rabi season in Dhod tehsil of Sikar district, reflecting rich ecological diversity and functional importance. The order Hymenoptera was the most dominant, represented by families Ichneumonidae (*Enicospilus purgatus*, *Perilissus cingulator*, *Campoletis chloridae*), Vespidae (*Vespa orientalis*), Apidae (*Apis dorsata, A. cerana indica, A. florea, A. mellifera*, *Amegilla zonata*, *Xylocopa fenestrata*, *Megachile disjuncta*, *Ceratina smaragdula*), Formicidae (*Monomorium minimum*, *Camponotus compressus*, *Dorylus spp*.), and Braconidae (*Diaeretiella rapae*, *Cotesia plutellae*). These insects played key roles as pollinators, parasitoids, and social regulators within the agro ecosystem. The second most abundant order, Coleoptera, included predatory and decomposer families such as Scarabaeidae (*Onitis falcutus*), Coccinellidae (*Coccinella septempunctata*, *Menochilus sexmaculata*, *Hippodamia variegata*), Cicindelidae (*Cicindela bicolor*), Carabidae (*Chlaenius pictus*, *Harpalus signaticornis*, *Dromius quadrimaculatus*, *Chlaenius bimaculatus*), and Staphylinidae (*Aleochara bilineata*). The order Diptera comprised pollinators from the families Syrphidae (*Sphaerophoria spp.*, *Eupeodes corollae*, *Xanthogramma spp.*, *Syrphus spp*.) and Muscidae (*Musca domestica*), while Lepidoptera was represented by Pieridae (*Catopsilia pomona*, *Eurema hecabe*) and Nymphalidae (*Danaus chrysippus*, *Phalanta phalantha*, *Tirumala limniace*, *Euploea core*). Predatory taxa such as Odonata—families Libellulidae (*Pantala flavescens*, *Crocothemis servilia*) and Coenagrionidae (*Coenagrion sp*.)—along with Neuroptera families Ascalaphidae (*Ascalaphus spp*.) and Chrysopidae (*Chrysoperla sillemi*), and Dictyoptera family Mantidae (*Mantis religiosa*), further enhanced the ecological balance. The coexistence of these diverse insect groups—predators, parasitoids, pollinators, and decomposers—indicates a stable, resilient, and functionally rich agro ecosystem, where natural pest regulation and pollination contribute significantly to sustainable agricultural productivity in the region.

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Fig.1: Composition of insects fauna in terms of different families, recorded in the study area during the study period

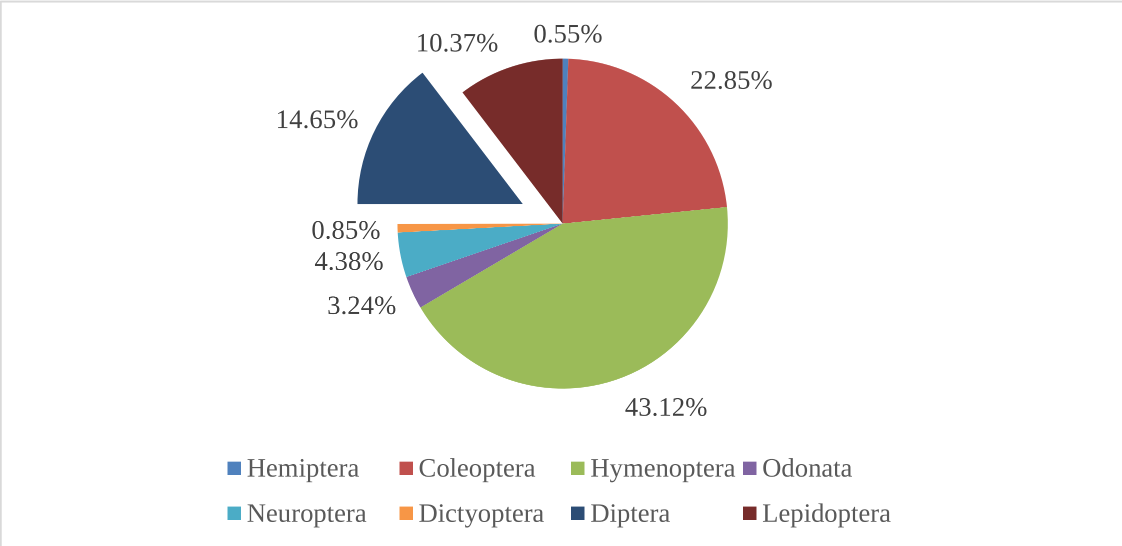
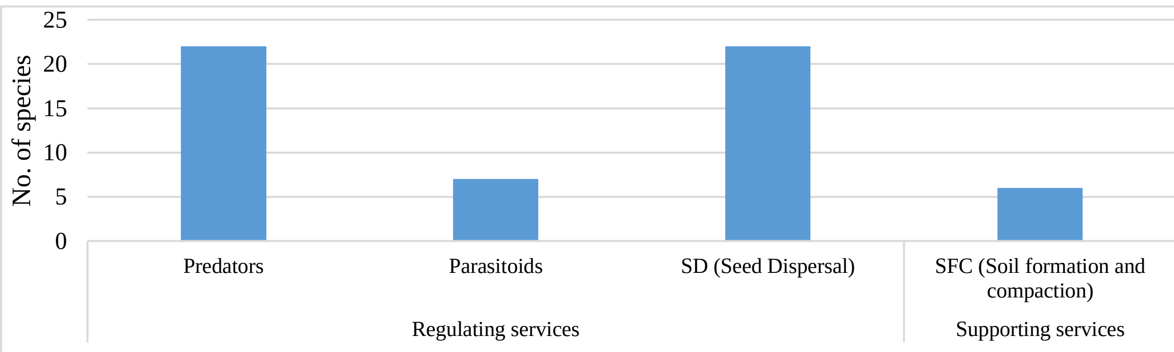


Figure shows the number of species and their corresponding relative abundance of insect orders. A total of 46 species were recorded across eight orders, with their contribution to total abundance varying widely. Hymenoptera emerged as the dominant order, with 17 species contributing 43.12% of total individuals. Coleoptera was the second most diverse order with 10 species and 22.85% of individuals. Diptera and Lepidoptera, with 6 species each, contributed 14.65% and 10.37% of individuals, respectively. Orders with lower species richness and abundance, such as Odonata (3 species, 3.24%), Neuroptera (2 species, 4.38%), Dictyoptera (1 species, 0.85%), and Hemiptera (1 species, 0.55%), contributed less numerically but hold ecological importance as specialized predators of pest insects, helping maintain ecosystem balance.

Functionally, 22 species were predators, 22 pollinators, 7 parasitoids, and 6 soil builders. Predators such as *Coccinella septempunctata* and *Chrysoperla sillemi* played key roles in pest control. Pollinators, including *Apis dorsata, A. cerana*, and hoverflies, supported mustard and gram pollination. Soil-builders like *Onitis falcutus* and *Camponotus compressus* enhanced soil aeration and organic recycling. Parasitoids such as *Campoletis chloridae* and *Cotesia plutellae* regulated pest populations naturally.

Fig.3: Contribution of beneficial insect species to regulating services and supporting services



Species distribution across sites revealed that Harsh (Site 5) supported the highest diversity, hosting all 46 recorded species.

This suggests that habitat heterogeneity, availability of floral resources, and minimal pesticide exposure favor higher insect diversity. In contrast, Shahpura and Jana exhibited moderate diversity, while Dhod and Kudan recorded slightly lower abundances, likely due to higher anthropogenic disturbance and monocropping. The uniformity of species representation across all sites indicates ecological stability and resilience within the Rabi cropping systems.

Table 2: Diversity indices of beneficial insects in Dhod tehsil during two consecutive rabi seasons (2021–22 to 2022–23)

Diversity Indices	**2021–22**	**2022–23**	**2021–23**
Dominance	0.02392	0.02505	0.02428
Simpson	0.9761	0.9749	0.9757
Shannon	3.772	3.725	3.762
Evenness	0.9448	0.9428	0.9353

Diversity indices further validated the stability of the insect community. Low dominance values (0.02392–0.02505) indicated that no single species dominated the assemblage. High Simpson (0.9749–0.9761) and Shannon (3.725–3.772) indices reflected high diversity and species evenness (0.9428–0.9448). These values collectively suggest a balanced community structure where beneficial insects coexist and collectively contribute to pest regulation, pollination, and nutrient cycling. The slight interannual variation in species abundance was attributed to changes in rainfall and temperature between the two study years.

The findings demonstrate that Dhod tehsil’s Rabi agro ecosystems sustain diverse beneficial insect populations despite semi-arid conditions. The prevalence of pollinators such as *Apis spp.* and predators like *coccinellids* indicates active natural pest regulation. High diversity indices reflect ecological stability and resilience, essential for sustainable crop production. Habitat heterogeneity, such as maintaining native vegetation and minimizing chemical pesticide use, plays a crucial role in supporting these beneficial populations. Implementing integrated pest management (IPM) strategies emphasizing conservation of natural enemies, crop rotation, and pollinator corridors can enhance ecological balance and reduce dependency on chemical control. Such biodiversity-based management aligns with national and global initiatives for sustainable agriculture.

4. Conclusion

The study concludes that the Rabi cropping systems of Dhod tehsil support a rich diversity of beneficial insects that play critical roles in pollination, pest regulation, and soil enrichment. The dominance of Hymenoptera and Coleoptera underscores their ecological significance. Promoting biodiversity-friendly agricultural practices can enhance ecosystem services, crop yield, and long-term sustainability. Conservation of these beneficial insects through eco-friendly pest management and habitat enhancement is imperative for resilient agricultural systems in semi-arid regions like Sikar district.

5. References

1. Altieri, M. A. (2018). Agroecology: The science of sustainable agriculture (3rd ed.). CRC Press.
2. Arnett, R. H. Jr. (2000). American Insects: A Handbook of the Insects of America North of Mexico. CRC Press.
3. Bhattacharyya, R., Ghosh, B., Mishra, P., Mandal, B., Rao, C., Sarkar, D., et al. (2015). Soil degradation in India: Challenges and potential solutions. Sustainability, *7*(4), 3528–3570.

4. Bianchi, F. J. J. A., Booij, C. J. H., & Tscharntke, T. (2006). Sustainable pest regulation in agricultural landscapes: a review on landscape composition, biodiversity, and natural pest control. Proceedings of the Royal Society B: Biological Sciences, *273*(1595), 1715–1727.
5. Bommarco, R., Kleijn, D., & Potts, S. G. (2013). Ecological intensification: harnessing ecosystem services for food security. Trends in Ecology & Evolution, 28(4), 230–238.
6. Borror, D. J., Triplehorn, C. A., & Johnson, N. F. (1989). *An Introduction to the Study of Insects* (6th ed.). Saunders.
7. Dainese, M., et al. (2019). A global synthesis reveals biodiversity-mediated benefits for crop production. Science Advances, *5*(10), eaax0121.
8. Getanjaly, V., Rai, P., Sharma, R., & Kushwaha. (2015). Beneficial insects and their value to agriculture. Research Journal of Agriculture and Forestry Sciences, *3*(5), 25-30.
9. Khurana, A., et al. (2020). Pollinators and ecosystem services in India: status, threats and opportunities. Current Science, *119*(11), 1898–1905.
10. Kremen, C., & Mace, G. M. (2019). Conversations on the sustainable use of land: forage for thought. Proceedings of the National Academy of Sciences, *116*(52), 26320–26329.
11. Kumar, A., et al. (2016). Agricultural growth and its relationship with non-farm employment: Evidence from India. Journal of Rural Studies, *46*, 79–87.
12. Losey, J. E., & Vaughan, M. (2006). The economic value of ecological services provided by insects. BioScience, 56(4), 311–323.
13. Magurran, A. E. (2013). Measuring Biological Diversity. Wiley-Blackwell.
14. Macfadyen, S., Davies, A. P., & Zalucki, M. P. (2015). Assessing the impact of arthropod natural enemies on crop pests at the field scale. Insect Science, *22*, 20–34
15. Pal, S., & Tripp, R. (1998). Socioeconomic Impacts of Agricultural Research in India. IFPRI.
16. Rawal, S. (2017). Agricultural challenges in arid Rajasthan. Rajasthan Economic Review, 3(1), 121–135.
17. Ricketts, T. H., et al. (2008). Landscape effects on crop pollination services: are there general patterns. Ecology Letters, 11(5), 499–515.
18. Rondon, S. I., Clough, G. H., & Corp, M. K. (2008). How to identify, scout and control insect pests in vegetable crops. Oregon State University Extension Service, pp 1-8
19. Sahrawat, K. L., et al. (2000). Strategies to improve management of degraded soils in the dry zones of India. Geoderma, 94(1–2), 179–192.
20. Sharma, P., & Ghosh, K. (2013). Soil constraints and their amelioration in arid regions: insights from Rajasthan. Arid Land Research and Management, 27(1), 1–17.
21. Singh, R., et al. (2021). Impact of pesticide use on pollinator communities in Indian agroecosystems. Environmental Research, 199, 111308.