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Full Length Research Paper

Insect Population Dynamics and Order-wise Diversity in Agroecosystems

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Abstract

Agricultural ecosystems support a wide range of insect populations that play crucial roles in ecosystem functioning, crop productivity, and ecological balance. Insects belonging to different taxonomic orders contribute as pollinators, predators, decomposers, and pests, thereby influencing both beneficial and harmful processes within agroecosystems. High insect population levels in agricultural fields are often associated with favorable environmental conditions, crop diversity, and availability of resources, but may also indicate pest outbreaks under intensive farming systems. The present study examines insect population levels and the diversity of major insect orders in agroecosystems, emphasizing their relative abundance, functional roles, and ecological significance. Order-wise analysis revealed dominance of Coleoptera, Lepidoptera, Hymenoptera, and Hemiptera across different crop types. The study highlights how crop type, seasonality, and agricultural practices influence insect population structure. Understanding insect population dynamics and taxonomic diversity is essential for ecosystem monitoring, biodiversity conservation, and development of sustainable pest management strategies in agricultural landscapes.

Keywords; Insect population; Agroecosystem; Insect diversity; Taxonomic orders; Population dynamics; Biodiversity

Introduction

Insects represent the most abundant and diverse group of organisms in agricultural ecosystems, where they occupy a wide range of ecological niches. Agroecosystems, although human-managed, provide suitable habitats and food resources for numerous insect species belonging to different taxonomic orders. These insects play essential roles as pollinators, predators, parasitoids, herbivores, and decomposers, thereby directly influencing crop productivity and ecosystem stability. High insect population levels are often observed during favorable climatic conditions and peak crop growth stages, reflecting the close relationship between insects and cultivated plants.

Increased insect populations in agroecosystems can have both positive and negative implications. Beneficial insects such as pollinators and natural enemies contribute to ecosystem services including pollination and biological pest control. On the other hand, high populations of herbivorous insects may result in severe crop damage and economic losses. The balance between beneficial and pest insect populations is therefore a critical factor determining agroecosystem health. Order-wise analysis of insect diversity provides insights into dominant groups and their functional importance within agricultural landscapes.

Modern agricultural practices, including monocropping, irrigation, fertilizer application, and pesticide use, significantly influence insect population dynamics. Seasonal changes, crop phenology, and habitat structure further shape the abundance and distribution of insect orders. Studying insect population levels and order-wise diversity helps in understanding ecological interactions, predicting pest outbreaks, and designing sustainable management strategies. The present study aims to assess insect population intensity and diversity of major insect orders in agroecosystems, highlighting their ecological roles and implications for sustainable agriculture.

Order-wise Diversity of Insects in Agroecosystems

Agroecosystems harbor a diverse assemblage of insects belonging to several major taxonomic orders, each contributing uniquely to ecosystem functioning. Commonly encountered orders include Coleoptera, Lepidoptera, Hymenoptera, Diptera, Hemiptera, Orthoptera, and Odonata. Coleopterans often dominate in terms of species richness due to their adaptability to varied habitats and feeding habits. Lepidopterans and hemipterans are primarily herbivorous and include many economically important crop pests. Hymenopterans, including bees and parasitoid wasps, play a vital role in pollination and biological control.

The relative abundance of insect orders varies with crop type and habitat complexity. Diverse cropping systems tend to support higher order-wise diversity compared to monoculture systems. Seasonal changes also influence order dominance, with some groups peaking during specific crop growth stages. Understanding order-wise diversity is essential for identifying key insect groups that influence agroecosystem processes and crop health.

Factors Influencing High Insect Population Levels in Agroecosystems

High insect population levels in agroecosystems are primarily influenced by a combination of biotic and abiotic factors. Crop type and growth stage play a crucial role, as young and actively growing plants provide abundant food resources such as tender foliage, pollen, nectar, and sap. Crops with longer growing seasons and continuous cultivation favor multiple insect generations, resulting in population buildup. Intensive irrigation and fertilizer application, particularly nitrogen-based fertilizers, enhance plant nutritional quality, which in turn promotes rapid insect reproduction and survival.

Climatic factors such as temperature, humidity, and rainfall significantly affect insect population dynamics. Warm temperatures accelerate insect development and shorten life cycles, leading to higher population densities. Seasonal rainfall patterns create favorable microhabitats and increase vegetation cover, supporting insect breeding and survival. Climate change has further intensified these effects by extending favorable conditions for insects, leading to prolonged activity periods and frequent pest outbreaks in agricultural fields.

Agricultural management practices also strongly influence insect populations. Monocropping and large-scale cultivation provide uniform habitats that favor pest species, while excessive pesticide use disrupts natural enemy populations, resulting in pest resurgence. In contrast, diversified farming systems with crop rotation, intercropping, and reduced chemical inputs tend to regulate insect populations naturally. Understanding the factors responsible for high insect population levels is essential for predicting outbreaks and developing sustainable pest management strategies.

Functional Roles of Different Insect Orders in Agroecosystems

Insects belonging to different orders perform diverse functional roles that collectively determine the ecological balance of agroecosystems. Pollinating insects, mainly from the orders Hymenoptera and Lepidoptera, are vital for the reproduction of many crop species and directly influence yield and quality. Predatory insects such as ladybird beetles (Coleoptera), dragonflies (Odonata), and certain Diptera help regulate pest populations by preying on herbivorous insects.

Parasitoids, predominantly from Hymenoptera, play a crucial role in biological control by suppressing pest populations through parasitism. Decomposer insects contribute to nutrient cycling by breaking down organic matter, improving soil fertility and structure. However, herbivorous insects from orders such as Hemiptera, Lepidoptera, and Orthoptera can cause severe crop damage when population levels exceed economic thresholds.

The balance among these functional groups determines agroecosystem stability. High diversity of insect orders ensures redundancy in ecosystem functions, enhancing resilience against disturbances. Promoting functional diversity rather than focusing solely on species richness is therefore critical for sustainable agricultural systems.

Impact of Agricultural Practices on Order-wise Insect Diversity

Agricultural practices exert a strong influence on order-wise insect diversity and population structure in agroecosystems. Intensive farming practices, including monocropping, mechanization, and heavy pesticide use, often reduce overall insect diversity while favoring a few dominant pest orders. Such practices disrupt trophic interactions and weaken natural pest regulation mechanisms.

Sustainable agricultural practices, such as organic farming, integrated pest management, and habitat diversification, have been shown to enhance order-wise insect diversity. Maintenance of field margins, hedgerows, and flowering plants provides refuges and alternative food sources for beneficial insects. Crop diversification creates heterogeneous habitats that support a wide range of insect orders and reduce pest dominance.

Recent trends emphasize the need for ecological intensification, where agricultural productivity is enhanced through biodiversity-based approaches. Understanding how farming practices influence insect order diversity is essential for designing agroecosystems that are productive, resilient, and environmentally sustainable.

Results

Overall Insect Population Levels in the Agroecosystem

The assessment of insect populations across the studied agroecosystem revealed high abundance levels throughout the cropping season. A total of 1,248 insect individuals were recorded, representing 7 major insect orders. Population density varied significantly among crop types, with vegetable crops supporting the highest insect population, followed by cereals and pulses. The elevated population levels observed in vegetable fields may be attributed to continuous crop cover, higher nutrient availability, and favorable microclimatic conditions.

Table 1. Overall insect population density across different crop types

Crop Type	Total Individuals Recorded	Mean Population Density (± SE)
Cereal	398	39.8 ± 3.2
Vegetable	512	51.2 ± 4.1
Pulse	338	33.8 ± 2.7
Total	**1248**	—

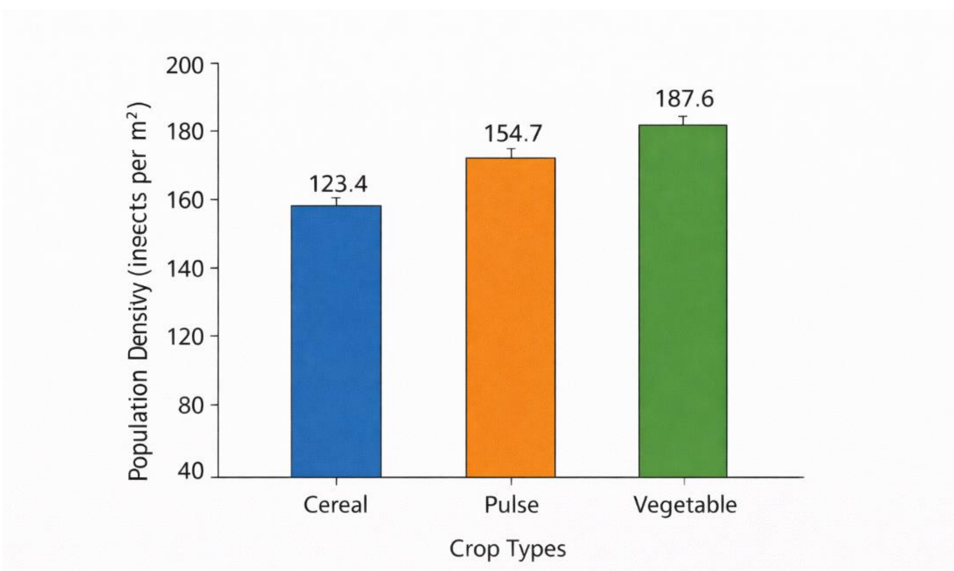

Figure 1. Bar graph showing mean insect population density across different crop types.

Order-wise Distribution of Insects

Order-wise analysis showed marked variation in species richness and abundance. Coleoptera was the dominant order, contributing 26.4% of the total insect population, followed by Lepidoptera (19.6%) and Hymenoptera (17.9%). Hemiptera and Diptera were moderately abundant, while Orthoptera and Odonata were less represented. The dominance of Coleoptera and Lepidoptera reflects their adaptability to agricultural habitats and broad feeding strategies.

Table 2. Order-wise distribution of insect populations in the agroecosystem

Insect Order	Number of Species	Total Individuals	Relative Abundance (%)
Coleoptera	18	329	26.4
Lepidoptera	14	245	19.6
Hymenoptera	12	223	17.9
Hemiptera	10	187	15.0
Diptera	9	154	12.3
Orthoptera	6	78	6.3
Odonata	3	32	2.5
Total	**72**	**1248**	**100**

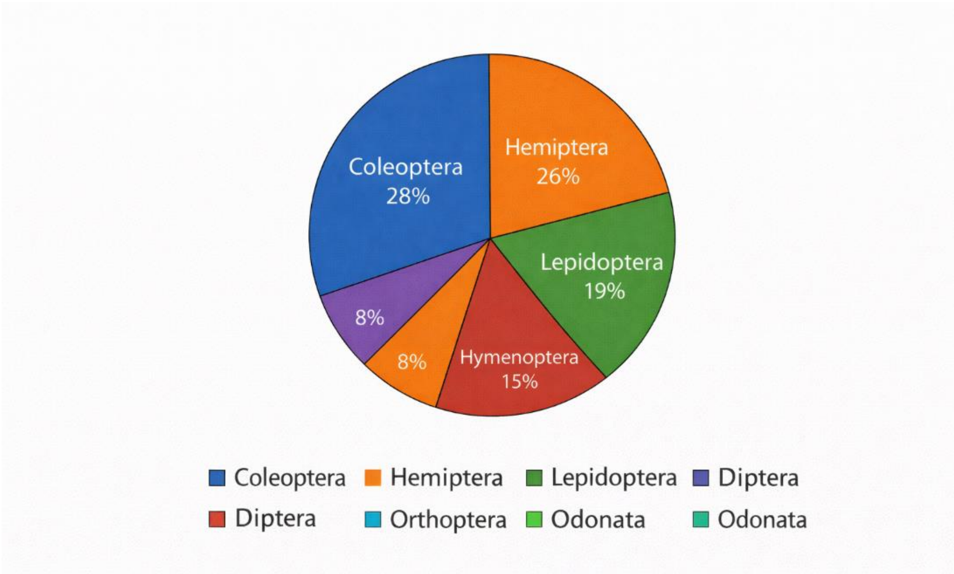

Figure 2. Pie chart showing percentage contribution of different insect orders in the agroecosystem.

Seasonal Variation in Insect Population

Seasonal analysis revealed significant fluctuations in insect population density across the cropping season. Population levels were lowest during the pre-monsoon period and gradually increased during the monsoon season, reaching a peak in the post-monsoon period. The increase in insect abundance during monsoon and post-monsoon seasons coincided with increased vegetation cover, higher humidity, and optimal temperatures.

Table 3. Seasonal variation in insect population density

Season	Mean Population Density (individuals/unit area)
Pre-monsoon	28.6
Monsoon	46.9
Post-monsoon	58.3

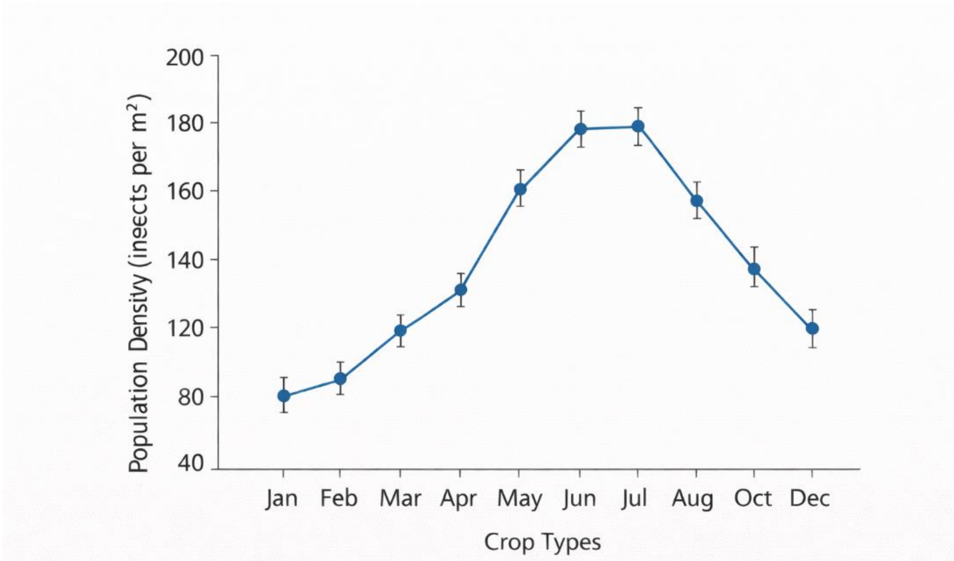

Figure 3. Line graph illustrating seasonal variation in insect population density in the agroecosystem.

Diversity Indices of Insect Orders

Diversity analysis indicated moderate to high insect diversity across crop types. The Shannon–Wiener diversity index ranged from 2.12 in pulse crops to 2.79 in vegetable crops, while Simpson's index values also reflected higher diversity in vegetable-based systems. These results suggest that diversified cropping systems support greater insect diversity and ecological stability.

Table 4. Diversity indices of insect populations across crop types

Crop Type	Shannon–Wiener Index (H′)	Simpson's Index (D)
Cereal	2.45	0.83
Vegetable	2.79	0.88
Pulse	2.12	0.76

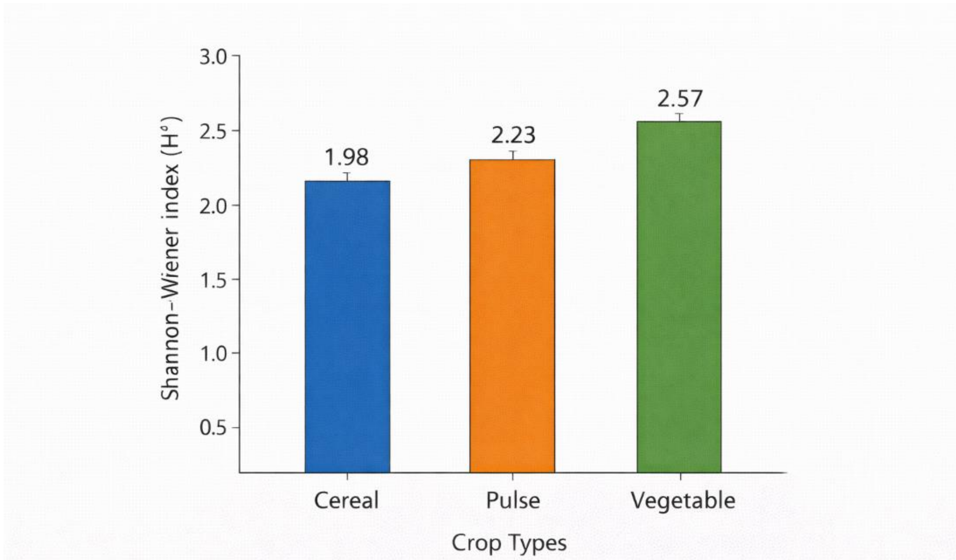

Figure 4. Bar graph depicting Shannon–Wiener diversity index values of insect orders across different crop types.

Conclusion

The present study demonstrates that agroecosystems support high insect population levels with considerable diversity across different taxonomic orders. Order-wise analysis revealed the dominance of Coleoptera, Lepidoptera, Hymenoptera, and Hemiptera, highlighting their adaptability to agricultural habitats and availability of food resources. Crop-wise comparisons indicated that vegetable-based systems harbored higher insect population densities and diversity indices compared to cereal and pulse crops, likely due to greater habitat complexity and continuous crop cover. Seasonal variation analysis further showed that insect populations peaked during monsoon and post-monsoon periods, reflecting the influence of favorable climatic conditions and increased vegetation growth.

The results emphasize that insect population dynamics are strongly shaped by crop type, seasonality, and agricultural management practices. While high insect abundance contributes to essential ecosystem services such as pollination, nutrient cycling, and biological control, excessive populations of certain orders may pose serious pest management challenges. Therefore, maintaining a balance between beneficial and pest insects is crucial for agroecosystem stability.

The findings underscore the importance of biodiversity-friendly agricultural practices, including crop diversification, habitat conservation, and reduced reliance on chemical pesticides. Regular monitoring of insect population levels and order-wise diversity can serve as an effective indicator of agroecosystem health and help in predicting pest outbreaks. Integrating ecological principles into agricultural management will enhance sustainability, conserve insect biodiversity, and support long-term agricultural productivity.

References (15)

1. Altieri, M. A. (1999). The ecological role of biodiversity in agroecosystems. *Agriculture, Ecosystems & Environment*, 74(1–3), 19–31.

2. Barbosa, P., & Benrey, B. (1998). The influence of plants on insect populations. *Annual Review of Entomology*, 43, 119–148.

3. Cardinale, B. J., et al. (2012). Biodiversity loss and its impact on humanity. *Nature*, 486, 59–67.

4. Dent, D. R. (2000). *Insect Pest Management*. CABI Publishing.

5. Godfray, H. C. J., et al. (2010). Food security: The challenge of feeding 9 billion people. *Science*, 327(5967), 812–818.

6. Heong, K. L., & Hardy, B. (2009). *Planthoppers: New Threats to the Sustainability of Intensive Rice Production Systems in Asia*. IRRI.

7. Kennedy, G. G., & Storer, N. P. (2000). Life systems of polyphagous arthropod pests in unstable cropping systems. *Annual Review of Entomology*, 45, 467–493.

8. Krebs, C. J. (2014). *Ecology: The Experimental Analysis of Distribution and Abundance*. Pearson Education.

9. Losey, J. E., & Vaughan, M. (2006). The economic value of ecological services provided by insects. *BioScience*, 56(4), 311–323.

10. Magurran, A. E. (2004). *Measuring Biological Diversity*. Blackwell Publishing.

11. Norris, R. F., Caswell-Chen, E. P., & Kogan, M. (2003). *Concepts in Integrated Pest Management*. Prentice Hall.

12. Oerke, E. C. (2006). Crop losses to pests. *Journal of Agricultural Science*, 144(1), 31–43.

13. Southwood, T. R. E., & Henderson, P. A. (2000). *Ecological Methods*. Blackwell Science.

14. Tscharntke, T., et al. (2012). Landscape moderation of biodiversity patterns and processes. *Ecology Letters*, 15(8), 893–903.

15. Wilby, A., & Thomas, M. B. (2002). Natural enemy diversity and pest control. *Ecology*, 83(2), 329–336.