International Journal of Entomology Research
www.entomologyjournals.com
ISSN: 2455-4758
Received: 29-07-2026, Accepted: 28-08-2026, Published: 12-09-2026
Volume 11, Issue 3, 2026, Page No. 506-511

An assessment of insect species diversity and seasonality in agricultural agroecosystems of Muzaffarpur district, Bihar

Divyanshu Saurabh[1], Dr. Dhiraj Kumar[2]
[1] Research Scholar, B. R. A. Bihar University, Muzaffarpur, Bihar, India
[2] Assistant Professor, Department of Zoology, Rameshwar Mahavidyalaya, B. R. A. Bihar University, Muzaffarpur, Bihar, India
DOI: https://doi.org/10.66856/ijer.2026.11.3.11325

Abstract
Insect biodiversity is integral to agroecosystem functioning, contributing to pollination, pest regulation, decomposition, and nutrient cycling. This study assessed insect diversity and seasonal variation across major cropping systems in Muzaffarpur district, Bihar, India, over a 12-month period from August 2024 to July 2025. A total of 186 insect species belonging to 11 orders and 34 families were recorded using standard entomological sampling techniques across five representative agricultural sites. Lepidoptera (24.19%), Coleoptera (17.20%), and Hymenoptera (15.05%) were the most species-rich orders. Functionally, pest species constituted the largest group (38.71%), followed by pollinators (18.28%), predators (16.13%), mixed-role taxa (15.59%), and decomposers/detritivores (11.29%). “The highest number of species records was obtained during the monsoon (85), followed by summer (66) and winter (35).” The coexistence of pest and beneficial insect groups highlights the multifunctional nature of agricultural insect communities and the importance of conserving beneficial taxa. The findings emphasize the need for seasonal insect monitoring, habitat management, and ecologically based Integrated Pest Management (IPM) to support biodiversity conservation and sustainable agricultural production in subtropical agroecosystems.

Keywords: Insect biodiversity, Seasonality, Agroecosystem, Integrated Pest Management (IPM), Muzaffarpur, Sustainable agriculture

Introduction

Insects are important components of agricultural ecosystems, performing key functions such as pollination, herbivory, decomposition, nutrient cycling, and natural pest regulation. However, several insect species are major agricultural pests that adversely affect crop yield and quality. Understanding insect diversity, functional roles, and seasonal patterns is therefore essential for sustainable agricultural management and biodiversity conservation (Altieri, 1999) [2].

Muzaffarpur district of northern Bihar has diverse agricultural and horticultural cropping systems, providing varied habitats and resources for insect communities. “Seasonal variation in temperature, rainfall, humidity, crop phenology, and vegetation can influence insect abundance, distribution, and community composition, thereby affecting pest dynamics and their management (Sharma & Dhillon, 2020) [21].”

Seasonal variation strongly influences insect community composition, abundance, and population dynamics in agricultural ecosystems. Climatic factors such as temperature, rainfall, and humidity can affect insect development, reproduction, distribution, and interactions with host plants and natural enemies, thereby influencing pest occurrence and management decisions (Sharma & Dhillon, 2020) [21]. Seasonal monitoring is therefore important for identifying periods of increased pest activity and changes in beneficial insect communities.

Agricultural biodiversity also contributes to ecosystem functioning and biological pest regulation. Predators and parasitoids can suppress herbivorous insect populations, while pollinators provide essential ecosystem services to agricultural crops. Greater landscape and habitat diversity can support natural-enemy communities and enhance natural pest regulation in agricultural systems (Bianchi *et al*., 2006; Tscharntke *et al*., 2012) [25]. Habitat management can further provide food, shelter, and alternative resources for predators and parasitoids, strengthening conservation biological control (Landis *et al*., 2000; Gurr *et al*., 2017) [11, 14]. Therefore, documenting insect diversity and seasonal distribution provides valuable baseline information for pest monitoring, conservation of beneficial insects, and development of ecologically based integrated pest management (IPM) strategies.

Despite the agricultural importance of Muzaffarpur, comprehensive information on insect diversity and seasonal distribution across different agricultural habitats remains limited. Recent studies in the region have mainly focused on particular crops or pest groups, such as insect pests associated with vegetable crops, while broader assessments of insect communities across agricultural ecosystems remain comparatively scarce (Kumari & Singh, 2026). Studies from Bihar have also demonstrated considerable seasonal variation in insect fauna associated with individual crop ecosystems, highlighting the importance of systematic seasonal monitoring (Giri & Mohapatra, 2024). A broader assessment across multiple agricultural habitats can therefore provide useful baseline information on insect composition, seasonal distribution, and functional diversity for ecological monitoring and pest management.

The present study was undertaken to assess insect species diversity and seasonal distribution across selected agricultural agro-ecosystems of Muzaffarpur district, Bihar. The study aimed to document the taxonomic composition of the insect community, compare seasonal patterns of occurrence, and classify recorded insects according to their major ecological functions, including pests, pollinators, predators, parasitoids, and decomposers. The findings are expected to provide baseline information for biodiversity monitoring, conservation of beneficial insects, and development of region-specific integrated pest management (IPM) strategies.

Research Methodology

Study Area

The study was conducted in Muzaffarpur district, northern Bihar, India (26.12°–26.39° N and 85.23°–85.56° E). Five representative agricultural sites were selected based on crop diversity, land use, and surrounding vegetation, covering litchi orchards, vegetable fields, maize fields, and mixed-cropping areas. Insect sampling was conducted for one year, from August 2024 to July 2025 [1], with visits twice a month at each site.

Insect Sampling and Identification

Insects were sampled using sweep nets, pitfall traps, light traps, sticky traps, hand collection, and visual observations across different agricultural habitats (Southwood, 1978; Montgomery *et al*., 2021) [17]. Specimens were preserved, labelled, and identified using standard taxonomic keys and reference literature, with expert assistance where required.

Data Analysis

Insect records were organized by site, season, order, family, and functional group. Species richness, abundance, and seasonal distribution were compared among summer, monsoon, and winter. Data were analyzed and graphically presented using Microsoft Excel and R software.

Functional Classification

Insects were classified as pests, pollinators, predators, parasitoids, or decomposers based on their documented ecological roles (Altieri, 1999; Landis *et al*., 2000) [2, 14].

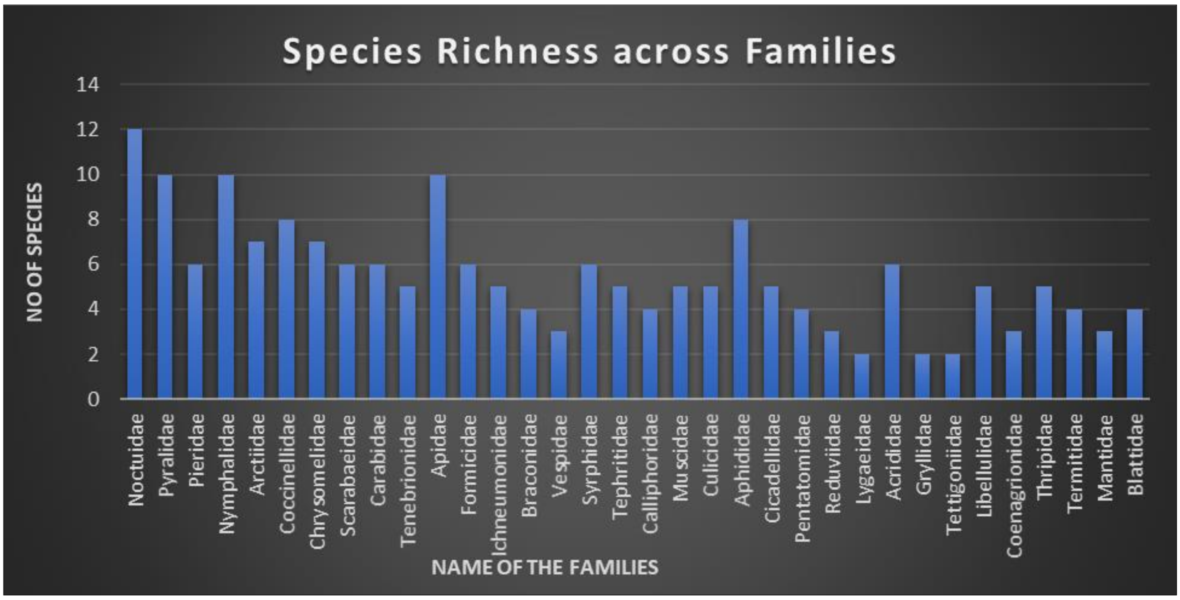
Results and Discussion

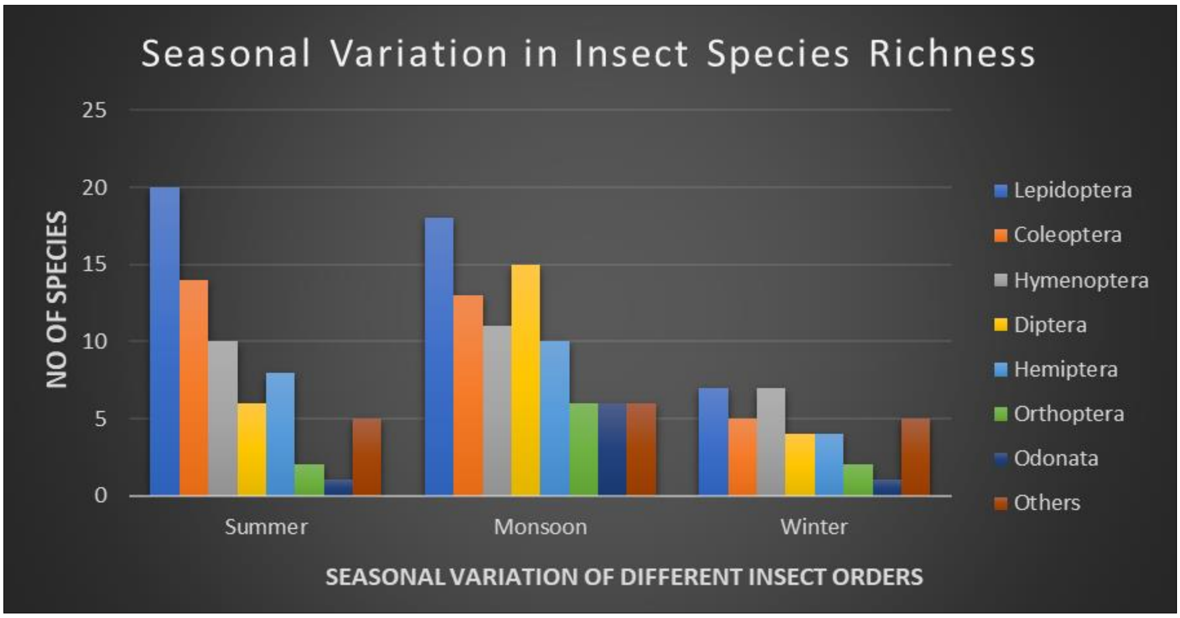
A total of 186 insect species representing 11 orders and 34 families were recorded during the study period as shown in Table 1. Lepidoptera was the most species-rich order, comprising 45 species (24.19%), followed by Coleoptera (32 species; 17.20%) and Hymenoptera (28 species; 15.05%). Diptera and Hemiptera accounted for 25 (13.44%) and 22 species (11.83%), respectively, while Orthoptera and Odonata contributed 10 (5.38%) and 8 species (4.30%). The remaining orders collectively contributed 16 species (8.60%). Based on functional classification, pests constituted the largest group (72 species; 38.71%), followed by pollinators (34; 18.28%), predators (30; 16.13%), mixed-function taxa (29; 15.59%), and soil decomposers/detritivores (21; 11.29%) (Table 3). The pest accumulation included aphids, leafhoppers, thrips, lepidopteran larvae, beetles, grasshoppers, and fruit flies. The groups included bees, butterflies, hoverflies, ladybird beetles, predatory bugs, dragonflies, mantids, and parasitoid wasps recorded under beneficial groups. Seasonal records showed the highest number of insect species during the monsoon (85), which is followed by summer (66) and winter (35) (Table 2). The higher number of records during the monsoon may be associated with increased vegetation and resource availability, although climatic factors were not statistically evaluated in the present study.

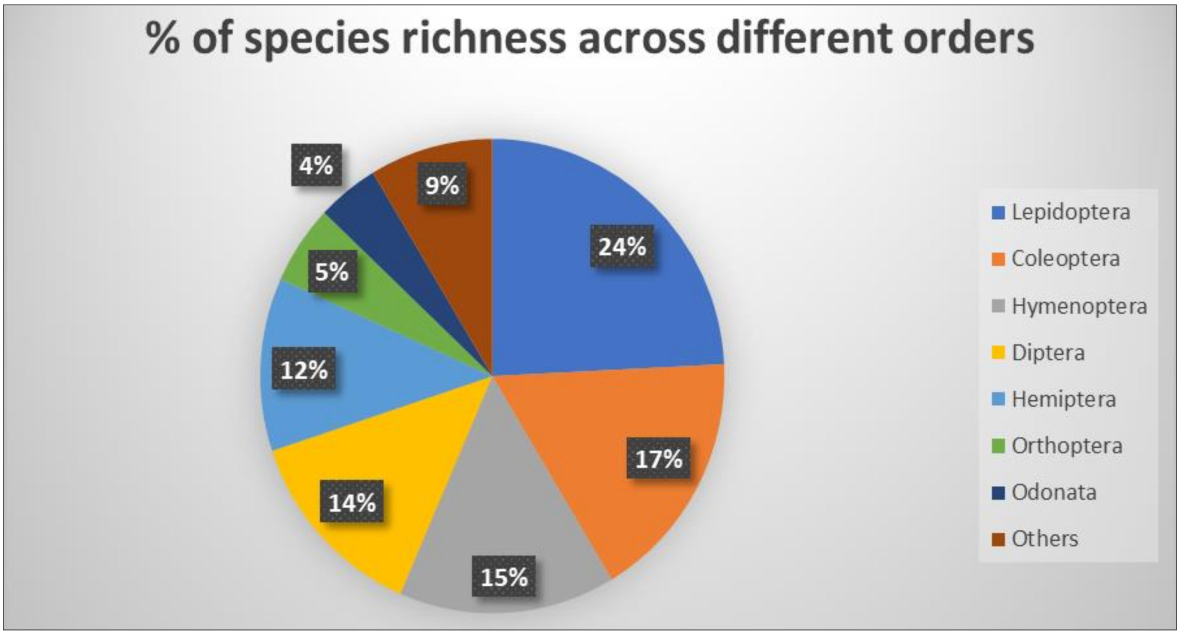
Table 1: Diversity, Ecological Roles, and Host Associations of Major Insect Orders in Agricultural Ecosystems:

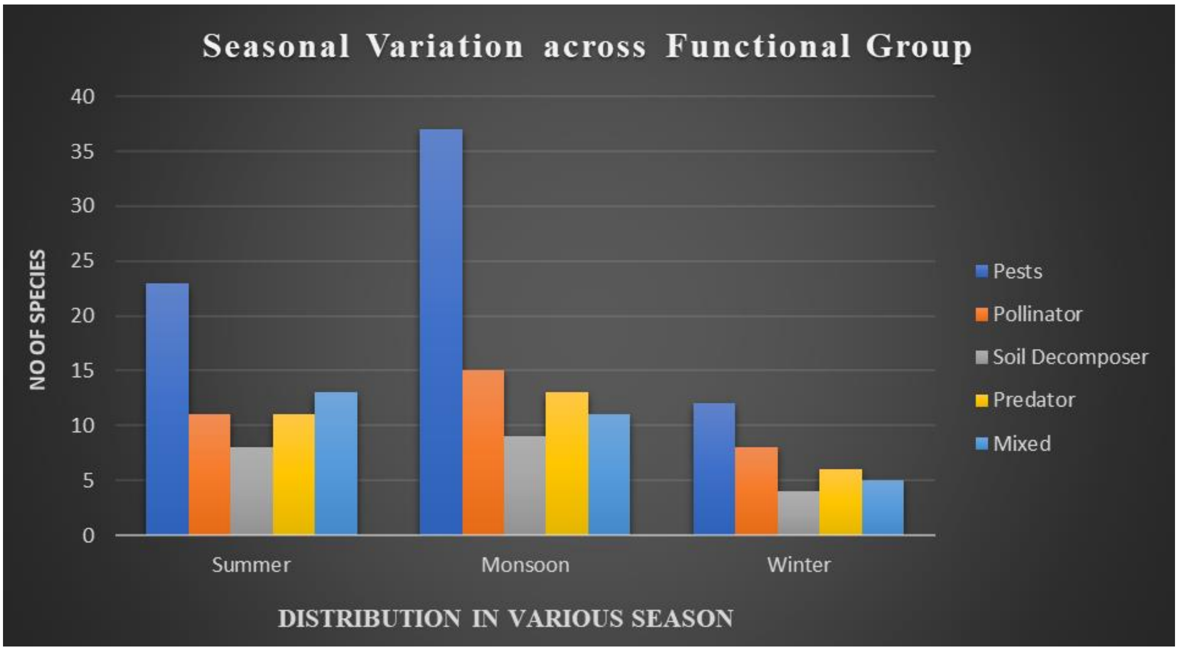
S. No.	Order	Family	Common name	Hosts	Ecological Role	No. of Species
1.	Lepidoptera	Noctuidae	Armyworms, Cutworms	Maize, Pulses, Vegetables	Pest	12
2.		Pyralidae	Fruit/Stem Borers (e.g., litchi)	Sugarcane, Rice, Litchi	Pest	10
3.		Pieridae	Cabbage Butterfly	Cabbage, Mustard, Cauliflower, Radish	Pollinator/minor pest	6
4.		Nymphalidae	Brush-footed Butterflies	Flowers, Fruit trees (for nectar)	Pollinator	10
5.		Arctiidae	Tiger Moths	Cotton, Vegetables, Various cultivated plants	Mixed	7
6.	Coleoptera	Coccinellidae	Ladybird Beetles	Feeds on aphids on Mustard, Vegetables, Litchi	Predators	8
7.		Chrysomelidae	Leaf Beetles	Brinjal, Okra, Cucurbits, Beans	Pests	7
8.		Scarabaeidae	White Grubs, Dung Beetles	Sugarcane, Potato, Groundnut	Decomposer / Soil pests	6
9.		Carabidae	Ground Beetles	Found in all crop fields	Predators	6
10.		Tenebrionidae	Darkling Beetles	Stored grains, Wheat, Rice	Scavengers / Minor Pests	5
11.	Hymenoptera	Apidae	Honey Bees, Carpenter Bees	Litchi, Mango, Mustard, Sunflower, Cucurbits	Pollinator	10
12.		Formicidae	Ants	Associated with fruits, vegetables	Mixed (Beneficial / Pests)	6
13.		Ichneumonidae	Ichneumon Wasps	Parasitize caterpillars in Vegetables, Pulses, Cereals	Parasitoids	5
14.		Braconidae	Braconid Wasps	Parasites of Helicoverpa, Spodoptera pulses, maize	Parasitoids	4
15.		Vespidae	Paper Wasps	Mango, Litchi (fruit pests)	Predator/ Pollinator	3
16.	Diptera	Syrphidae	Hoverflies	Pollinators – Vegetables, Mustard, Litchi	Predator/ Pollinator	6
17.		Tephritidae	Fruit Flies	Mango, Litchi, Guava, Cucurbits	Pests	5
18.		Calliphoridae	Blowflies	Decaying matter; indirectly found in agro-ecosystems	Decomposers	4

19.		Muscidae	House Flies	Organic matter; can be secondary pests on vegetables	Scavengers	5
20.		Culicidae	Mosquitoes	Not crop pests, breed in water bodies near fields	Non-agricultural / Neutral	5
21.	Hemiptera	Aphididae	Aphids	Mustard, Beans, Peas, Litchi, Tomato, Brinjal	pests	8
22.		Cicadellidae	Leafhoppers	Rice, Maize, Brinjal, Cotton, Vegetables	Pests / Disease Vectors	5
23.		Pentatomidae	Stink Bugs	Pulses, Rice, Cotton, Vegetables	Mixed	4
24.		Reduviidae	Assassin Bugs	Predators in vegetable and pulse fields	Predators	3
25.		Lygaeidae	Seed Bugs	Pulses, Mustard, Cotton, Grains	Minor Pests	2
26.	Orthoptera	Acrididae	Grasshoppers	Rice, Wheat, Maize, Grasses	Pests	6
27.		Gryllidae	Crickets	Rice fields, under debris, occasionally damaging seedlings	Minor Pests	2
28.		Tettigoniidae	Katydids	Found on leafy vegetables, sometimes feeding on foliage	Herbivores	2
29.	Odonata	Libellulidae	Dragonflies	Feed on mosquitoes and insects near paddy fields	Predators	5
30.		Coenagrionidae	Damselflies	Found in rice fields, feeding on small insects	Predators	3
31.	Thysanoptera	Thripidae	Thrips	Onion, Chilli, Mango, Litchi, Tomato	Pests	5
32.	Isoptera	Termitidae	Termites	Sugarcane, Groundnut, Maize, Tree crops	Decomposer / Soil pests	4
33.	Mantodea	Mantidae	Praying Mantids	Predators found in all crops – vegetables, pulses, cereals	Predators	3
34.	Blattodea	Blattidae	Cockroaches	Stored products, compost, organic matter	Decomposers	4
Total Orders =11		Families =34			No. of Species =186	






% of species richness across different orders
4%
9%
24%
5%
12%
17%
14%
15%
Lepidoptera
Coleoptera
Hymenoptera
Diptera
Hemiptera
Orthoptera
Odonata
Others


Seasonal Variation across Functional Group
NO OF SPECIES
40
35
30
25
20
15
10
5
0
Summer
Monsoon
Winter
DISTRIBUTION IN VARIOUS SEASON
Pests
Pollinator
Soil Decomposer
Predator
Mixed

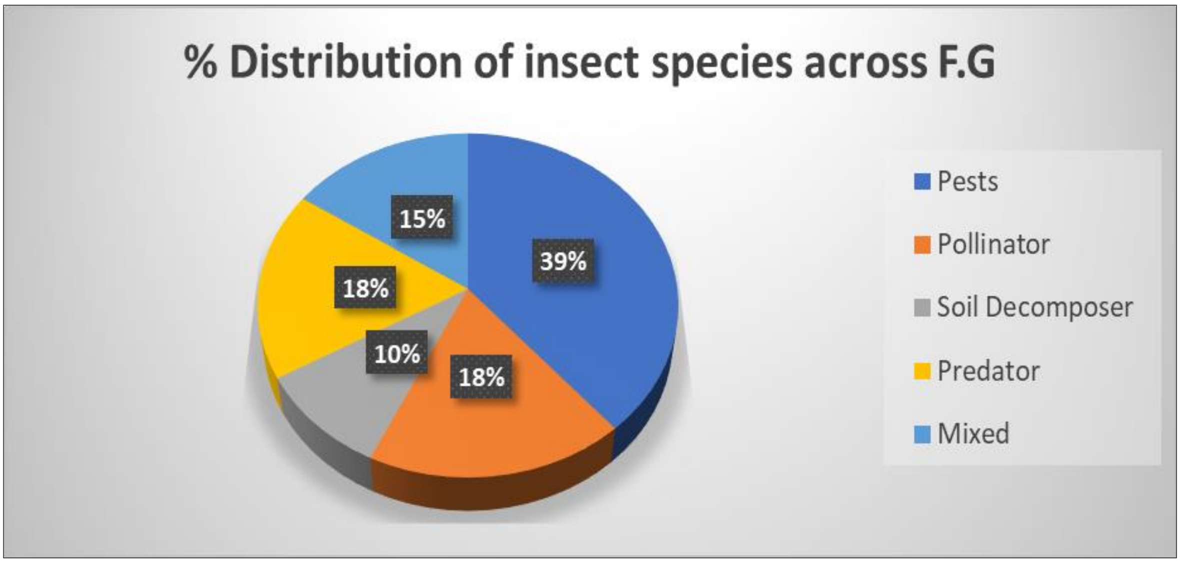

% Distribution of insect species across F.G
15%
39%
18%
10%
18%
Pests
Pollinator
Soil Decomposer
Predator
Mixed

Table 2: Seasonal abundance and order-wise species recorded in study area:

S. No.	Insect Order	Summer	Monsoon	Winter	Number of Species	% of Total Diversity
1	Lepidoptera	20	18	7	45	24.2
2	Coleoptera	14	13	5	32	17.2
3	Hymenoptera	10	11	7	28	15.1
4	Diptera	6	15	4	25	13.4
5	Hemiptera	8	10	4	22	11.8
6	Orthoptera	2	6	2	10	5.4
7	Odonata	1	6	1	8	4.3
8	Others	5	6	5	16	8.6
	Total	66	85	35	186	100

Table 3: Seasonal variation in insect species diversity across functional groups

Functional Group	Summer	Monsoon	Winter	Total	% Distribution of Total F.G.
Pests	23	37	12	72	38.71
Pollinators	11	15	8	34	18.28
Decomposers/detritivores	8	9	4	21	11.29
Predators	11	13	6	30	16.13
Mixed	13	11	5	29	15.59
Total	66	85	35	186	100

Discussion

The present study recorded a diverse insect community comprising both pest and beneficial taxa in which pest insects represented the largest functional group (38.71%), including aphids, leafhoppers, thrips, lepidopteran larvae, beetles, grasshoppers, and fruit flies. Due to their presence across the surveyed agricultural habitats the importance of regular monitoring and ecologically based pest-management practices get emphasized. Pollinators represented 18.28% of the recorded insect community where Bees, butterflies, and hoverflies shows important contribution to pollination services in agricultural landscapes. The production of fruit, vegetable, or seed from 87 of 115 leading global food crops was dependent to some degree on animal pollination reported by Klein *et al*. (2007) [13].

The occurrence of diverse pollinator groups in this study highlights their ecological importance within the surveyed agro-ecosystems. Natural enemies such as predators and parasitoids, including ladybird beetles, ground beetles, predatory bugs, mantids, dragonflies, braconid wasps, and ichneumonid wasps, constituted an important component of the insect community and they can contribute to biological control by suppressing pest populations. Habitat management that provides shelter, nectar, pollen, and alternative prey or hosts can enhance natural-enemy communities and support ecological pest regulation (Landis *et al*., 2000; Gurr *et al*., 2017) [11, 14].

Decomposer and detritivore groups, including termites, blowflies, and cockroaches, also contributed to the recorded fauna. Insects provide important ecosystem services, including decomposition, nutrient cycling, pollination, and natural pest control (Losey & Vaughan, 2006) [15].

The existence of both pest and beneficial insects validates the multifunctional nature of agricultural insect communities for maintaining habitat diversity and landscape heterogeneity can influence insect biodiversity, community structure, and ecosystem functioning (Tscharntke *et al*., 2012) [25]. Conservation of pollinators and natural enemies, together with appropriate pest monitoring and habitat management, can therefore contribute to biodiversity conservation and integrated pest management.

Though, agricultural strengthening, habitat loss, fragmentation, and agrochemical exposure can negatively affect beneficial orthropod communities, particularly pollinators (Potts *et al*., 2010). Therefore, conservation-oriented practices such as crop diversification, maintenance of flowering resources, and preservation of suitable non-crop habitats may help sustain functional insect diversity and ecosystem services in agricultural landscapes.

Conclusion

The study documented 186 insect species belonging to 11 orders and 34 families in the agricultural ecosystems of Muzaffarpur, Bihar, demonstrating considerable taxonomic and functional diversity. Lepidoptera, Coleoptera, and Hymenoptera were the most species-rich orders, while pest insects constituted the largest functional group, followed by pollinators, predators, and decomposers.

Seasonal variation in insect occurrence was observed, with the highest number of species recorded during the monsoon, followed by summer and winter. The presence of diverse pollinators, predators, parasitoids, and decomposers highlights the ecological importance of insects within agricultural landscapes.

The findings emphasize the importance of seasonally informed insect monitoring, conservation of beneficial insects, and habitat management as components of sustainable pest management. Integrating these approaches with localized integrated pest management (IPM) can support pest monitoring while conserving beneficial insect communities. The study provides baseline information for future ecological monitoring, biodiversity conservation, and development of sustainable agricultural management strategies in Muzaffarpur.

References

1. Akhtar N, Tahir HM, Azizullah, Ali A, Fajar R, Muzamil A, *et al*. Survey and seasonal abundances of major insect pest species in the maize fields of Punjab, Pakistan. Int J Trop Insect Sci. 2025;45(5):2211-2224. doi: 10.1007/s42690-025-01588-3

2. Altieri MA. The ecological role of biodiversity in agroecosystems. Agric Ecosyst Environ. 1999;74(1-3):19-31. doi: 10.1016/S0167-8809(99)00028-6
3. Altieri MA, Letourneau DK, Risch SJ. Vegetation diversity and insect pest outbreaks. Crit Rev Plant Sci. 1984;2(2):131-169. doi: 10.1080/07352688409382193
4. Altieri MA, Nicholls CI, Dinelli G, Negri L. Towards an agroecological approach to crop health: Reducing pest incidence through synergies between plant diversity and soil microbial ecology. npj Sustain Agric. 2024;2:6. doi: 10.1038/s44264-024-00016-2
5. Bell LW, Ryan MH, Ewing MA, Moore GA, Lane PA. Prospects for three Dorycnium species as forage plants in agricultural systems: A review of their agronomic characteristics. Aust J Exp Agric. 2008;48(4):467-479. doi: 10.1071/EA07109
6. Chaudhari AK, Singh VK, Kedia A, Das S, Dubey NK. Essential oils and their bioactive compounds as eco-friendly novel green pesticides for management of storage insect pests:P rospects and retrospects. Environ Sci Pollut Res Int. 2021;28(15):18918-18940. doi: 10.1007/s11356-021-12841-w
7. Dickie F, Miyamoto M, Collins CMT. The potential of insect farming to increase food security. In: Edible insects. IntechOpen;2019. doi: 10.5772/intechopen.88106
8. Djihouessi MB, Djihouessi MB, Aina MP. A review of habitat and biodiversity research in Lake Nokoué, Benin Republic: Current state of knowledge and prospects for further research. Ecohydrol Hydrobiol. 2019;19(1):131-145. doi: 10.1016/j.ecohyd.2018.04.003
9. Eigenbrode SD. Climate change and managing insect pests and beneficials in agricultural systems. Agron J. 2023. doi: 10.1002/agj2.21399
10. Gurr GM, Liu J, Read DMY, Catindig JLA, Cheng JA, Lan LP, *et al*. Parasitoids of Asian rice planthopper (Hemiptera: Delphacidae) pests and prospects for enhancing biological control by ecological engineering. Ann Appl Biol. 2011;158(2):149-176. doi: 10.1111/j.1744-7348.2010.00455.x
11. Gurr GM, Wratten SD, Landis DA, You M. Habitat management to suppress pest populations: Progress and prospects. Annu Rev Entomol. 2017;62:91-109. doi: 10.1146/annurev-ento-031616-035050
12. Kishimoto-Yamada K. How much have we learned about seasonality in tropical insect abundance since Wolda 1988? Entomol Sci. 2015;18(3):247-258. doi: 10.1111/ens.12134
13. Klein AM, Vaissière BE, Cane JH, Steffan-Dewenter I, Cunningham SA, Kremen C, *et al*. Importance of pollinators in changing landscapes for world crops. Proc Biol Sci. 2007;274(1608):303-313. doi: 10.1098/rspb.2006.3721
14. Landis DA, Wratten SD, Gurr GM. Habitat management to conserve natural enemies of arthropod pests in agriculture. Annu Rev Entomol. 2000;45:175-201. doi: 10.1146/annurev.ento.45.1.175
15. Losey JE, Vaughan M. The economic value of ecological services provided by insects. Bioscience. 2006;56(4):311-323. doi: 10.1641/0006-3568(2006)56
16. Majeed W, Rana N, de AZEVEDOKOCHEB, Nargis S. Seasonality and climatic factors affect diversity and distribution of arthropods around wetlands. Pak J Zool. 2020;52(6):2135-2144. doi: 10.17582/journal.pjz/20200112020107
17. Montgomery GA, Belitz MW, Guralnick RP, Tingley MW. Standards and best practices for monitoring and benchmarking insects. Front Ecol Evol. 2021;8:579193. doi: 10.3389/fevo.2020.579193
18. Pierre JF, Jacobsen KL, Latournerie-Moreno L, Torres-Cab WJ, Chan-Canché R, Ruiz-Sánchez E. A review of the impact of maize-legume intercrops on the diversity and abundance of entomophagous and phytophagous insects. PeerJ. 2023;11:e15640. doi: 10.7717/peerj.15640
19. Prajapati AP, Patel PB, Bhimani HD, Desai AV. Population dynamics of major insect pests of cowpea (Vigna unguiculata L. Walp) and its correlation with different abiotic factors under south Gujarat conditions. Int J Chem Stud. 2020;8(3):2307-2311. doi: 10.22271/chemi.2020.v8.i3ag.9554
20. Ryckewaert P, Deguine JP, Brévault T, Vayssières JF. Fruit flies (Diptera: Tephritidae) on vegetable crops in Réunion Island (Indian Ocean): State of knowledge, control methods and prospects for management. Fruits. 2010;65(2):113-130. doi: 10.1051/fruits/20010006
21. Sharma HC, Dhillon MK. Climate change effects on arthropod diversity and its implications for pest management and sustainable crop production. In: Hatfield JL, Sivakumar MVK, Prueger JH, editors. Agroclimatology: Linking agriculture to climate (Agronomy Monograph 60). Madison (WI): American Society of Agronomy;2020. doi: 10.2134/agronmonogr60.2016.0019
22. Skendžić S, Zovko M, Živković IP, Lešić V, Lemić D. The impact of climate change on agricultural insect pests. Insects. 2021;12(5):440. doi: 10.3390/insects12050440
23. Tscharntke T, Grass I, Wanger TC, Westphal C, Batáry P. Beyond organic farming—Harnessing biodiversity-friendly landscapes. Trends Ecol Evol. 2021;36(10):919-930. doi: 10.1016/j.tree.2021.06.010
24. Tscharntke T, Klein AM, Kruess A, Steffan-Dewenter I, Thies C. Landscape perspectives on agricultural intensification and biodiversity–ecosystem service management. Ecol Lett. 2005;8(8):857-874. doi: 10.1111/j.1461-0248.2005.00782.x
25. Tscharntke T, Tylianakis JM, Rand TA, Didham RK, Fahrig L, Batáry P, *et al*. Landscape moderation of biodiversity patterns and processes—Eight hypotheses. Biol Rev Camb Philos Soc. 2012;87(3):661-685. doi: 10.1111/j.1469-185X.2011.00216.x
26. Wagner DL. Insect declines in the Anthropocene. Annu Rev Entomol. 2020;65:457-480. doi: 10.1146/annurev-ento-011019-025151