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DIVERSITY INDICES AND RELATIVE ABUNDANCE OF INSECTS IN AGROFOREST AND AGROECOSYSTEM IN NARSAPUR OF MEDAK DISTRICT, TELANGANA INDIA

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ABSTRACT

Proper identification and validation of insect population is vital for any study related to biodiversity and population dynamics. The present research was conducted in farmer field of Narsapur during Kharif 2024-2025. Different diversity indices, including Simpson diversity index, Shannon-weiner diversity index, Pielou's evenness index and Relative abundance of major insect orders were recorded using various sampling methods (Visual observation, sweep net, pitfall trap, pheromone trap, Sticky traps). Among all the orders, Hymenoptera turned out to be the most abundant insect order in both the ecosystems with 15.91% and 17.14% in agroecosystem and agroforest ecosystem respectively. Similarly, between both the ecosystem, highest diversity index ($1-D = 0.956$; $H = 3.32$), evenness index ($e = 0.790$) and relative abundance (54.72 %) was recorded slightly higher in agroforest ecosystem in regards with agroecosystem.

Key words: Biodiversity, Diversity indices, Ecosystems, Evenness, Abundance

Introduction

Rice is a staple food for major population of our country. Rice crop is infested by more than 100 species of insects, Down the line of history, monocropping of rice caused a drastic increase in pest population and there by decrease in the yield of the crop. The diversity and abundance of insects vary accordingly to abiotic and biotic factors. Agroforestry is a type of agricultural system, constituting wide diversity of plants and provides habitat for different insect pests, predators and pollinators, which are associated to crop productivity (Donald 2004). Trees due to their wide complexity in their structure support higher diversity of arthropod communities for longer period (Lawton, 1978). Agroforestry due to the integration of crops with trees offer elevated biodiversity compared to conventional agriculture (Holloway and stork, 1991). The insect is an integral part of any ecosystem, hence for proper management of these insects, we must

have thorough knowledge about the diversity of insects occurring in an ecosystem, their incidence, abundance and species richness. Insect monitoring can be carried out using various sampling methods which serves as a tool for monitoring ecological comparison between communities. Calculation of diversity indices serve as essential aid to understand the insect community structure, assess stability of ecosystem. Given the limited research in agroforest ecosystem in Telangana state, the present research was conducted in Thirumalapur village of Narsapur mandal in Medak district of Telangana. The study was conducted with objective to understand the baseline insect diversity and their relative abundance in both the communities of agroecosystem and agroforest ecosystem.

Material and Methods

The current study was performed in the Farmer's field of Thirumalapur village of Narsapur Mandal of

Medak district which lies between (Latitude 17.904944° N, Longitude 78.253132° E) at an altitude of 500-600 meters above mean sea level. Uniform area of crop field was considered to perform the study. Insect sampling was conducted in both monocropped rice (agroecosystem) and rice bordered with teak (agroforestry) ecosystems using various combination of active and passive methods.

Active Collection Methods

a) **visual observation:** With system aticdiagonal walks in the fields during morning and evening hours, insects were identified, recorded and photos were documented for later identification.

b) **sweep net:** sweep net with 30 cm hoop diameter about 60 cm bag length was used for collection of flying and jumping insects in the fields of rice. Diagonally for every 50-meter interval five sweeps were performed at weekly intervals and the insects collected were preserved in 70% ethanol bottles for future identification.

Passive collection methods

a) **pitfall trap:** especially used for trapping soil dwelling insects. Plastic cups with wide open mouth were buried in the soil surface and each cup was filled with soap water up to one fourth of its depth and insects trapped were collected and preserved for identification up to family level.

b) **sticky trap:** Yellow sticky trap for about 4 traps per acre were installed randomly in the field. These traps were coated with greasy adhesives which were used for collecting mainly sucking pests complex and flying insects and other natural enemies in the ecosystems, then the captured insects were counted using the magnifying lens.

c) **pheromone trap:** in the present study, pheromone trap was used for monitoring and collection of the yellow stem borer (*Scirpophaga incertulas*). These traps with YSB lures were installed in the field at random locations about 4 traps per acre.

Preservation and identification

Collected Insects with hard body were dry pinned in the insect boxes and soft bodied insects were preserved in 70% alcohol in glass vials while spiders were preserved in 75% alcohol. In the current study identification was done up to family level (taxa) using keys provided by Triplehorn and Johnson (2005). Various diversity indices of insects in these two communities were estimated using PAST (Paleontological Statistics Tool) version 3.25 Software tool. Diversity Indices included:

1. Shannon-Weiner Diversity Index: $H = -\sum P_i \ln P_i$

Where,

$P_i = S / N$ S = number of species

N = total number of individuals,

P_i = proportion of i th species \ln = logarithm to base e.

2. Simpson's Diversity Index (SDI): $D = \sum n_i (n_i - 1) / N(N-1)$

Where,

n_i = total number of individuals of a particular species,

N = total number of individuals of all species.

3. Pielou's Evenness Index (e) = $H / \ln S$

Where,

H = Shannon – Wiener diversity index,

S = total number of species in the sample

4. Relative abundance(%) = $n_i X 100/N$

Where,

N= the total number of individuals of all species;

n_i = the number of individuals of species.

Results and Discussion

Altogether 3,220 individuals were collected from the study location during *Kharif* 2024–25 of which 1,458 are recorded from agroecosystem and 1,762 individuals reported from agroforest ecosystem (Fig. 1) using different samplings methods. These insects belonged to ten different orders within 35 families. Among the ten orders documented of which order Hemiptera (six families), Orthoptera (5 families) and Coleoptera (5 families) each followed by Araneae (Here, in this study, Araneae was considered as an order level taxa), Lepidoptera and Hymenoptera with 4 families each, Diptera (3 families), Odonata (2 families) and Neuroptera, Mantodea were reported with one family each in the agroecosystem. Similarly, 10 different orders belonging to 35 families were documented in agroforest ecosystem where, in terms of families, Order Hemiptera (6 families) and Orthoptera (5 families), Coleoptera (5 families) were with most numerous families followed by Araneae (4 families), Lepidoptera (4 families), Hymenoptera (4 families), Diptera (3 families), Odonata with 2 families and

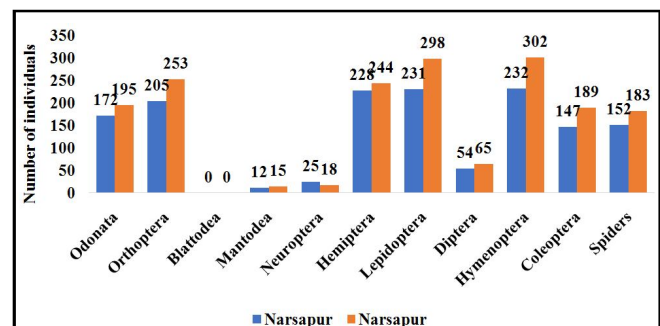


Fig. 1: Illustration of number of individuals collected from two ecosystems of Narsapur location.

Table 1: Order wise diversity indices at Narsapur location in agroecosystem and agroforest ecosystem.

Orders	Agroecosystem			Agroforest ecosystem		
	Simpson (1-D)	Shannon (H)	Pielous evenness (e)	Simpson (1-D)	Shannon (H)	Pielous evenness (e)
Odonata	0.481	0.674	0.981	0.434	0.625	0.934
Orthoptera	0.709	1.378	0.793	0.679	1.29	0.726
Hemiptera	0.682	1.444	0.706	0.767	1.613	0.837
Lepidoptera	0.456	0.898	0.614	0.625	1.167	0.803
Diptera	0.662	1.091	0.993	0.638	1.053	0.955
Hymenoptera	0.683	1.253	0.875	0.708	1.307	0.924
Coleoptera	0.734	1.457	0.859	0.729	1.461	0.862
Araneae	0.735	1.356	0.971	0.742	1.371	0.985

Neuroptera, Mantodea with one family each, which concluded that the higher number of families were noted from the order Hemiptera followed by orthoptera and Coleoptera while in terms of individuals, most numerous individuals were collected from the order Hymenoptera (232, 302) while least number of individuals recorded from the order Mantodea (12, 15) respectively in agroecosystem and agroforest ecosystem (Fig. 1). These results align with Navya *et al.* (2025) who explored insect diversity in safflower crop and reported hymenopterans as one of the most dominated orders. In the current study, major portion of predatory insect individuals was from Hymenoptera, coleoptera and Araneae which was in line with Anbalagan *et al.*, (2020) who also reported Hymenoptera and coleoptera as leading predators in his study in rice fields of Tamil Nadu. Trend of insect orders reported based on the number of individuals collected were as below:

a) N- agroecosystem: Hymenoptera (232) > Lepidoptera (231) > Hemiptera (228) > Orthoptera (205) > Odonata (172) > Araneae (152) > Coleoptera (147) > Diptera (54) > Neuroptera (25) > Mantodea (12) (Fig. 1).

b) N- agroforest ecosystem: Hymenoptera (302) > Lepidoptera (298) > Orthoptera (253) > Hemiptera (244) > Odonata (195) > Coleoptera (189) > Araneae (183) > Diptera (65) > Neuroptera (18) > Mantodea (15) (Fig. 1).

Different indices namely., Simpson diversity index, Shannon-Weiner index, Pielou's evenness index and Relative abundance were calculated for all the major insect orders which were represented by more than one family.

Shannon-weiner diversity index

Shannon-Weiner Index allows to compare diversity of different communities, by considering both taxa (in this study, families were considered) and number of individuals of each family within each order. Higher the (H) value of a community, higher the diversity. In agroecosystem of Narsapur, Coleoptera recorded the

highest diversity index (H= 1.457) followed by Hemiptera (H= 1.444), Orthoptera (H= 1.378), Araneae (H= 1.356), Hymenoptera (H= 1.253), Diptera (H= 1.091), Lepidoptera (H= 0.898), Odonata (H= 0.674). Odonata reported lowest diversity (H= 0.674). These findings were in accordance with Fathima *et al.*, (2021) who reported orthoptera and coleopters were most abundant with Shannon-Weiner diversity ranged from 0.07 to 0.23. Similarly, in agroforest ecosystem with slight difference, Hemiptera (H= 1.613) recorded highest diversity index value followed by Coleoptera (H= 1.461), Araneae (H = 1.371), Hymenoptera (H= 1.307), Orthoptera (H= 1.290), Lepidoptera (1.167), Diptera (1.053), Odonata (H= 0.625) (Table 1). This indicates that population of insects pests (sucking pests) and predators from coleoptera were higher in diversity. The diversity index recorded for insect orders in the present study were relatively in the same range with Aminah and Nurhidayat (2023) reported Shannon diversity index of herbivore insects in the inorganic rice ecosystem (H = 1.76) was higher than organic ecosystem (H = 1.68).

On analysing and comparing the values between both the ecosystems, Shannon-weiner index was higher in agroforest ecosystem (H= 3.320) than agroecosystem (H= 3.270) (Table 2) which were in consistent with Thei *et al.*, (2020) who studied diversity and abundance of arthropod in rice fields (H= 3.18). This might be due to increased and favourable microhabitat at conditions, prevailed due to presence of trees, population of insects were higher in agroforest ecosystem than agroecosystem.

Simpson's Diversity Index (SDI)

The Simpson diversity index is used for calculating species richness, in current study, used for calculating taxa richness i.e., family. It takes into account of both richness and evenness of particular taxa.

In the present study, Simpson diversity index (1-D) was found to be highest in the Araneae (1-D = 0.735) followed by the order Coleoptera (1-D = 0.734), Orthoptera (1-D = 0.709), Hymenoptera (1-D = 0.683),

Table 2: Diversity indices of ecosystems at Narsapur.

location	Ecosystem	Simpson(1-D)	Shannon(H)	Pielous evenness (e)	Margalef (R)
Narsapur	Agroecosystem	0.951	3.270	0.752	4.667
	Agroforest ecosystem	0.956	3.320	0.790	4.549

Hemiptera (1-D = 0.682), Diptera (1-D = 0.662), Odonata (1-D = 0.481) and lowest value reported in the order Lepidoptera (1-D = 0.456). In agroforest ecosystem, the diversity index value reported for the order Hemiptera (1-D = 0.767) was found to be highest followed by Araneae (1-D = 0.742), Coleoptera (1-D = 0.729), Hymenoptera (1-D = 0.708), Orthoptera (1-D = 0.679), Diptera (0.638), Lepidoptera (1-D = 0.625) and Odonata (1-D = 0.434) (Table 1). The present findings were more or less in line with Raju *et al.*, (2021) who studied spider fauna diversity in rice ecosystems across three zones of Telangana in Kharif season and reported Simpson's diversity index (1-D) values ranging between 0.83 to 1.00. (Table 1). Nwoueni and Gaoue (2022) found that agroforestry increased the arthropod diversity in addition, it also positively facilitated reduced herbivore control in pendjari bioserve, south Africa.

Pielou's Evenness Index

Pielous evenness index measures the even distribution of insect individuals in a particular community. Here, in each particular community on calculating the evenness index, in agroecosystem, order Diptera (e = 0.993) exhibited highest evenness followed by Odonata (e = 0.981), Araneae (e = 0.971), Hymenoptera (e = 0.875), Coleoptera (e = 0.859), Orthoptera (e = 0.793), Hemiptera (e = 0.706) and Lepidoptera (e = 0.614) (Table 1). In the agroforest ecosystem, evenness was highest in the Araneae (e = 0.985) followed by Diptera (e = 0.955), Odonata (e = 0.934), Hymenoptera (e = 0.924), Coleoptera (e = 0.862), Hemiptera (e = 0.837), Lepidoptera (e = 0.803) and least evenness was recorded from Orthoptera (e = 0.726). (Table 1). Between the ecosystems when diversity indices were compared, even distribution of insects was higher in agroforest ecosystem (e = 0.790) than agroecosystem (e = 0.752) in the Narsapur (Table 2). The present findings were in accordance with the Utami *et al.*, (2020) who studied arthropod diversity in monoculture vs. polyculture peat and plantations. Mixed systems (e.g., Balangeran + Paddy) had higher arthropod abundance and diversity. Campera *et al.*, (2024) concluded from his study that habitat heterogeneity enhances invertebrate diversity which was effect of agricultural intensification.

Relative Abundance (RA)

In the present findings, in terms of insect individuals, when two ecosystems in Narsapur area were compared,

highest RA of insects were reported in agroforest ecosystem (RA= 54.72%) than agroecosystem (RA= 45.28%). In the agroecosystem, the results indicated that Hymenoptera (RA= 15.91 %) was the most abundant insect order followed by Lepidoptera (RA= 15.84 %), Hemiptera (RA= 15.64 %), Orthoptera (RA= 14.06 %), Odonata (RA= 11.80%), Araneae (RA= 10.43%), Coleoptera (RA= 10.08 %), Diptera (RA= 3.70 %), Neuroptera (RA= 1.71 %) while least abundant order was Mantodea (RA= 0.82 %) (Table 3). In the agroforest ecosystem, highest relatively abundant order reported was Hymenoptera (RA= 17.14%) followed by Lepidoptera (RA= 16.91%), Orthoptera (RA= 14.36%), Hemiptera (RA= 13.85%), Odonata (RA= 11.07%), Coleoptera (RA= 10.73%), Araneae (RA= 10.39%), Diptera (RA= 3.69%), Neuroptera (RA= 1.02%) and Mantodea (RA= 0.85%) (Table 3). So, in both the ecosystems, Hymenopterans were relatively higher than other insect orders which was in accordance with Ane and Hussain (2016) who also reported Hymenoptera as most abundant order in his study. It is also inferred that slightly higher abundance of hymenopterans seen in agroforest ecosystem than agroecosystem ensuring presence of parasitoid population relatively higher in agroforest ecosystem.

Conclusion

The present study revealed that higher abundance and diversity of insect individuals in agroforest ecosystem was due to increased microhabitat due to the presence of trees which might have enhanced their oviposition rate, favourable shelter for their survival and development.

Table 3: Relative abundance of insect orders in Narsapur location.

Orders	Relative abundance (%)	
	Agroecosystem	Agroforest ecosystem
Odonata	11.80	11.07
Orthoptera	14.06	14.36
Blattodea	0.00	0.00
Mantodea	0.82	0.85
Neuroptera	1.71	1.02
Hemiptera	15.64	13.85
Lepidoptera	15.84	16.91
Diptera	3.70	3.69
Hymenoptera	15.91	17.14
Coleoptera	10.08	10.73
Araneae	10.43	10.39

Also, Mohamed *et al.*, (2022) in his study on insect diversity in two rice field one cultivated with *turnera trioniflora* and the other without. He concluded the plot with beneficial plant exhibited higher insect diversity ($H = 1.57$) compared to Plot B which is without plantation ($H = 1.23$) suggested, these plants provided resources supporting greater diversity and abundance.

Disclaimer

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