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ECOLOGICAL ASSESSMENT OF INSECT PEST AND NATURAL ENEMY DIVERSITY IN SPRAYED AND UNSPRAYED GROUNDNUT ECOSYSTEMS DURING THE VEGETATIVE STAGE IN NORTHERN TELANGANA

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ABSTRACT

Accurate documentation of insect communities is essential for understanding arthropod diversity and ecological interactions in groundnut ecosystems. Hence, the present study was conducted during *rabi* 2025–26 at the Agricultural Research Station, Adilabad to compare the abundance and diversity of insect pests and natural enemies in sprayed and unsprayed groundnut ecosystems during the vegetative stage. Arthropods were sampled using Yellow Pan Traps (YPT), Yellow Sticky Traps (YST), sweep net collections and visual observations. A total of 18,077 insect pests belonging to 32 families under six orders and 7,724 natural enemies belonging to 36 families under seven orders were recorded. Hemiptera was the dominant pest order followed by Thysanoptera and Lepidoptera, while Hymenoptera was the predominant natural enemy group followed by Araneae and Coleoptera. Aleyrodidae and Formicidae were the most abundant pest and natural enemy families, respectively. Diversity indices revealed comparatively higher ecological stability in the unsprayed ecosystem. For insect pests, Shannon diversity (1.14), Pielou's evenness (0.76), Berger–Parker dominance (0.23), Simpson's index (0.11), Hill number (63.36) and Margalef richness index (7.80) were higher in the unsprayed module than in the sprayed module (1.11, 0.74, 0.25, 0.12, 58.14 and 7.87, respectively). Similarly, natural enemies recorded higher diversity in the unsprayed ecosystem (1.36, 0.87, 0.21, 0.07, 129.99 and 9.71) compared to the sprayed ecosystem (1.33, 0.86, 0.23, 0.08, 119.81 and 9.81, respectively). The findings emphasize the importance of conserving beneficial arthropods and adopting ecologically sustainable IPM strategies in groundnut ecosystems.

Keywords **:** Groundnut, pests, natural enemies, vegetative stage, sprayed and unsprayed.

Introduction

Groundnut (*Arachis hypogaea* L.) is an important oilseed crop cultivated extensively in tropical and subtropical regions due to its high nutritional and economic value (Atwal and Dhaliwal, 2008). The crop supports a diverse assemblage of arthropods including insect pests, predators, parasitoids and pollinators, whose interactions greatly influence ecosystem stability and crop productivity. Among these, sucking pests such as aphids, leafhoppers, whiteflies and thrips, along with defoliators like tobacco caterpillar and leaf miner, are major constraints to groundnut production causing significant yield losses through continuous feeding damage and reduction in photosynthetic efficiency (Kandakoor *et al*., 2012; Naresh *et al*., 2017). The abundance and distribution of these pests are largely influenced by climatic conditions, crop phenology and management practices, leading to variation in pest incidence across ecosystems (Rahman *et al*., 2021; Ongolu *et al*., 2024).

Groundnut ecosystems also harbour diverse natural enemies such as coccinellids, reduviids, spiders and hymenopteran parasitoids which contribute substantially to natural biological control of pests (Latha *et al*., 2022). However, indiscriminate use of insecticides can adversely affect these beneficial arthropods, resulting in ecological imbalance, pest resurgence and disruption of trophic interactions (Bharghavi *et al*., 2024; Madhuri *et al*., 2024). Therefore, assessment of insect pest and natural enemy diversity has become increasingly important for understanding ecological stability and developing sustainable pest management strategies.

Comparative diversity studies between sprayed and unsprayed ecosystems provide valuable information on the influence of chemical disturbance on arthropod abundance, species composition and community structure. Evaluation of biodiversity using ecological indices and different sampling techniques helps in comprehensive documentation of arthropod fauna and their ecological interactions within crop ecosystems. However, information on the diversity and abundance of insect pests and natural enemies in groundnut ecosystems of Northern Telangana remains limited. Hence, the present investigation was undertaken to assess the diversity and abundance of insect pests and natural enemies in sprayed and unsprayed groundnut ecosystems during the vegetative stage.

Materials and Methods

The study was conducted in the *Rabi* season of 2025-26 in the research plots of the Agricultural Research Station, Adilabad. The experimental field comprised an area of 1000 m² and was divided into two equal-sized modules of 450 m² each, separated by a distance of approximately 100 m to minimize inter-plot interference. Groundnut variety K-6 was sown by following the recommended agronomic practices. One module was maintained as an untreated control (unsprayed ecosystem) without any insecticidal application throughout the study period. The second module was maintained as a recommended plant protection module (sprayed ecosystem), wherein need-based insecticidal applications of Thiamethoxam 25 WG @ 0.5 g/l and chlorantraniliprole 18.5 SC @ 0.3 ml/L were imposed one time at vegetative stage when the insect pest population crossed the Economic Threshold Level (ETL).

Observations on insect pests and natural enemies were recorded at fortnightly intervals during the vegetative stage of the crop in both the modules using four different sampling techniques, yellow pan traps (4 per module), yellow sticky traps (2 per module), sweep net collections (five sweeps at five points) and visual counts and collections from randomly selected 50 plants per module. The collected insects were brought to laboratory and were identified up to family level based on standard taxonomic keys and available literature.

The abundance and diversity of insect pests and natural enemies collected through different sampling methods were analysed using BIODIVERSITY PRO 2.0 software to compare the stability of the ecosystem and understand the impact of the chemical pesticides on the insects. Diversity parameters such as, Shannon-Wiener Diversity Index or species diversity (H’) (Shannon & Weaver,1949), Pielou’s evenness, Berger–Parker dominance, Simpson’s diversity index (1–D) (Simpson,1949), Hill number, and Margalef richness index, were computed separately for sprayed and unsprayed ecosystems.

Results and Discussion

Pest Abundance

A total of 18,077 insect pests belonging to 32 families were recorded from groundnut ecosystem during the vegetative stage under both unsprayed and sprayed modules. Among these, 9,393 and 8,684 insect pests were collected from the unsprayed and sprayed field respectively during the cropping season (Table 1). In the unsprayed ecosystem, the order of abundance was found to be Hemiptera > Lepidoptera > Thysanoptera > Diptera > Orthoptera > Coleoptera, whereas in sprayed ecosystem Hemiptera > Thysanoptera > Lepidoptera > Diptera > Orthoptera > Coleoptera (Figure 1). Within Hemiptera, Aleyrodidae was the most abundant family with 2,196 and 2,177 individuals in the unsprayed and sprayed modules, respectively, followed by Cicadellidae (1,043 and 971), Aphididae (692 and 673) and Delphacidae (669 and 551). Thripidae was another dominant family with 1,416 individuals in the unsprayed module and 1,420 individuals in the sprayed module. Similar observations were reported by Navya *et al*. (2025), who documented Hemiptera and Thysanoptera as the predominant insect groups in groundnut ecosystems of Southern Telangana and emphasized that sucking pests constituted the major share of the arthropod fauna during the crop growth period.

Among Lepidopteran pests, Noctuidae recorded comparatively higher abundance with 624 and 442 individuals in the unsprayed and sprayed modules, respectively, followed by Gelechiidae with 477 and 480 individuals (Table 1). Caterpillars feed voraciously on leaves, flowers and reproductive parts, thereby reducing photosynthetic area and crop productivity. Similar observations were reported by Birajdar *et al.* (2025), who stated that leaf miner and other lepidopteran pests significantly contribute to yield losses in groundnut ecosystems.

Table 1 : Family wise abundance of the pest in sprayed and unsprayed modules

S. No.	Pest Family	Unsprayed Module	Sprayed Module
	Hemiptera		
1	Cicadellidae	**1043**	**971**
2	Delphacidae	**669**	**551**
3	Aphididae	**692**	**673**
4	Aleyrodidae	**2196**	**2177**
5	Membracidae	**85**	**81**
6	Reduvidae	**110**	**81**
7	Miridae	**154**	**143**
8	Pyrrhocoridae	**143**	**91**
9	Alydidae	**12**	**10**
10	Lygaeidae	**10**	**12**
11	Psyllidae	**164**	**140**
12	Oxycarenidae	**65**	**62**
13	Pentatomidae	**38**	**26**
	Thysanoptera		
14	Thripidae	**1416**	**1420**
	Lepidoptera		
15	Gelechiidae	**477**	**480**
16	Noctuidae	**624**	**442**
17	Lycaenidae	**85**	**64**
18	Arctiidae	**47**	**49**
19	Erebidae	**2**	**2**
20	Scythrididae	**141**	**166**
21	Crambidae	**16**	**12**
22	Papilionidae	**22**	**17**
23	Nymphalidae	**19**	**11**
24	Pieridae	**16**	**8**
	Diptera		
25	Agromyzidae	**44**	**42**
26	Cecidomyiidae	**378**	**286**
27	Stratiomyidae	**150**	**150**
	Coleoptera		
28	Chrysomelidae	**132**	**108**
	Orthoptera		
29	Acrididae	**114**	**114**
30	Tetrigidae	**91**	**78**
31	Pyrgomorphidae	**142**	**115**
32	Gryllidae	**98**	**102**

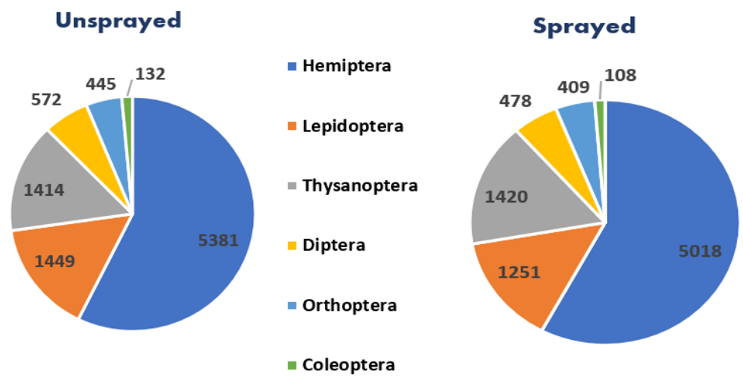

Fig. 1: Order-wise composition of insect pests in sprayed and unsprayed groundnut ecosystems during vegetative stage

Pest Diversity

Diversity analysis of insect pest communities in groundnut during the vegetative phase indicated only slight variation between management practices. The Shannon diversity index recorded a marginally higher value in the unsprayed ecosystem (H′ = 1.14) compared to the sprayed system (H′ = 1.11). Similar observations were reported by Chethan *et al.* (2019), indicating a modest increase in species diversity under reduced disturbance conditions. Similarly, Simpson's index remained low in both conditions (0.11 in unsprayed and 0.12 in sprayed), reflecting limited overall diversity with mild species concentration. Species richness, as reflected by Margalef's index, remained nearly comparable (7.80 in unsprayed and 7.87 in sprayed), indicating that pesticide application had little effect on total species count.

Evenness structure and dominance patterns revealed more subtle ecological distinctions. Pielou's evenness values (0.76 in unsprayed and 0.74 in sprayed) indicated a fairly balanced distribution of individuals among taxa, with slightly better uniformity in the unsprayed field. Berger–Parker dominance values (0.23 and 0.25, respectively) pointed to a marginal increase in proportional dominance under chemical exposure, implying selection pressure favouring tolerant groups. Hill's N1 values further supported this trend, with higher effective common species in the unsprayed module (63.36) than in the sprayed module (58.14), while N2 remained negligible in both systems, confirming the absence of a single overwhelmingly dominant species (Table 2). Overall, the pest assemblage was consistently dominated by Aleyrodidae, Thripidae and Cicadellidae, reflecting their adaptability to dry, monocropped agroecosystems and their ability to withstand environmental stressors such as high temperature, moisture deficit, and chemical disturbance.

Table 2 : Diversity indices of insect pests in unsprayed and sprayed modules of groundnut ecosystem in *rabi* 2025-26 during vegetative stage.

Module	No. of Species	Species diversity (Shannon-Wiener Index) (H)	Pielou's species evenness Index(J')	Berger Parker Index (B)	Simpson Index (D)	Hill No(N1)	Hill No (N2)	Margalef species richness index
Unsprayed	32	1.14	0.76	0.23	0.11	63.36	0	7.8
Sprayed	32	1.11	0.74	0.25	0.12	58.14	0	7.87

Natural enemy Abundance

The abundance of natural enemies recorded during the vegetative stage of groundnut indicated the presence of 7,724 beneficial arthropods representing 36 families distributed among seven major taxonomic groups. The unsprayed module recorded a comparatively higher total abundance (4021 individuals) than the sprayed module (3703 individuals), indicating that pesticide application exerted a suppressive effect on beneficial fauna. Among these, Hymenoptera constituted the most dominant group, in both ecosystems, contributing 2,029 individuals in the unsprayed plot and 1,921 individuals in the sprayed plot, accounting for nearly half of the total natural enemy population. It is followed by Araneae, Coleoptera, Diptera, Hemiptera, Odonata and Dermaptera across both sprayed and unsprayed ecosystems (Figure 2).

Within Hymenoptera, Formicidae (855 and 856 individuals), Diapriidae (216 and 237 individuals) and Braconidae (201 and 200 individuals) were particularly abundant, reflecting the suitability of groundnut fields for predator and parasitoid activity. In current study, Formicidae reported highest number of individuals which was in line with Ikhsan and Hamid (2020) who reported Formicidae as one of the most abundant Hymenopteran families in tidal swamp rice fields.

The predominance of hymenopteran parasitoids highlights their major role in regulating herbivorous insect populations under groundnut agroecosystems. Similar dominance of parasitoid complexes and natural enemy guilds in crop ecosystems has been reported by Landis *et al*. (2000) and Mahendra *et al*. (2024), who emphasized that diversified natural enemy communities contribute substantially to biological regulation of pests and maintenance of ecological balance.

Spiders (Araneae) constituted the second most abundant group with 876 and 837 individuals in the unsprayed and sprayed modules, respectively, represented mainly by Salticidae, Lycosidae and Araneidae, indicating active predatory pressure on small phytophagous insects. The four families of spiders reported in current findings were in accordance with Anitha and Vijay (2016), who studied diversity of predatory fauna in rice ecosystem. The ecological significance of spiders as generalist predators capable of stabilizing pest populations has been widely documented by Nyffeler and Sunderland (2003).

Coleopteran predators such as Coccinellidae and Staphylinidae, along with predatory hemipterans including Anthocoridae, Reduviidae and Geocoridae, and dipteran predators and parasitoids including Tachinidae and Syrphidae, were more numerous in the unsprayed ecosystem. The comparatively greater abundance of natural enemies under unsprayed conditions suggests that reduced chemical disturbance favoured survival, ecological stability and effective biological regulation within the groundnut agroecosystem. Similar observations on the abundance and diversity of predatory Hemiptera under ecologically favourable crop conditions were reported by Chaitanya *et al*. (2024).

Table 3 : Family-wise abundance of the Natural enemies in sprayed and unsprayed modules

S. No.	Natural Enemy Family	Unsprayed Module	Sprayed Module
	Coleoptera		
1	Coccinellidae	**180**	**162**
2	Staphylinidae	**106**	**83**
3	Carabidae	**30**	**36**
	Hemiptera		
4	Anthocoridae	**47**	**27**
5	Lygaeidae	**21**	**22**
6	Reduvidae	**25**	**26**
7	Nabidae	**9**	**9**
8	Miridae	**55**	**64**
9	Geocoridae	**56**	**38**
	Diptera		
10	Syrphidae	**44**	**53**
11	Dolichopodidae	**34**	**36**
12	Tachinidae	**152**	**150**
	Hymenoptera		
13	Formicidae	**855**	**856**
14	Platygasteridae	**116**	**84**
15	Diapriidae	**216**	**237**

16	Eupelmidae	**64**	**59**
17	Mymaridae	**37**	**24**
18	Braconidae	**201**	**200**
19	Cynipidae	**45**	**41**
20	Eulophidae	**89**	**67**
21	Aphelinidae	**79**	**74**
22	Ceraphronidae	**119**	**91**
23	Chalcididae	**50**	**48**
24	Ichneumonidae	**39**	**32**
25	Trichogrammatidae	**14**	**14**
26	Eurytomidae	**42**	**36**
27	Encyrtidae	**51**	**47**
28	Megaspilidae	**12**	**11**
	Dermaptera		
29	Labiduridae	**155**	**107**
	Araneae		
30	Lycosidae	**215**	**163**
31	Araneidae	**183**	**185**
32	Salticidae	**195**	**207**
33	Oxyopidae	**141**	**146**
34	Tetragnathidae	**142**	**136**
	Odonata		
35	Libellulidae	**129**	**59**
36	Coenagrionidae	**73**	**73**

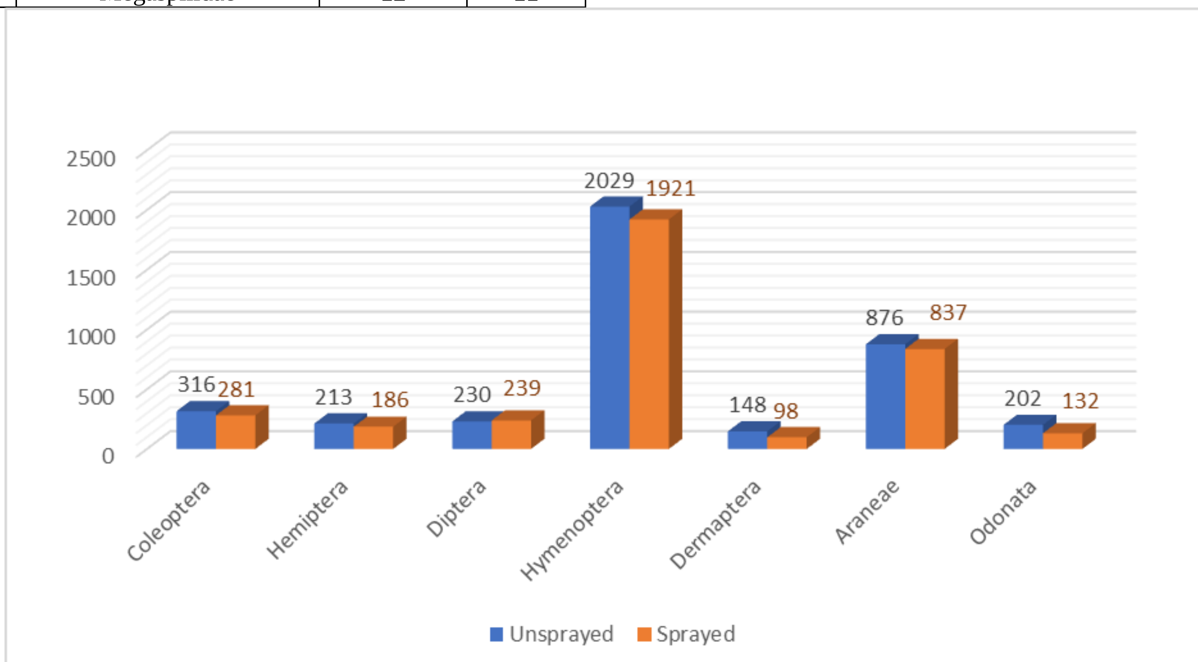

Fig. 2 : Order-wise composition of natural enemies in sprayed and unsprayed groundnut ecosystems during vegetative stage

Natural Enemy Diversity

Diversity indices revealed relatively richer and more evenly distributed natural enemy communities in the unsprayed ecosystem. Shannon diversity was marginally higher in the unsprayed module (H′ = 1.36) than in the sprayed module (H′ = 1.33), indicating slightly greater community heterogeneity under reduced chemical stress. Likewise, Pielou's evenness values of 0.87 and 0.86 suggested near-uniform distribution of taxa in both systems, although the unsprayed module maintained better equitability. Berger–Parker dominance values remained low in both ecosystems (0.21 in unsprayed and 0.23 in sprayed), confirming the absence of a single overwhelmingly dominant natural enemy group. Hill's N1 values further demonstrated a higher effective number of common species in the unsprayed module (129.99) than in the sprayed module (119.81), indicating comparatively stable trophic organization under unsprayed conditions. (Table 4)

The slightly elevated Simpson's index in the sprayed ecosystem (0.08) may indicate increased concentration of a few pesticide-tolerant taxa. Margalef's richness index remained almost similar between the two modules (9.71 and 9.81), showing that pesticide application had limited influence on total taxa richness but affected relative abundance and community structure. Similar observations were reported by Tamburini *et al*. (2021) that pesticide use can reduce the effectiveness of ecosystem services such as biological pest control by disrupting beneficial arthropod communities and modifying trophic interactions within agricultural landscapes.

Table 4 : Diversity indices of natural enemies in unsprayed and sprayed modules of groundnut ecosystem in *rabi* 2025-26 during the vegetative stage

Module	No. of Species	Species diversity (Shannon-Wiener Index) (H)	Pielou's species evenness Index(J')	Berger Parker Index (B)	Simpson Index (D)	Hill No(N1)	Hill No (N2)	Margalef species richness index
Unsprayed	36	1.36	0.87	0.21	0.07	129.99	0	9.71
Sprayed	36	1.33	0.86	0.23	0.08	119.81	0	9.81

The relatively uniform impact of insecticides on both dominant and less abundant taxa may have contributed to the maintenance of overall community structure. Since no taxa were completely eliminated from the ecosystem, richness-based diversity measures showed only minimal variation after pesticide application. Overall, the study emphasizes the importance of conserving beneficial arthropods and adopting integrated sampling approaches for sustainable pest management in groundnut ecosystems.

Disclaimer

Author(s) hereby declares that no generative AI technologies such as Large Language Models (Chat GPT, COPILOT, etc) and text-to-image generators have been used by them during writing or editing manuscripts.

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Competing Interests

Author(s) declared that no conflict of interests exists.

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