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DIVERSITY AND RELATIVE ABUNDANCE OF PESTS AND NATURAL ENEMIES IN CONVENTIONAL RICE CROP

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ABSTRACT

A study on quantification of diversity and relative abundance of pests, hemipteran predators and hymenopteran parasitoids in conventional rice was conducted in the research fields of the Indian Institute of Rice Research, Rajendranagar during *Rabi*, 2020. The methods of collection included were yellow pan traps, visual count, yellow sticky traps, sweep net and D-net. In this study, 12 families of pests, 9 families of predators and 10 families of parasitoids were recorded. The most abundant families among insect pests, predators and parasitoids were Cicadellidae (51.56%), miridae (55.13%) and eulophidae (62.19%), respectively. Shannon weiner index of insect pests, predators and parasitoids was 1.58, 1.15 and 0.99 respectively. Further, Margelef diversity index of insect pests, predators and parasitoids was 11.93, 0.84 and 1.02, respectively. Furthermore, the Pielou's eveness index was 0.61, 0.64 and 0.48, respectively. Sticky traps for pests and parasitoids and visual counts for predators were found as effective methods of collection.

Key words : Diversity, Relative abundance, Pest, Rice.

Introduction

Rice (*Oryza sativa*. L) serves as a staple food crop for approximately half of the world's population, with its global demand increasing due to population growth and changing consumer preferences, particularly in developing nations across Africa and South Asia. Cultivated across a hundred countries, rice occupies 163 million hectares of land globally and yields 500 million tons of milled rice annually (FAO, 2018). In India and other regions, rice productivity faces significant limitations due to the impact of insect pests, diseases, and weeds (Babendreier *et al*., 2020). Rice production is hampered by both abiotic and biotic stresses, with insect pests alone responsible for approximately 25% of these losses, amounting to around Rs. 240 billion (approximately 30 billion USD) (Dhaliwal *et al*., 2010). There are over 100 insect species that pose a threat to rice crops from seedling stage to maturity, as well as during storage. Although most of these insects cause minimal damage, tropical Asia experiences about 20 species of significant importance that regularly inflict direct harm through feeding or act as vectors for diseases (Heinrichs and Muniappan, 2017). In India, the expanded cultivation of high-yielding rice varieties and increased use of chemical fertilizers have contributed to increased incidences of both pests and diseases. So that here an experiment conducted to access the biodiversity and relative densities of pests of rice, Hemipteran predators and Hymenopteran parasitoids by using different methods of collection.

Materials and Methods

The experiment was conducted at the research fields of Indian Institute of Rice Research, Rajendranagar, Hyderabad during November, 2020. The rice variety BPT 5204 (Samba Mahsuri) was raised in 900 square meters plots, with three replications. The main field was well-puddled and 25-day-old seedlings were transplanted keeping a spacing of 20 cm × 10 cm. 200g carbofuran 3G was applied to nursery beds. In the main field, foliar sprays of cartap hydrochloride 2g and chlorpyriphos 2.5 ml per litre was applied when YSB/leaf folder and hispa beetle cross ETL. Observations on pests and natural enemy abundance were made in the field at 30, 45, 60, 90 and 120 days after transplanting (DAT) during morning hours when insects were inactive. Various methods of insect collection such as yellow pan traps (YPN) (N=3 at each plot), visual counts (VC) and collection from randomly selected 20 hills in 1 m^2 quadrat (5 quadrat per plot), sweep netting (SN) by moving diagonally across the plots (Five sweeps at five points), yellow sticky traps (ST) (N=5 traps/ plot) and D-net for collection of aquatic insects were used. Insects collected were sorted into orders and families. Hemipteran families were identified based on keys provided by Thirumalai and Kumar (2005), while Hymenopteran families were identified using keys from Goulet and Huber (1993). Calculations of the Shannon-Wiener diversity index, Margalef's species richness index and Pielou's evenness index was done by using PAST (Paleontological Statistics Tool) version 3.25 software. Additionally, the relative abundance (RA) of each family was computed using the formula:

Relative abundance (%) = ni × 100 / N

where, N represents the total number of individuals across all families and ni denotes the number of individuals in the i-th family.

Results and Discussion

A total of 673 individuals of insect pests belonging to 13 families were recorded. Relative abundance of cicadellidae was highest (51.56%) followed by delphacidae (17.09%). The maximum number of pest individuals were trapped in ST (42%), followed by VS (30%), however, maximum number of pest families were collected through SN (10) followed by VC (8) (Table 1, Figs. 1A and 2A). Oo *et al*. (2020) documented a total of 71 insect species across 40 families and 8 orders in rice fields. Notable findings include 18 species of beetles, 9 species of bugs, 8 species of dragonflies and varying numbers of other insect types such as butterflies, leafhoppers, plant hoppers, moths, borers, crickets and others. During the monsoon season, 41 pest species were observed, while 36 pest species were noted in summer paddy fields. Among three rice leaf folder species, highest population of *Cnaphalocrocis medinalis* (83.34%) was recorded in each location followed by *M. exigua* (12.22%) and *B. arotraea* (4.43%) in Odisha (Rautaray *et al*., 2019). In rice, lepidopterans constituted the highest number species (21%) followed by hymenopterans (18%), hemipterans (17%), but the hemipterans were collected in highest number (223) (Nayak *et al*., 2018). Ashrith *et al*. (2017) found that lepidopteran pest population was more in direct seeded rice (105) than compared to transplanted rice (88), whereas sucking insect pest population was higher in transplanted rice (157) than direct seeded rice (90).

Hemipteran predators were added up to 390 individuals, belonging to 6 families. Relative abundance of miridae was highest (55.13%) followed by pentatomidae (22.31%). The best method of collecting

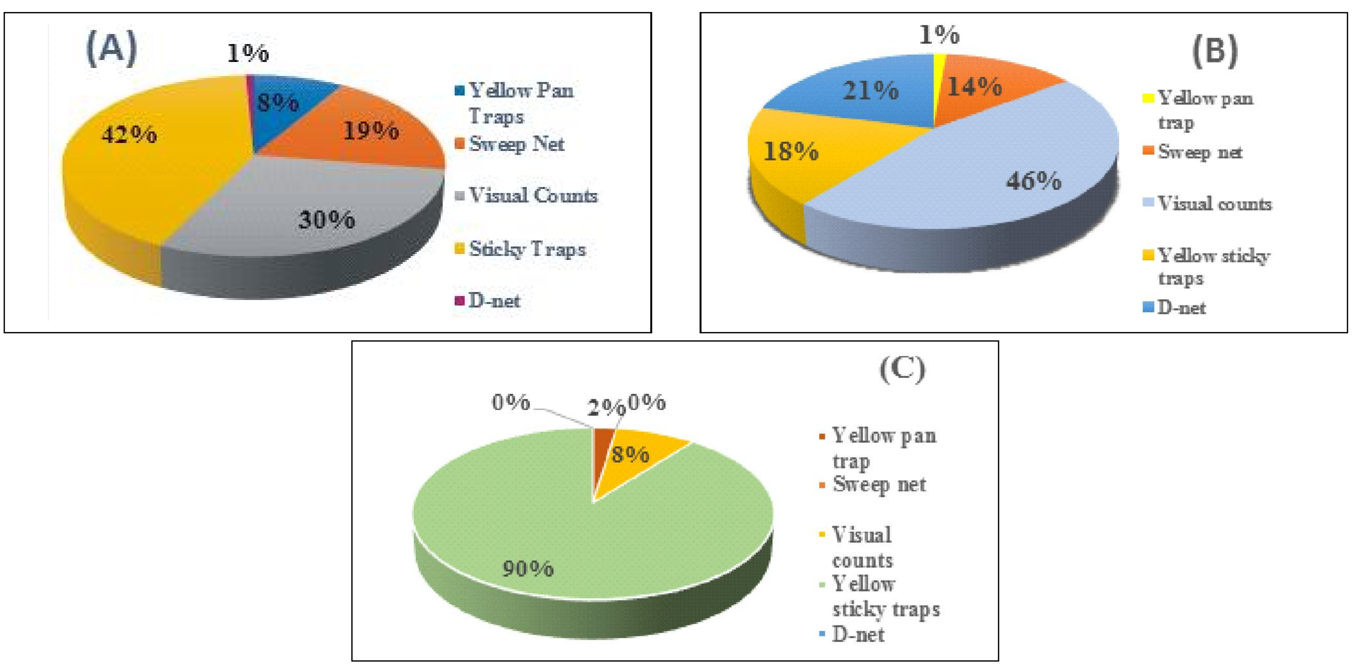

Fig. 1 : Percent contribution of different methods of collection to number of individuals (A) Pests of rice (B) Hemipteran predators (C) Hymenopteran parasitoids.

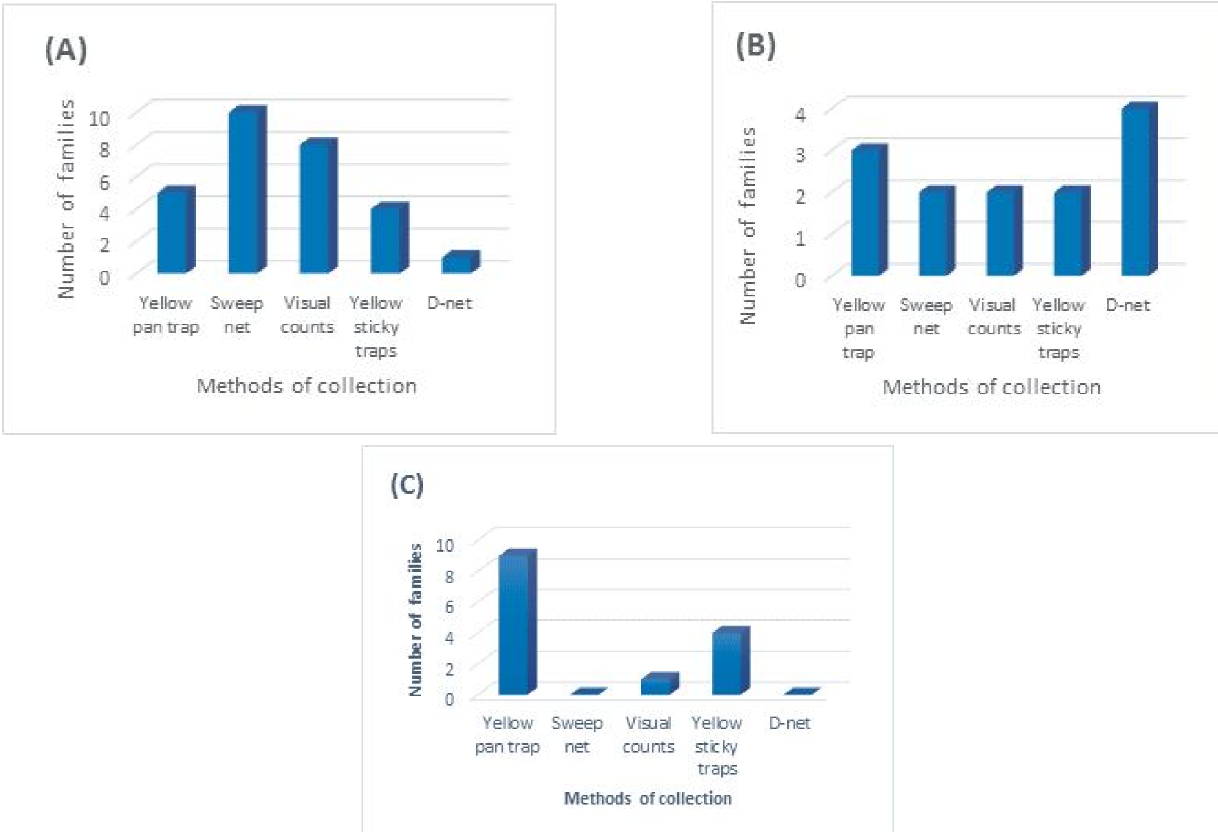

Fig. 2 : Number of families in each method of collection (A) Pests of rice (B) Hemipteran predators (C) Hymenopteran parasitoids.

Table 1 : Methods of collection of pests of rice and relative abundance of families.

Families	Methods of collection	No. of individuals	Relative abundance (%)
Crambidae	YPT, SN, VC, ST	61	9.06
Hespiriidae	SN, VC	2	0.30
Nymphalidae	SN	2	0.30
Arctiidae	SN, VC	3	0.45
Acrididae	SN	45	6.69
Delphacidae	YPT, SN, VC, ST, DN	115	17.09
Cicadellidae	YPT, SN, VC, ST	347	51.56
Pentatomidae	SN, VC	44	6.54
Alydidae	SN, VC	28	4.16
Chrysomelidae	SN, VC	14	2.08
Ephydridae	YPT	3	0.45
Cecidomyiidae	ST	2	0.30
Thripidae	YPT	7	1.04
Total		673	

(SN- Sweep Net; VC- Visual Count method; DN- D-Net Collection; YPT- Yellow Pan Trap; ST- Yellow Sticky Trap).

hemipteran predators was VC (46%) followed by D-net method (21%), however, maximum number of families were trapped in D-net method (4) followed by YPT (3) (Table 2, Figs. 1B and 2B). A total of 2597 hymenopteran parasitoids belonging to 9 families were collected in the study. Relative abundance of eulophidae was highest (62.19%) followed by scelionidae (19.02%). The maximum number of parasitoids individuals were trapped in ST (90%), followed by SN (8%), however, maximum number of parasitoid families were collected through YPT (9) followed by ST (4) (Table 2, Figs. 1C and 2C). Shannon-Wiener diversity index, Margalef's species richness index and Pielou's evenness index of pests, hemipteran predators and hymenopteran parasitoids were presented in the Table 4.

Daniel *et al*. (2020) conducted surveys on the Ichneumonid fauna in rice ecosystems, collecting a total of 604 individuals representing 14 subfamilies, 24 genera, and 33 species. Diversity indices including Simpson's index, Shannon-Wiener index, and Pielou's index were used to assess diversity across different zones. The western zone exhibited the highest diversity with values of 0.92, 1.15 and 0.39 for Simpson's index, Shannon-Wiener index and Pielou's index, respectively. In contrast, the Cauvery delta zone showed the lowest diversity with values of 0.83, 0.89,

Table 2 : Methods of collection of Hemipteran predators in rice and relative abundance of families.

Families	Methods of collection	No. of individuals	Relative abundance (%)
Miridae	YPT, VC, ST, DN	215	55.13
Pentatomidae	SN, VC, ST	87	22.31
Geocoridae	YPT, SN	7	1.79
Veliidae	YPT, DN	72	18.46
Mesoveliidae	DN	6	1.54
Corixidae	DN	3	0.77
Total		390	

(SN- Sweep Net; VC- Visual Count method; DN- D-Net Collection; YPT- Yellow Pan Trap; ST- Yellow Sticky Trap).

Table 3 : Methods of collection of Hymenopteran parasitoids and their relative abundance.

Families	Methods of collection	No. of individuals	Relative abundance (%)
Eulophidae	YPT, SN, ST	1615	62.19
Scelionidae	YPT, ST	494	19.02
Trichogrammatidae	YPT, ST	370	14.25
Diapriidae	YPT	5	0.19
Mymaridae	YPT, ST	105	4.04
Platygastridae	YPT	5	0.19
Torymidae	YPT	1	0.04
Ceraphronidae	YPT	1	0.04
Chalcididae	YPT	1	0.04
Total		2597	

(SN- Sweep Net; VC- Visual Count method; DN- D-Net Collection; YPT- Yellow Pan Trap; ST- Yellow Sticky Trap).

Table 4 : Diversity indices of pests, predators and parasitoids.

Diversity Index	Pests	Hemipteran predators	Hymenopteran parasitoids
Shannon weiner index	1.58	1.15	1.05
Margelef diversity index	1.93	0.84	1.02
Pielou's eveness index	0.61	0.64	0.48

and 0.38, respectively. The dominant species, *Leptobatopsis indica*, accounted for 8.1% of the Ichneumonid population. Ikhsan *et al.* (2020) employed four trapping techniques namely insect net, malaise trap, pitfall trap, and yellow pan trap to study hymenoptera diversity in different locations. They identified a total of 4,701 individuals belonging to 39 families and 319 species of hymenoptera. The study revealed higher species diversity and evenness of Hymenoptera parasitoids and predators in Keritang compared to Batang Tuaka and Reteh. The families Formicidae, Braconidae, Ichneumonidae and Scelionidae exhibited the highest species richness, while formicidae, scelionidae, diapriidae and braconidae had the highest number of individuals recorded. Wakhid *et al.* (2020) collected a total of 3,306 individuals representing 45 species of aquatic insects belonging to 30 genera, 20 families and 7 orders and hemiptera found to be most abundant comprising 28.89 % of the total collected insects. Hashim *et al.* (2017) collected, a total of 1936 insect specimens representing 28 species, 19 families and 7 orders from rice. Hemipterans were found to be dominant during night time with *Nilaparvata lugens* from family Delphacidae found in highest number (258). Odonata recorded the highest diversity index (H' = 1.2587). For nocturnal insects, hemiptera recorded the highest values for both diversity index (H' = 1.2655) and richness index (Imargalef = 5.8390). Mahendra *et al.* (2024) demonstrated the effectiveness of yellow sticky traps and yellow pan traps (Sahoo *et al.*, 2023) in attracting a wide range of herbivorous hemipterans and hymenopteran parasitoids, establishing them as optimal tools for sampling and studying these insect groups.

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