Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2017; 5(6): 762-765

Received: 04-09-2017
Accepted: 06-10-2017

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Insect diversity: A comparative study in direct seed and transplanted rice ecosystem

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Abstract
In the present study, attempted to describe insect diversity in direct seed and transplanted rice growing area of Hyderabad Karnataka region in Karnataka. The investigation was carried out for one year in two cropping seasons *viz.*, rabi and *Kharif*. Lepidopteran pest population is more in DSR than compared to TR, whereas sucking insect pest population was higher in TR than DSR. In case of natural enemies spider and coccinellids, the population was more in DSR than TR, but mirid bug which is a specific predator on BPH was more in TR than DSR. The diversity indices used here are Shannon-Wiener index (H), which is sensitive to changes in the abundance of rare species in a community and Simpson index (λ), which is sensitive to changes in the most abundant species in a community. Species richness (R) examines the number of species occurring in a habitat and when all species in a sample are maximum. In DSR ecosystem maximum taxa recorded were eight during 70 DAS. However, the highest number of individuals (69) was recorded during 80 DAS Shannon index was more during 70 DAS whereas Simpson_1-D was more during 80DAS.

Keywords: direct seeded rice, diversity index, BPH, miridbug

Introduction
In India, rice is grown mainly by transplanting the seedlings into the puddled to the soil, which require a large amount of water and labors. In recent years both are scarce and expensive, making rice production less profitable. Also, drudgery involved in transplanting is of serious concern. All these factors demanded major shift from Puddled Transplanted Rice (TR) production to Direct Seeded Rice (DSR) in irrigated and assured or high rainfall areas. A wide area of land inhabited by the rice crops, tropical humid and dynamic environment and variety of growth stages in short period has always been a great attraction by other species to adopt it as their niches [1]. It is occupied by various kinds of invertebrates that inhabit soil, water and vegetation area of rice ecosystems. Land-dwelling arthropod community largely comprises of insects and spiders. Terrestrial arthropods include rice pests, their natural enemies and non-rice pest insects that visit rice ecosystems for other concerns. 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 [2]. According to biodiversity productivity hypothesis, biodiversity plays a significant role in maintaining a sustainable agronomic systems. To gain productive results, it is necessary to conserve diversity in agricultural systems. Practices like overuse of pesticides, monoculture, grazing, poor farming techniques, etc. are posing threats to biodiversity associated with rice farming system. Hence, an attempt was made to study the incidence, diversity and some of the principal components responsible for diversity.

Material and Methods
The ARS, Gangavathi is one of the major paddy growing region in Karnataka, India. It is situated at 76° 32' E longitude, and 15° 15' N latitude with an altitude of 419 meters above mean sea level and Main Agricultural Research Station, Raichur situated at 77° 20' E longitude, and 16° 12' N latitude with an altitude of 389 meters above mean sea level.
Rice crop was raised directly by sowing the seeds in half an acre area similarly crop were raised by transplanting method separately in another half an acre area. The observation on the status of insect pests and natural enemies in DSR crop under protected and unprotected condition has recorded the incidence of leaf folder [3].

Yellow stem borer, nymphs and adult of green leaf hopper and plant hoppers (BPH and WBPH) from ten randomly selected hills were counted. The per cent of leaf damage and yellow stem borer was calculated by using the following formula [4].

$$\text{Per cent stem borer incidence} = \frac{\text{Number of dead heart/white ears}}{\text{Total number of tillers/panicles}} \times 100$$

$$\text{Per cent leaf folder incidence} = \frac{\text{Number of damaged leaves}}{\text{Total number of healthy leaves}} \times 100$$

The data obtained on per cent incidence was subjected to arcsin transformation before it was used for statistical analysis.

The common predators *viz.,* spiders, mirid bug and Coccinellid were counted on ten hills in each plot and later averaged to per hill basis

The diversity of spiders were analyzed by widely used indices *viz.,* the Shannon-Wiener index (H), which is sensitive to changes in the abundance of rare species in a community and the Simpson index (λ), which is sensitive to changes in the most abundant species in a community, Margalef Richness index (R) and Evenness index (E) of spider communities were calculated [5].

Results and Discussion

Numerous insect occupies paddy ecosystem. An attempt was made to know the dispersion pattern of insect pests of paddy and their natural enemy's occurrence in direct seeded rice (DSR) and transplanted rice (TR) ecosystem and results are presented in table 1.

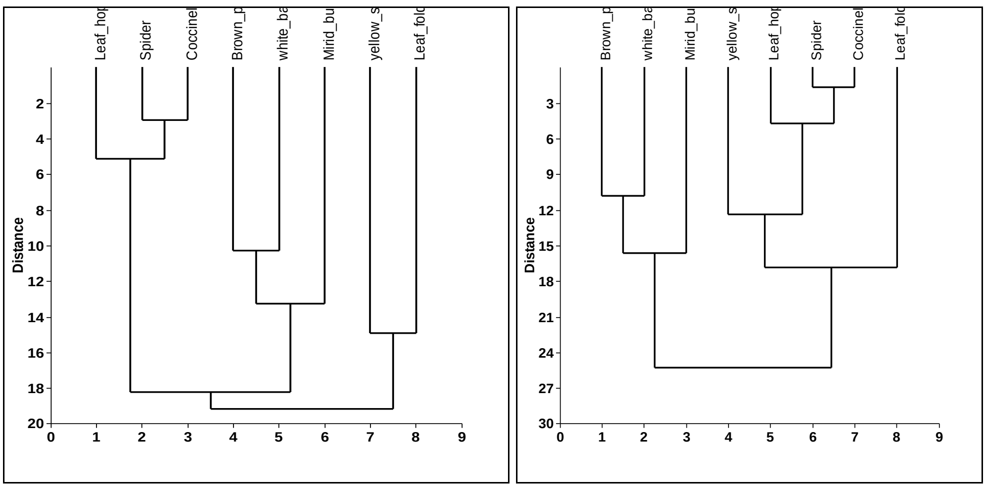
The incidence of leaf folder and yellow stem borer was started early and were noticed after 30 and 40 days after sowing, respectively. Leaf folders were noticed up to 100 days after sowing whereas yellow stem borer incidence lasted up to 80 days after sowing. The Number of leaf folder and yellow stem borers recorded in DSR was more compared to TR ecosystem. These studies revealed that the larvae of *Scirpophaga* spp usually overwinter at the basal part of rice stubbles in fallow (unploughed fields) wherein the stubbles are neither removed nor burnt because of this population build up easily and adds to the subsequent crop. Hence, the ploughing or harrowing of fields immediately after harvest will be helpful in preventing the surviving populations. [6] opined that leaf folder and YSB damage was more in direct seeded rice than the transplanted rice. In case of sucking, pests incidence of Leaf hopper started early and lasted till 100 DAS, as compared to BPH and WBPH. BPH and WBPH incidence was noticed during 60 DAS and was recorded even at 110 DAS. Here the population of sucking insects was more in TR than DSR. High plant density and humidity in transplanted fields which might have influenced the occurrence of plant hoppers [7]. Among natural enemies spider, equally abundant an evenness index (E) will be at its and coccinellid incidence was more in DSR than TR. However, the population was more in TR than DSR.

Lepidopteran pest population is more in DSR than compared to TR, whereas sucking insect pest population was higher in TR than DSR. In case of natural enemies spider and coccinellids, the population was more in DSR than TR, but mirid bug which is a specific predator on BPH was more in TR than DSR (Fig 1).

The diversity indices used here are Shannon-Wiener index (H), which is sensitive to changes in the abundance of rare species in a community and Simpson index (λ), which is sensitive to changes in the most abundant species in a community. Species richness (R) examines the number of species occurring in a habitat and when all species in a sample are maximum. In DSR ecosystem maximum taxa recorded were eight during 70 DAS. However, the highest number of individuals (69) were recorded during 80 DAS Shannon index was more during 70 DAS whereas Simpson_1-D was more during 80DAS (Table 2) [8]. Stated that increasing disturbance levels lead to decreasing spider richness. This is true for the sample-rarefied richness, in which DSR had higher richness than the TR culture. In transplanted paddy eight taxa were recorded, the highest number of individual insects (80) was recorded during 80 DAS. Shannon and Simpson_1-D index was more during 70 DAS indicating maximum diversity (Table 3).

Cluster Analysis

Cluster analysis reveals that spiders and coccinellids populations were dependent on white backed and brown plant hopper. Rice leaf folder and yellow stem borer population were observed maximum in DSR ecosystem. Whereas, sucking pests like BPH, WBPH and green leafhopper population was observed highest in TPR ecosystem [9]. In this cluster analysis indicates that there is a relationship between the insect pests and their natural enemies in both the ecosystem respectively (Fig 1).



A B

Fig 1: Cluster analysis of pest and natural enemies in A) Direct-seeded and B) Transplanted rice eco system

Principal component analysis

Principal component analysis revealed that two components explained 83 per cent of the variability of insect pests existing in DSR and TPR ecosystems. The maximum abundance of rice leaf folder and yellow stem borer adults in DSR ecosystem. It might be due to the rapid growth of rice plant to increase the population. In TPR ecosystem also observed more diverse and complex habitat of BPH, WBPH and GLH than the DSR fields. Among two components natural enemies like a spider, mirid bug and coccinellids abundance and richness were maximum in TPR ecosystem (Fig. 2). A transplanted ecosystem with more structural diversity and higher plant community and complexity offer more shelter and micro habitat for natural enemies [10].

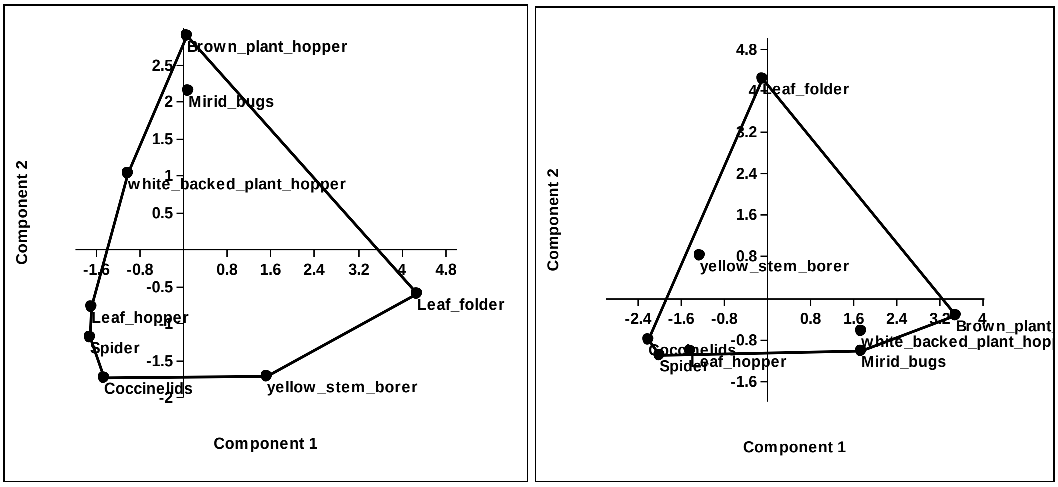


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Fig 2: Principal component analysis of pest and natural enemies in A) Direct-seeded and B) Transplanted rice ecosystem

Conclusion

There is plenty of diversity in paddy fields of the major rice-growing areas. Greatest diversity of rice pests was seen to be in India because of their huge land area. Plant hoppers (Brown plant hopper and white-backed plant hopper) and leafhoppers (green leafhopper, zigzag leafhopper) were found to be widely distributed in paddy fields of major rice producers. These pests are responsible for huge economic losses to rice yields, and different strategies are being developed against them to keep them at a normal level. India being the biggest producer has to need to developed genomic strategies to keep their rice pests below threshold level to control pests in their rice fields.

Table 1: Dispersion pattern of pests and natural enemies in DSR and transplanted rice ecosystem

	Leaf folder		Yellow stem borer		Leaf hopper		BPH		WBPH		Spider		Mirid bugs		Coccinelids	
	DSR	TR	DSR	TR	DSR	TR	DSR	TR	DSR	TR	DSR	TR	DSR	TR	DSR	TR
DAS 20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DAS 30	6	4	0	0	0	0	0	0	0	0	0	0	0	0	1	0
DAS 40	6	5	4	1	0	0	0	0	0	0	1	0	0	0	1	1
DAS 50	9	7	6	5	1	1	0	0	0	0	1	1	0	0	2	1
DAS 60	10	9	10	7	1	1	4	8	1	5	1	1	0	0	2	1
DAS 70	11	9	8	5	1	3	8	12	4	10	1	1	9	11	1	1
DAS 80	12	10	13	11	5	4	11	16	9	14	1	1	18	23	0	1
DAS 90	10	9	0	0	3	3	12	18	7	14	2	2	15	18	1	1
DAS 100	8	6	0	0	2	3	11	16	7	9	2	1	7	9	0	0
DAS 110	0	0	0	0	0	0	9	13	3	7	0	0	0	0	0	0

DAS – Days after sowing, DSR - Direct seeded rice, TR- Transplanted rice, BPH – Brown plant hopper, WBPH – White-backed plant hopper

Table 2: Diversity index of pest and natural enemies in direct seeded rice ecosystem

Diversity index	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	80 DAS	90 DAS	100 DAS	110 DAS
Taxa_S	2.00	4.00	5.00	7.00	8.00	7.00	7.00	6.00	2.00
Individuals	7.00	12.00	19.00	29.00	43.00	69.00	50.00	37.00	12.00
Dominance_D	0.76	0.38	0.34	0.27	0.19	0.18	0.21	0.21	0.63
Shannon_H	0.41	1.13	1.27	1.54	1.79	1.78	1.68	1.64	0.56
Simpson_1-D	0.24	0.63	0.66	0.73	0.81	0.82	0.79	0.79	0.38
Evenness_e^H/S	0.75	0.77	0.71	0.67	0.75	0.85	0.76	0.86	0.88
Menhinick	0.76	1.16	1.15	1.30	1.22	0.84	0.99	0.99	0.58
Margalef	0.51	1.21	1.36	1.78	1.86	1.42	1.53	1.39	0.40
Equitability_J	0.59	0.81	0.79	0.79	0.86	0.91	0.86	0.91	0.81
Fisher_alpha	0.94	2.10	2.21	2.93	2.90	1.95	2.22	2.03	0.69
Berger-Parker	0.86	0.50	0.47	0.34	0.26	0.26	0.30	0.30	0.75

DAS – Days after sowing

Table 3: Diversity index of pest and natural enemies in transplanted rice ecosystem

Diversity index	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	80 DAS	90 DAS	100 DAS	110 DAS
Taxa_S	1.00	3.00	5.00	7.00	8.00	8.00	7.00	6.00	2.00
Individuals	4.00	7.00	15.00	32.00	52.00	80.00	65.00	44.00	20.00
Dominance_D	1.00	0.55	0.34	0.22	0.18	0.19	0.22	0.24	0.55
Shannon_H	0.00	0.80	1.26	1.65	1.83	1.78	1.63	1.56	0.65
Simpson_1-D	0.00	0.45	0.66	0.78	0.82	0.81	0.78	0.76	0.46
Evenness_e^H/S	1.00	0.74	0.71	0.74	0.78	0.74	0.73	0.79	0.96
Menhinick	0.50	1.13	1.29	1.24	1.11	0.89	0.87	0.90	0.45
Margalef	0.00	1.03	1.48	1.73	1.77	1.60	1.44	1.32	0.33
Equitability_J	0.00	0.72	0.79	0.85	0.88	0.85	0.84	0.87	0.93
Fisher_alpha	0.43	1.99	2.63	2.77	2.64	2.21	1.99	1.88	0.55
Berger-Parker	1.00	0.71	0.47	0.28	0.23	0.29	0.28	0.36	0.65

DAS – Days after sowing

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