Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2019; 7(3): 1359-1362

Received: 10-03-2019
Accepted: 13-04-2019

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Bio-diversityof photo-tactic hemipteran insects in the rice ecosystems Jabalpur district, Madhya Pradesh, India

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Abstract
The present research work was carried out at two distinct locations (Research Field and Farmer's Field) of District Jabalpur, Madhya Pradesh during two cropping season of rice i.e. Kharif of 2015 and 2016. Farmer's Field was less disturbed eco-system where farmer followed traditional agriculture practices for growing crops. Research Field ecologically was highly disturbed area where scientists were fallowed intensive agricultural practices for growing crops. Light trap was used for study of biodiversity of Hemipteran phototactic insect fauna. Total 37 species of order Hemiptera belongs to 12 families were collected from rice ecosystem. Family Pentatomidae was the dominating family among the all 12 families. 5 species were collected more in number at Farmer's Field in comparison to Research Field. 37 species were collected at Farmer's Field, while 32 species were at Research Field.

Keywords: Light trap, hemiptera, rice, diversity, taxonomy, eco-system

Introduction
Rice is a very important crop in India it has occupied 37.38 million ha area under cultivation and production was 104.8 [1]. while in Madhya Pradesh area under rice cultivation was 2.02 million ha and production was 5.32 MT [2]. Rice ecosystem provides favorable conditions for various kinds of invertebrates that inhabit soil, water and vegetation. Over 800 species of insects in rice ecosystems have been reported worldwide. Out of these, 100 species attack rice, while rest are considered as friendly insects [3]. Almost 20 insects are considered as rice pests of economic importance that include stem borers, gall midge, defoliators and vectors like leafhoppers and plant hoppers [4]. According to biodiversity productivity hypothesis [5], biodiversity plays a significant role in maintaining a sustainable agronomic system.
Order Hemiptera is also an integral part of insect bio-diversity in rice eco-system. The order Hemiptera is the largest of the non-endopterygote orders constituting 90000 species in about 140 families. Hemipteran insects are widely distributed found in all major habitats. They play an important role in maintaining the eco-system.
Practices like over use of pesticides, monoculture, grazing, poor farming techniques etc. are posing threats to insect biodiversity associated with rice farming system [6]. Agricultural activities create fragmented landscapes, which cause small isolated patches of species to go extinct [7]. These oversimplified environments lead to intensified pest outbreaks, as well as a reduction in critical components of an ecosystem, such as pollinators [8]. In order to gain productive results, it is necessary to conserve diversity in agricultural systems.
Light trap is a well-known tool for the study of biodiversity of phototactic insects. Light-trapping has become a general term which refers to all methods of attracting nocturnal insects with lamps or artificial light sources. Phototropic behavior and phototactic response of insects are being largely used to monitor pest activity for their effective suppression [9]. Light trap still occupied an important place in entomological studies world wide for survey, detection and management of insect pest population in various Agro-Horticulture crops [10]. Keeping the importance of biodiversity in mind for maintaining a sustainable agronomic system, this study proposed the insect diversity in rice ecosystem by using the light trap.

Materials and Methods
The present two year (2015 and 2016) explorative field research on Hemipteran phototactic insects rice ecosystems was carried out at two distinct locations separated from each other by

natural barriers. One of the location was Research Field (RF) of Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV) Jabalpur while the other was Farmer's Field (FF)located in Jatwa village, Panagar Block of district Jabalpur. The farmer's field was about twelve kilo metres away from field in JNKVV.

District Jabalpur, lies in the Agro-climatic Zone-VII (Satpura hills and Kymore plateau) of Madhya Pradesh. Geographically, Jabalpur district is situated at 23.10°N – 79º57′E latitude, 23.17º N – 79.95ºE longitude and at an altitude of 411.78 m above the mean sea level. The annual rainfall varies from 1300 to 1400 mm with an average of 1350 mm.The climatic conditions prevalent in Jabalpur are essentially semi-arid and sub-tropical.

Description of the rice ecosystem

Research Field (RF)

RF is located in the JNKVV campus. The well-leveled field with heavy soil and bunds are well equipped with irrigation facilities and motor able roads. Commercial farming for productionin the fields of JNKVV is the largest producer of Breeder seeds in India. Mechanization, high inputs (use of fertilizers, weedicides and insecticides), inter-culture operationsand clean bunds are the characteristic features of this production system. Rice-wheat cropping sequence practiced in fields with bunds and roads are well illuminated as well as surrounded by colonies of human dwellings has acoustic disturbance also. The adjacently flowing perennial narrow stream drains into the River Hiran about 10 kilometres away.

Farmer Field (FF)

FF located 12 kilometres away from the RF in village- Jatwa, Panagar block of district Jabalpur too has fields with black soil. The narrow field bunds in FF, do not often permit tractor movement on them and are not illuminated as found in RF. Comparatively better vegetation cover, traditional crop production with minimum disturbance of soil, limited use of irrigation, inputs and inter cultural operations are the characteristic feature that differentiated the FF with RF. Unlike RF, FF is away from human dwellings and have lessacoustic disturbance and illumination. Unlike that in RF, the FF has a pond and the River Hiran flows very near to the village.

Light traps

One light trap was installed in the cross road of rice fields in RF, while the light trap in the FF was installed on the bund in close proximity to the electric pole.

Description of the Light traps

Insects were collected by "Jawahar light trap" designed and developed by JNKVV, Jabalpur. Light trap is fitted with mercury vapour lamp (80 W) as light source, comprised of two components:-

a. Trapping device

It is made up of 24 gauge Galvanised Iron (GI) sheet consisting of a funnel (40 cm top diameter), three baffle plates (each 30 x 12 cm). In the model used, there is a long funnel stem (pipe) provided in the place of collection chamber which is directly attached to collection tray.

b. Insect collection chamber

It is also made up of 24 gauge GI sheet (40 cm x 40 cm x 15 cm) with cupboard and built-in locking system.

Dichlorvos 76 EC (as fumigating agent) was placed in the collection tray to kill the trapped insects in the collection chamber.

Operation of Light traps

Both the light trapsswitched on daily in the evening between 6.00 and 6.30pm throughout the rice cropping season from July to November. The insects collected in the collection tray of the light trap werecarefully emptied in the collection bag early in the morning between 6.00 and 6.30am. The insect filled bag was brought to the laboratory in the Department of Entomology, College of Agriculture where it was sorted, counted and documented everyday.

Identification of insects

The sorting of the insects collected according to their order and family was followed by its setting and mounting. Preservation of the dried specimens were performed by keeping the insects set in oven for 24 hours at 54°C and thereafter well labeled specimens were stored in insect boxes and show cases.

Identification of insects were done on the basis of key and specimens available in the insect museum of

- Department of Entomology, JNKVV, Jabalpur
- Department of Entomology, University of Agricultural Sciences, Bangalore and
- Zoological Survey of India, Jabalpur.

Results and discussion

Bio-diversity of photo-tactic Hemipteran insects in the rice ecosystems

a. FF, 2015

32 species belonging to 12 families were collected from the FF during Kharif season 2015. Reduviidae, Pentatomidae and Coreidae was the predominant family represented by 5 species each followed by Dictyopharidae (4 species), Cicadellidae (4 species), Bleostomatidae and Pyrrhocoridae (2 species). Families Lophopidae, Fulgoridae, Largidae, Flatidae and Nepidae were represented by one species each (Table 1).

b. RF, 2015

29 species belonging to 11 families were collected from the RF during Kharif season 2015.Reduviidae and Pentatomidae was the predominant families represented by 5 species each followed by Coreidae (4 species), Dictyopharidae (4 species), Cicadellidae (3 species), Bleostomatidae (2 species), Pyrrhocoridae (2 species) while Lophopidae, Fulgoridae, Largidae, Flatidae and Nepidae represented by one species each (Table 1).

c. FF, 2016

In year 2016, Order Hemiptera was represented by 37 species and 12 families. Pentatomidae was the predominant family represented by 8 species followed by Reduviidae and Coreidae (5 species), while Dictyopharidae, Cicadellidae and Pyrrhocoridae were represented by four species each. Bleostomatidae was represented by two species, while Lophopidae, Fulgoridae, Largidae, Flatidae and Nepidae were represented by one species each (Table 1).

d. RF, 2016

32 species belonging to 11 families were collected from the RF during Kharif season 2016. Pentatomidae were the predominant family represented by 6 species followed by Reduviidae (5 species), Coreidae, Dictyopharidae and Pyrrhocoridae represented by 4 species each. Cicadellidae with 3 species and Bleostomatidaewas represented by 2 species. Lophopidae, Fulgoridae, Largidae, Flatidae and Nepidae were represented by one species each (Table 1).

e. Pooled FF

Pooled data revealed that total 37 species belonging to 12 families were collected from the FF. Pentatomidae was the predominant family represented by 8 species followed by Reduviidae (5 species), Coreidae (5 species), while Dictyopharidae, Cicadellidae and Pyrrhocoridae were represented by 4 species each. Bleostomatidae was represented by 2 species, while Lophopidae, Fulgoridae, Largidae, Flatidae and Nepidae represented by one species each (Table 1).

f. Pooled RF

At RF, Hemiptera was represented by 32 species and 11 families. Pentatomidae was the predominant family represented by 6 species followed by Reduviidae (5 species), Coreidae, Dictyopharidae and Pyrrhocoridae with 4 species each. Cicadellidae (3 species), Bleostomatidae (2 species). Lophopidae, Fulgoridae, Largidae, Flatidae and Nepidae were represented by one species each (Table 1).

In year 2015, three species were collected more in number at FF in comparison to RF. In year 2016 the species richness was more at FF in comparison to RF. Five species were collected more in number at FF during Kharif season 2016. Pooled data also revealed that the number of species was more at FF where the farmer followed the traditional cultivation practices. No use of insecticides, less use of fertilizers, minimum intercultural operation with limited irrigation. Similarly [11] also reported significantly very high activity of beneficial predacious species in light trap at farmer's field, compared to research farm shows the importance of minimum use of pesticides and least disturbances to ecosystem.

Totalphoto-tactic Hemipteran insects collected in rice eco-system

Total 37species belonging 12 families were collected from FF and RF during Kharif season of 2015 and 2016. Pentatomidae was the predominant family represented by 8 species followed by Reduviidae and Coreidae (5 species), Dictyopharidae, Cicadellidae and Pyrrhocoridae were represented by 4 species each. Family Bleostomatidae was represented by 2 species. Lophopidae, Fulgoridae, Largidae, Flatidae and Nepidae were represented by one species each (Table 1). Similarly [12] observed the population densities of hemipterous insects by using Robinson light trap at Al-Arish city, North Sinai during 1994-96. Ninety-two hemipterous species belonged to 58 genera of 16 families [13]. alsoreported 14 species of order Hemiptera through light trap in paddy ecosystem at Jabalpur, MP, during *kharif* season of 2004.

Table 1: Biodiversity of photo-tactic Hemipteran insects in the rice ecosystems of Jabalpur District, Madhya Pradesh, India.

S. No.	Insect species collected	Number of insects collected in light trap			
		FF		RF	
		2015	2016	2015	2016
Family – Pentatomidae (8)					
1	*Plautiacrossota* (Stal 1869)	0	12	0	4
2	*Nezaraviridula* (Linnaeus, 1758)	188	120	479	330
3	*Antestiopsiscruciata* (Fabricius, 1775)	4	9	3	4
4	*Andrallusspinidens* (Fabricius, 1787)	0	4	0	0
5	*Carbulascutellata* Distant 1887	18	19	6	5
6	*Bagrda sp.*	22	20	10	10
7	*Eocanthecona furcellata* (Wolff, 1811)	10	12	3	5
8	*Halysserrigera* (Westwood, 1837)	0	4	0	0
Family – Reduviidae (5)					
9	*Sirtheneacarinata* (Fabricius, 1798)	26	36	51	52
10	*Scadraannulipes* Reuter, 1881	210	420	183	304
11	*Ectomocorisululans* (Rossi, 1790)	9	6	9	2
12	*Sirthenea sp.*	16	6	6	5
13	*Oncocephalus sp.*	56	46	87	59
Family – Pyrrhocoridae (4)					
14	*Dysdercuscingulatus* (Fabricius, 1775)	251	124	688	402
15	*Antilochuscoquebertii* (Fabricius, 1803)	69	84	297	440
16	*Ectatops sp.*	0	22	0	13
17	*Probergrothius sp.*	0	9	0	2
Family – Coreidae (5)					
18	*Homeocerussignatus* Walker, 1871	25	18	31	32
19	*Notobitus sp.*	16	21	12	6
20	*Anoplocnemisphasiana* (Fabricius, 1781)	2	3	0	0
21	*Leptocorisaacuta* (Thunburg, 1873)	198	270	455	655
22	*Riptortuspedestris* (Fabricius, 1775)	20	48	6	12
Family – Dictyopharidae (4)					
23	*Putala sp.*	106	122	56	59
24	*Dictyphora sp.*	634	320	204	120
25	*Dictyophorium sp.*	40	44	16	20
26	*Dictyophora sp.*	2	12	18	18

Family – Cicadellidae (4)					
27	*Nephotettixvirescens* (Distant 1908)	9440	12360	24070	27922
28	*Nephotettixnigropictus* (Stal, 1870)	998	1160	2448	3882
29	*Cofana spectra* Distant, 1908	10360	16440	21010	28372
30	*Ledra sp.*	6	4	0	0
Family – Belostomatidae (2)					
31	*Lethocerusamericanus* (Leidy, 1847)	3	5	5	3
32	*Diplonychusrusticus* Fabricius, 1871	1466	1660	4282	3230
Family –Lophopidae (1)					
33	*Pyrillaperpusilla* (Walker, 1851)	2240	2960	6682	7829
Family –Fulgoridae(1)					
34	*Zanna sp.*	42	32	32	13
Family –Largidae(1)					
35	*Physopeltagutta* (Burmeister, 1834)	8	3	0	0
Family –Flatidea (1)					
36	*Flata sp.*	10	13	2	6
Family –Nepidae(1)					
37	*Nepacinerea*Linnaeus, 1758	4	6	2	1

Conclusion

In conclusion, Hemipteran insects play an important role in rice ecosystem. They are pest (ex. Cicadellidae, Lophopidae, Pentatomidae), predators (ex. Reduviidae), and predators on aquatic insects (Ex. Belostomatidae, Nepidae) in rice eco-system. Total 37 species belonging to 12 families of order Hemiptera were collected from rice ecosystem. Pentatomidae was the predominant family represented by 8 species followed by others. The bio-diversity of Hemipteran insects was more at FF, compared to RF. 5 species were collected more in number at FF. 37 species were collected at Farmer's Field while 32 species were at Research Field. Difference in the insect species collectionshows the importance of minimum use of pesticides and least disturbances to ecosystem.

Acknowledgement

Author extent gratitude to Dr. R. Pachori, Dr. A.K. Bhoumick, Dr. Moni Thomas and Dr. Amit Kumar Sharma for their able guidance and support for in completing the research. Author also thankful to Mr. Yogendra Mishra and Mr, Rajesh Arwe for their voluble support.

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