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Diversity of Insect Pest and Predator Species in Monsoon and Summer Rice Fields of Taungoo Environs, Myanmar

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Abstract

Paddy fields are natural and artificial wetland ecosystems that supply rice for the people and provide the wildlife especially insect diversity of different functional aspects. A total of 71 insect species belonging to 40 families under eight orders were observed during the study period. Among the 71 insect species, 18 species of beetles, nine species of bugs, eight species of dragonfly, five species of butterflies, four species of leafhoppers, plant hoppers and moths, three borer and spiders, two crickets, one species of skippers, grass hopper, hispa, ant, weevil, hairy caterpillar, leaf roller, katydid, thrips, maggot and water boatmen were recorded in the study sites. Total of 41 species of pests, 18 species of predators and 12 species of beneficial species (they function as pollinating the flowering plants in the paddy field wetland ecosystem) were recorded in the study sites. In the monsoon season, the 41 species of pest species, 18 species of predator species and 12 species of beneficial species were recorded from monsoon rice field. According to Shannon Evenness value (H'/S = −0.012564), the data showed that the insect species recorded from the one habitat was not the similar to another. In summer paddy fields, 36 species of pest species, 16 species of predator species and 9 species of beneficial species were recorded. Total arthropod insect species were recorded 61 species from the dry rice fields. According to Shannon Evenness value (H'/S = −0.000120), the data showed that the insect species recorded from the one habitat was not the similar to another. Population growth and duration of life cycle of insects is mainly dominated by the temperature, the duration of life cycle is shorter in the high temperature than in the low temperature.

Keywords

Indent, Insect Species Diversity, Pest and Predators, Seasonal Variation, Paddy Filed, Taungoo

1. Introduction

The insects play an important role in the paddy field ecosystem functioning as pests and their counter action of predator insects. The insects are the highest diversity among about 90% or more of global living species exist on earth planet. Most insects are destructive, vectors and predators. Among them, the pest species destroyed the plant species especially agricultural crops.

Insects are responsible for two major forms of damage to crops. These include aphids, whiteflies and scaled insects. Rice (*Oryza sativa*) is the staple food of over half of the world's population. Annual world rice production is approximately 460 million tons grown on more than 145 million hectare (ha). Over 90% of the world's rice is grown in Asia. The government has accorded the highest priority on the rice sector because of its crucial role in food security, economic and political importance to the country [1].

Myanmar is an agricultural country, having over 8 million hectares of paddy land, all are growing monsoon rice and in some of these fields where there is irrigating by the dams, the summer rice are growing. Monsoon rice occupies the largest portion of the rice area 80% and summer rice is 20%. There are about 70 rice varieties have been collected in Myanmar (IRRI), all have particular characters possessing good and bad. Twenty-eight varieties of these are widely grown by farmers. Rice varieties vary in characteristics such as grain length, thickness, color and aroma. The incidents of the pests are dependent on the varieties of rice species [2].

Insects are major constraint to rice production. Most of the rice plant parts are vulnerable by the insects feeding throughout the growing season from the time of sowing to the harvesting. Both the mature and immature stages of insects injure rice plants by chewing leaf and root tissues, boring and tunneling into stems, or sucking fluid sap from stems and grains. The injury from feeding of insects leads to damage showing symptoms of skeletonized and defoliated leaves, dead hearts, whiteheads, stunted and wilted plants and unfilled or picky grains. Ultimately insect damage affects the plant physiology leading to reduction in measurable yield, utility or economic return [3]. As the insect pests cause damage to rice plants and are one of the reasons of total annual yield loss of rice, it is important to study the rice insect pests, especially their seasonal abundance and incidence, to evaluate the control measures. Notable works on the rice field insect pests are those of Alam [4] [5]. The entomologists of BRRI initiated systematic surveys of rice field insect pests throughout Bangladesh dividing Bangladesh into several agro-ecological zones and collected rice insect pests from dif-

ferent crops, seasons and growth stages of the rice plants [6]-[11].

The arthropod community in rice fields includes rice pests, their natural enemies (predators and parasitoids) and other non-rice pest insects that inhabit or visit the vegetation. Over 800 species of arthropod community in rice ecosystem have been reported worldwide. The composition of the arthropod communities in the rice ecosystem is mainly influenced by the rice plants [10].

Irrigated rice fields are agronomically managed wetland ecosystems with a high degree of environmental heterogeneity operating on a short temporal scale, harbour a rich and varied fauna [11]. The fauna is dominated by micro (bacteria), meso (insects) and macro invertebrates (especially arthropods) inhabiting the soil, water and vegetation sub-habitats of the rice fields. The terrestrial arthropod community in rice fields consists mainly of insects and spiders (terrestrial invertebrates). The different communities of terrestrial arthropods in the rice field include rice pests, their natural enemies (predators and parasitoids) and other non-rice pest insects that inhabit or visit the vegetation which are collectedly known as beneficial insects although spiders are under the class Insecta [6].

The cultivation of rice in Myanmar varies according to seasonal changes and the availability of water supply. It is grown extensively throughout the country in three seasons. There are mainly two rice growing seasons, dry season rice and monsoon rice. The dry and humid climate of Myanmar is conductive to the proliferation of insect pests. The two rice crops grown under diverse ecological conditions are attacked throughout the growing periods by a number of insect pests of the **70** species of rice insect species recorded in Myanmar, 40 - 43 species have been found to be more damaging. The magnitude of damage varies in seasons, years and locations.

The climate condition of Taungoo environs was moist humid in monsoon season (a range of temperature of between 32.5˚C and 39˚C; that of humidity of 84.5 - 96 mm and rainfall with 103 cm) and hot dry in summer season (range of temperature between 22.5˚C and 33˚C; that of humidity of 41.5 - 63.0 mm) according to Department of Meteorology and Hydrology, Taungoo Township. The rice fields in Myanmar have diverse ecological conditions and presence of rice field insect pests is expected to be variable. But no attempt has been made to study the rice field insect pests in the Taungoo of Bago Region. The present study was aimed to prepare a list of rice field insect pests, their abundance and incidence on different stages of rice plants and in different growing seasons. This study was to access the abundance category, dominant index, Shannon index diversity of the paddy field ecosystem, and to compare the two ecosystems of monsoon and summer rice fields from Taungoo area of Myanmar.

2. Materials and Methods

2.1. Study Area and Study Period

Taungoo Township is located in upper part of Bago Region, eastern part of Middle Yoma Mountain range and close to lower boundary of Mandalay Region. It

is one high species diversity region. Soil types and weather condition is favorable condition for the growing paddy and other varieties of crops including peas and beans. Four paddy fields with an area of one hectare each from villages of Taungoo Township were selected as follows: **Study site 1**: around Nat Sin Gon village (N 18˚59'31.40" and E 96˚17'40.15"); **Study site 1I**: Along the road sides of Saba Oo village (N 18˚56'23.04" and E 96˚17'53.80"); **Study site III**: Nyaung kaing village (N 18˚58'53.49" and E 96˚15'54.77"); **Study site IV**: Htain Kone Pin village (N 18˚57'17.87" and E 96˚18'29.21"). The study period lasted from July, 2017 to May, 2018 (Figure 1).

2.2. Sample Collection

Five transect lines were designated evenly apart each other. Five sampling plots were located on each transect line. The insect specimens from all survey sites from both seasons of monsoon and summer were weekly collected during the time from 7:00 am to 5:00 pm. During the day time, insect net were also used by sweeping the net. The nocturnal insects were also collected using light traps, light traps were set out each corners of the paddy field and one was at the centre of the field. The collected specimens were socked out into different insect groups as butterflies, beetles, etc. and they were identified down into species levels depending into taxonomic and morphological characters. Those species were categorized as pests, predators and beneficial groups depending on the infestation and predation during the observation time and the confirmed with the references.

2.3. Data Analysis

Two parameters to access the insect diversity and Relative abundance of the recorded species were calculated. The Shannon index and Evenness formula were used for the assessment of insect species diversity as follows (Stiling, 1999) [12].

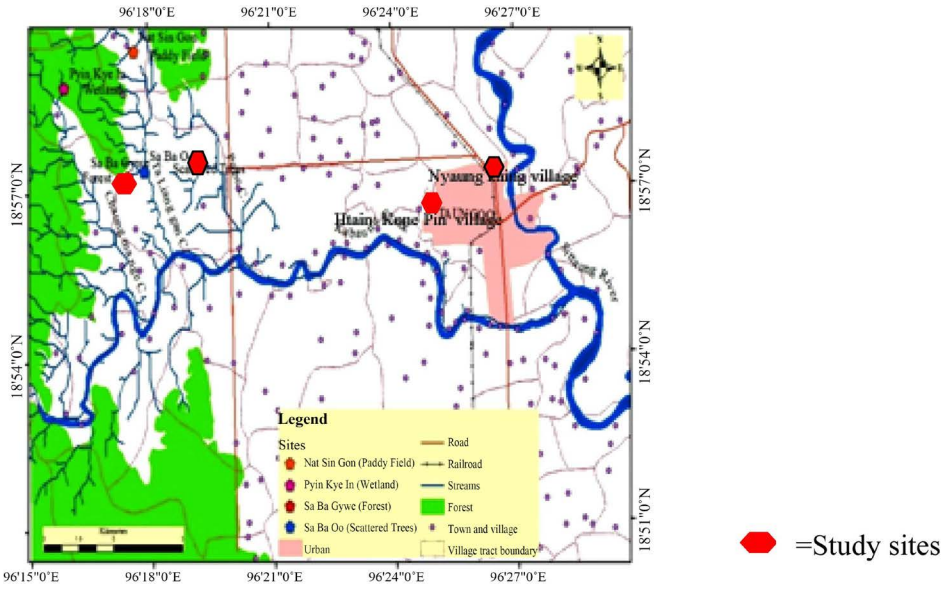

Figure 1. Map of Taungoo environs showing the four study site.

Equation 1

$$\text{Shannon Index} = H' = \sum Pi \ln Pi$$

$$\text{Shannon Index} = H'/S$$

$$Pi = \frac{\text{No. of insect species}}{\text{Total No. of all bird species}} \times 100$$

where, Ln = Log Normal,

S = Total numbers of species.

Relative abundance of monthly occurrence was also calculated based on each species. The calculation was followed after Kumar and Sivaperuman (2005) [13].

Equation 2

$$\text{Relative abundance} = \frac{\text{Total No. of partiular species}}{\text{Total No. of all species}} \times 100$$

The range of index value for the Abundance categories were determined as

Rare Species = (0.1 - 2.0) Common = (6.1 - 8.0)

Uncommon = (2.1 -4.0) Abundant = (8.1 - above)

Frequent = (4.1 - 6.0)

2.4. Identification

Identification was followed after Bingham (1905) [14], Bingham (1907) [15], Talbot (1939) [16], Kinyon (2004) [17].

3. Results and Discussion

The paddy field ecosystem was composted of a total of 71 insect species belonging to 40 families under nine orders with the three spider species. Among the 71 insect species, 18 species of beetles, nine species of bugs, eight species of dragonfly, five species of butterflies, four species of leafhoppers, plant hoppers and moths, three borer and spiders, two crickets, one species of skippers, grass hopper, hispa, ant, weevil, hairy caterpillar, leaf roller, katydid, thrips, maggot and water boatmen were recorded in the study sites (**Table 1**). Hence, those paddy fields were functioning ecosystem and healthy community and participate in every tropic level of these ecosystems. The insects are small animal functioning in various tropic levels. As a biodiversity conservation point of view, these paddy fields were sustainable ecosystem (**Table 1** and **Table 2**).

The paddy field ecosystem was highly diverse insect species and spiders inhibiting 71 species representing 40 families in the monsoon rice plantation and 32 families in summer rice growing season (**Table 2** and **Figure 2**). The species numbers under nine orders, Order Coleoptera, Diptera, Hemiptera, Orthroptera, Hymenoptera, Lepidoptera, Odonata, Thysamoptera and Aracnidae decreased in summer while it was more or less similar in both paddy growing seasons. The insect species numbers and its relative abundance was higher because they didn't applied the pesticides for this research and the surrounding paddy fields usually control the pest insects as chemical control. This area is also not far to the deciduous forest of Middle Yoma mountain range.

Table 1. Collected insect species from the paddy fields of Taungoo township.

ORDER/FAMILY	No.	Scientific Name	Common Name	Habit
I. COLEOPTERA				
Anobiidae	1.	*Xestobium rufovillosum*	Deathwatch beetle	Pest
Bostrichidae	2.	*Heterobostrychus aequalis*	Oriental wood borer	Beneficial
Carabidae	3.	*Harpalus rufipes*	Strawberry seed beetle	Pest
Coccinellidae	4.	*Micraspis discolor*	Lady bug beetle	Predator
Chrysomelidae	5.	*Aulocophora foveicollis*	Red pumpkin beetle	Pest
	6.	*Aulocophora nigripennis*	Leaf beetle	Pest
	7.	*Cassoda flaveola*	Pale tortoise beetle	Pest
	8.	*Gastrophysa atrocyanea*	Leaf bee	Pest
	9.	*Hoplasaenide acapitata*	Leaf beetle	Pest
	10.	*Monolepta australis*	Red shouldered leaf beetle	Pest
	11.	*Dicladispa armigera*	Rice hispa	Pest
Curculionidae	12.	*Sitophilus oryzae*	Weevil	Pest
Dermestidae	13.	*Anthrenus sp.*	Carpet beetle	Beneficial
Hydrophilidae	14.	*Hydrophilus triangularis*	Water scavenger beetle	Beneficial
Scaravaeidae	15.	*Heteronychus lioderes*	Scarab beetle	Pest
	16.	*Phyllophaga sp.*	May beetle	Pest
Staphylinidae	17.	*Paederus dermatitis*	Rove beetle	Predator
	18.	*Xylodromus sp.*	Rove beetle	Predator
II. DIPTERA				
Ephydridae	19.	*Hydrellia philippina*	Whorl maggot	Pest
III. HEMIPTER				
Alydidae	20.	*Stenocoris sp.*	Rice bug	Pest
	21.	*Leptocorisa oratorius*	Rice water bug	Pest
Cicadellidae	22.	*Cofana spectra*	White leafhopper	Pest
	23.	*Empoasca fabae*	Leafhopper	Pest
	24.	*Nephotettix virescens*	Leafhopper	Pest
	25.	*Recilia dorsalis*	Zigzag leafhopper white backed plant	Pest
	26.	*Nephotettix nifropictus*	Hopper	Pest
Corixidae	27.	*Corixa punctata*	Water boatmen	Beneficial
Delphacidae	28.	*Nilaparvata lugens*	Brown plant hopper	Pest
	29.	*Delphacodes sp.*	Brown plant hopper	Pest
	30.	*Sogatella furcifera*	Plant hopper	Pest
Dictyopharidae	31.	*Rhynochomitra microrhina*	Green plant hopper	Pest
Miridae	32.	*Phytocoirs sp.*	Bug	Beneficial
Lygaeidae	33.	*Scolopostethus pictus*	Bug	Beneficial
Cydnidae	34.	*Pangaeus bilineatus*	Burrowing bug	Pest
Pentatomoidae	35.	*Scotinopharaco arctata*	Black bug	Pest

Continued

Pyrrhocoroidae	36.	*Dysdercus cingulatus*	Red cotton bug Assassin	Beneficial
Reduviidae	37.	*Sirthenea dimidiate*	Dansel bug	Pest
Pentatomidae	38.	*Nezara viridula*	Green Stink Bug	Pest
IV. HYMENOPTERA				
Formicidae	39.	*Solenopsis geminate*	Alate queen ant	Predator
V. ORTHOPTERA				
Acrididae	40.	*Oxya chinensis*	Rice grasshopper	Pest
Grylidae	41.	*Gryllus texensis*	Field cricket	Pest
	42.	*Anaxipha sp.*	Field cricket	Predator
Tettigoniidae	43.	*Conocephalus fasciatus*	Katydid	Predator
V. LEPIDOPTERA				
Crambidae	44.	*Scirphphaga praelata*	Moth	Pest
	45.	*Scirphphaga intertulus*	Stem borer	Pest
	46.	*Marasmia exigua*	Rice leaf roller dark-headed	Pest
	47.	*Chilo polychrysus*	Striped borer	Pest
	48.	*Chilo suppressalis*	Striped rice stem borer	Pest
Erebidae	49.	*Cretonotos gangis*	Hairy caterpillar	Pest
	50.	*Laelia coenosa*	Moth	Pest
	51.	*Orygia sp.* (*caterpillar*)	Tusock moth	Pest
Hersperiidiae	52.	*Pelopidas mathias*	Rice skipper	Pest
Sphingidae	53.	*Theretra shendurneensis*	Moth	Pest
Nymphalidae	54.	*Danaus chrysippus*	Butterfly	Beneficial
	55.	*Junonia almanac*	Butterfly	Beneficial
	56.	*Junonia atlites*	Butterfly	Beneficial
	57.	*Melanitisleda ismene*	Rice butterfly	Beneficial
Pieridae	58.	*Eurema hecabe*	Butterfly	Beneficial
Pyralidae	59.	*Cnaphalocrocis medinalis*	Rice leaf folder	Pest
VII. ODONATA				
Libellulidae	60.	*Acisoma panorpoides*	Dragonfly	Predator
	61.	*Brachythemis contaminate*	Dragonfly	Predator
	62.	*Crocothemis erythraea*	Dragonfly	Predator
	63.	*Diplacodes nebulosa*	Dragonfly	Predator
	64.	*Diplacodes trivalis*	Dragonfly	Predator
	65.	*Neurothemistullia tullia*	Dragonfly	Predator
	66.	*Orthetrum sabina*	Dragonfly	Predator
	67.	*Trithemis kirbyi kirbyi*	Dragonfly	Predator
VIII. THYSANOPTERA				
Thripidae	68.	*Stenchaetothrips biformis*	Rice thrips	Pest
XI. ARANEAE				
Araneidae	69.	*Argiope catenulate*	Orb-weaver spider	Predator
Agelenidae	70.	*Tegenaria sp.*	Spider	Predator
Nesticidae	71.	*Nesticus cellulanus*	Spider	Predator

Table 2. Species composition in different families of insects and spiders from the paddy fields.

Sr. No.	Order	Monsoon season		Summer season	
		No. of Family	No. of Species	No. of Family	No. of Species
1	Coleoptera	10	18	9	15
2.	Diptera	1	1	1	1
3.	Hemiptera	13	19	8	15
4.	Hymenoptera	1	1	0	0
5.	Orthoptera	3	4	2	2
6.	Lepidoptera	7	16	7	16
7.	Odonata	1	8	1	8
8.	Thysamoptera	1	1	1	1
9.	Aracnidae	3	3	3	3
Total		40	71	32	61

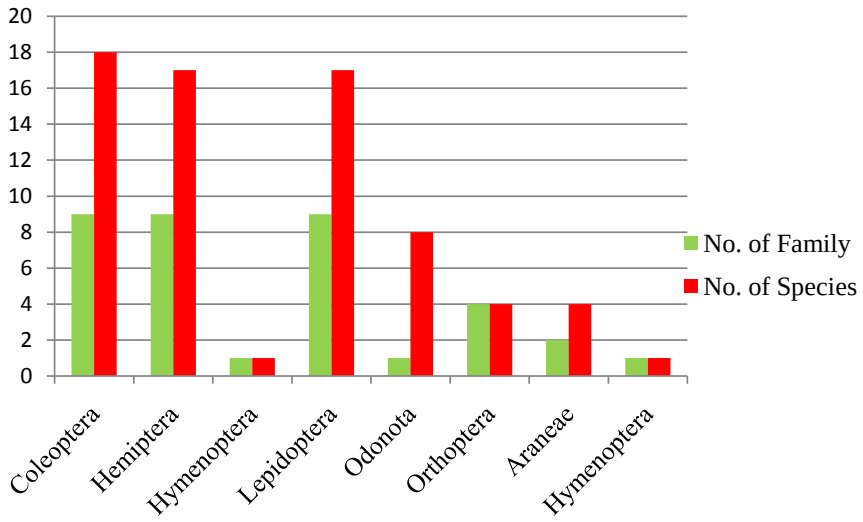

Figure 2. Species composition of family level of arthropod insect species in Taungoo environs.

In the study area of paddy field ecosystem, as relative abundance categories, most species are rare species in both monsoon (55 species) and summer (51 species) the uncommon species category was 12 species in Monsoon rice and 16 species in summer rice fields. No common species was assessed in both seasons. Actually, the spiders are not included in the insect group, here we assessed the abundance categories included with the spider species. However, this paddy field was well and sustainable ecosystem (**Table 3** and **Figure 3**).

As a agricultural aspect, In the study area of paddy field ecosystem, three growing seasons of the species number and individual numbers of insects and spiders were observed to varied in monsoon and summer rice growing seasons. During the monsoon season, the same numbers of species (69 species) was observed in

Table 3. Abundant category of recorded insect species in the study areas.

Abundance category	No. of species Monsoon	No. of species in Summer
Rare	55	51
Uncommon	12	16
Common	0	0
Frequent	2	2
Abundance	1	1
Total species	70	70

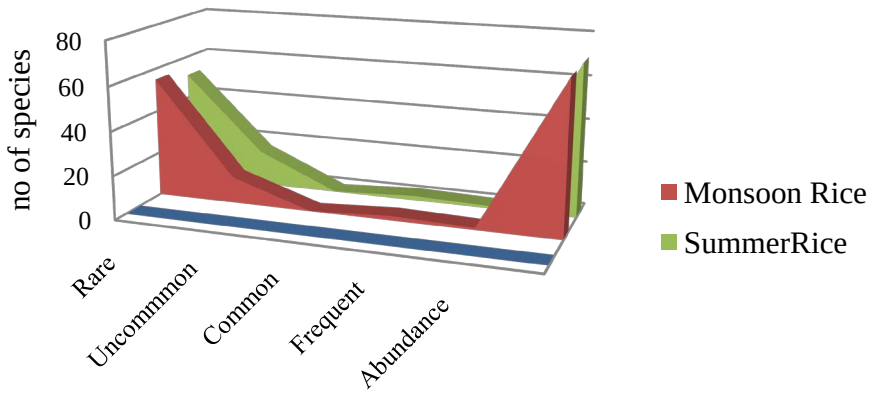

Figure 3. Abundant category of recorded insect species in the study areas.

three growing stages although particular species was found to vary with growing stages (Table 4). Total number and individual numbers of each and all observed species were logically difference in the growing stages. The different types of pest insects, such as stem borers, leaf folders, grain eaters were found with respective growing stages. Consequently, insect predator relationships between pests and carnivorous species were found to commonly specific.

According to the assessment on the Shannan species diversity index, the value was distinctly higher in monsoon season (H' = 4.52E−02, with E = 6.46E−04) than in summer season (H' = 2.5482, with E = 0.0364) respectively (Table 5). The typical values are generally between 1.5 and 3.5 in most ecological studies, the index is rarely greater than 4 according to the internet assessed. Hence, the paddy fields in the Taungoo environs were highly diverse and still healthy ecosystem.

4. Conclusion

Paddy field ecosystem located in Taungoo environs is highly diverse and still healthy ecosystem inhabiting a total of 71 insect species belonging to 40 families under eight orders, including 18 species of beetles, nine species of bugs, eight species of dragonfly, five species of butterflies, four species of leafhoppers, plant hoppers and moths, three borer and spiders, two crickets, one species of skippers, grass hopper, hispa, ant, weevil, hairy caterpillar, leaf roller, katydid, thrips,

Table 4. Comparison of insect species in different growing stages and seasons.

Growing stage	Monsoon	Rice field	Summer	Rice field
	No. of species	No. of individuals	No. of species	No. of individuals
Plantation	69	7349	59	7166
Flowering	69	17,517	63	10,116
Ripening	69	11,113	61	3521
Total numbers		35,978		20,803

Table 5. Comparative diversity value of summer and Moon son of Taungoo environ.

Scientific name	Summer Rice	*Pi*ln*Pi*	Moon Son Rice	*Pi*Ln*Pi*
1. Xestobiumrufovillosum	55	0	400	1.310E−05
2. *Heterobostrychusaequalis*	5	−3.22E−05	136	−1.390E−05
3. *Harpalusrufipes*	135	−1.04E−02	171	−1.681E−05
4. *Micraspis discolor*	110	−7.39E−03	327	−7.930E−06
5. *Aulocophorafoveicollis*	99	−6.18E−03	214	−1.836E−05
6. *Aulocophoranigripennis*	92	−5.48E−03	215	−1.839E−05
7. *Cassodaflaveola*	175	−1.58E−02	252	−1.747E−05
8. *Gastrophysaatrocyanea*	289	−3.46E−02	986	7.571E−04
9. *Hoplasaenideacapitata*	0	0.00E+00	361	3.020E−07
10. *Monoleptaaustralis*	0	0.00E+00	164	−1.633E−05
11. Dicladispa armigera	103	−6.61E−03	238	−1.807E−05
12. *Caulophilusoryzae*	11	−1.33E−04	219	−1.838E−05
13. *Anthrenus sp.*	0	0.00E+00	273	−1.589E−05
14. *Hydrophilusinquirenda*	426	−6.09E−02	1153	1.196E−03
15. *Heteronychuslioderes*	320	−4.03E−02	214	−1.836E−05
16. *Phyllophaga sp.*	215	−2.19E−02	190	−1.779E−05
17. *Paederus dermatitis*	0	0.00E+00	487	5.552E−05
18. *Xylodromus sp.*	205	−2.03E−02	183	−1.749E−05
19. *Stenocoris sp.*	337	−4.35E−02	390	9.518E−06
20. *Leptocorisaoratorius*	551	−8.60E−02	219	−1.838E−05
21. *Cofona spectra*	187	−1.76E−02	252	−1.747E−05
22. *Empoascafabae*	208	−2.08E−02	301	−1.246E−05
23. *Nephotettixvirescens*	15	−2.31E−04	315	−1.020E−05
24. *Recilia dorsaliszigzag*	15	−2.31E−04	35	−2.205E−06
25. *Corixapunctata*	0	0.00E+00	325	−8.323E−06
26. *Rhynchomitramicrorhina*	395	−5.47E−02	817	4.228E−04
27. *Phytocoirs sp.*	144	−1.15E−02	259	−1.705E−05
28. *Scolopostethuspictus*	2144	−3.18E−02	1945	4.933E−03
29. *Pangaeusbilineatus*	15	−2.31E−04	340	−5.090E−06
30. *Scotinopharacoarctata*	12	−1.52E−04	280	−1.520E−05
31. *Dysdercuscingulatus*	271	−3.14E−02	307	−1.158E−05
32. *Sirtheneadimidiata*	445	−6.46E−02	196	−1.801E−05

Continued

33. *Nephotettix nigropictus*	368	−4.94E−02	532	8.549E−05
34. *Nezara viridula*	0	0.00E+00	155	−1.563E−05
35. *Sogatella furcifera*	82	−4.51E−03	193	−1.793E−05
36. *Solenopsisgeminata*	0	0.00E+00	539	9.067E−05
37. *Oxyachinensis*	245	−2.69E−02	245	−1.781E−05
38. *Gryllustexensis*	350	−4.60E−02	211	−1.837E−05
39. *Anaxiphasp*	0	0.00E+00	1	−4.546E−09
40. *Conocephalusfasciatus*	245	−2.69E−02	280	−1.520E−05
41. *Scirphphagapraelata*	255	−2.86E−02	413	1.818E−05
42. *Scirphphaga intertulus*	198	−1.93E−02	82	−7.683E−06
43. Marasmia exigua	264	−3.01E−02	772	3.518E−04
44. *Creatonotosgangis*	209	−2.10E−02	182	−1.743E−05
45. *Laeliacoenosa*	149	−1.22E−02	137	−1.399E−05
46. *Orygia sp.*	424	−6.05E−02	350	−2.650E−06
47. Hydrellia philippina	243	−2.66E−02	77	−7.063E−06
48. *Pelopidas mathias*	708	−1.16E−01	323	−8.705E−06
49. *Theretrashendurneensis*	590	−9.37E−02	383	7.139E−06
50. *Danaus chrysippus*	589	−9.35E−02	278	−1.540E−05
51. *Junoniaalmana*	730	−1.20E−01	768	3.454E−04
52. *Junoniaatlites*	435	−6.26E−02	232	−1.825E−05
53. *Melanitis leda ismene*	336	−4.33E−02	144	−1.467E−05
54. *Euremahecabe*	458	−6.72E−02	257	−1.714E−05
55. *Chilo polychrysus*	1111	−1.73E−01	521	7.759E−05
55. *Chilo suppressalis*	1015	−1.64E−01	477	4.957E−05
56. *Cnaphalocrocis medinalis*	255	−2.86E−02	123	−1.254E−05
57. *Acisomapanorpoides*	19	−3.52E−04	102	−1.013E−05
58. *Brachythemiscontaminata*	85	−4.78E−03	69	−6.073E−06
59. *Crocothemiserythraea*	120	−8.54E−03	1985	5.199E−03
60. *Diplacodesnebulosa*	372	−5.02E−02	1011	8.157E−04
61. *Diplacodestrivalis*	446	−6.49E−02	797	3.901E−04
62. *Neurothemistulliatullia*	418	−5.93E−02	937	6.491E−04
63. *Orthetrumsabina*	808	−1.34E−01	819	4.265E−04
64. *Trithemiskirbyikirbyi*	287	−3.42E−02	1112	1.078E−03
65. *Argiopecatenulata*	323	−4.09E−02	1574	2.825E−03
66. *Argiopecatenulata*	449	−6.54E−02	1048	9.070E−04
67. *Tegenaria sp.*	463	−6.83E−02	1457	2.294E−03
68. *Nesticuscellulanus*	332	−4.26E−02	935	6.450E−04
69. Nilaparvata luges	170	−1.51E−02	776	3.58E−04
70. *Stenchaetothrips biformis*	0	0	3517	0.021787407
Total	21228	−2.50E+00	35,978	0.04520
Shannon Weiner index value	$H' = \Sigma Pi \ln Pi$	2.5482		4.52E−02
Shannon Evenness index value	$E = H' / S$	−3.57E−02		6.46E−04

maggot and water boatmen. 41 species of pest species, 18 species of predator species and 12 species of beneficial species were recorded from monsoon rice field. According to abundance category, rare species was highest (55 species) which follows uncommon species (12 species), frequent (2 species) and abundance (one species). It could be assumed as balance ecosystem. Among three growing stages, insect was collected the most in flowering stage and the lowest was in the plantation stage. In the comparison of monsoon and summer season, the most species and individual numbers were recorded in monsoon season.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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