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STUDY ON THE RELATIVE ABUNDANCE OF INSECT PESTS AND THEIR NATURAL ENEMIES ASSOCIATED IN RICE

M. M. Rahman

ABSTRACT

The field experiment was conducted at Bangladesh Agricultural University (BAU) farm in Mynmensingh during Boro season. Thirteen different rice pests viz. Short-horned grasshopper, yellow stem borer, dark-headed striped borer, pink borer, white-backed plant hopper, green leafhopper, brown Plant hopper, zigzag leafhopper, whorl maggot, long horned grasshopper, rice leaf roller, green semilooper and rice bug were recorded during the present study. Among the stem borers, yellow stem borer (*Scripophaga incertulas*) was most dominant throughout the crop season followed by the dark-headed striped borer (*Chilo polychrysa* and pink borer (*Sesamia inferens*). Green leafhopper (*Nephotettix virescens*) was the dominant species among the plant-sucking insects. The population of leaf feeding insects was quite high and their densities varied in relation to plant age and season. Local improved Pajam had lower infestation than high yielding variety BR2. Twelve natural enemies (predator/parasitiod) were recorded from the crop field. They were carabid beetle (*Ophionea nigrofaciata*), damselfly (*Agriocnemis famina famina*), ladybird beetle (*Micraspis discolor, M. crucea, Menochilous sexmaculatus*), spider (*Tetragnathus sp. Oxyopes sp.* and *Lycosa pseudoanmulata*), mirid bug (*Cyrtorhinus lividipennis*), *Tetrastichus schoenobii* and *Telenomus rowani.* The ladybird beetle *Micraspis discolor* was abundant from early to late stage of rice crops.

Key words: rice pests, natural enemies, and association with boro rice

INTRODUCTION

The continuous rice cropping in Bangladesh has created favorable situation for the insect pests. Moreover, the prevailing warm and humid conditions have favored rapid multiplication of insect pests and diseases. The estimated annual loss of rice in Bangladesh due to insect pests and disease amounts to 1.5 to 2.0 million tons (Siddique, 1992). So far, 175 species of insect pests have been recorded as rice pests of these 20-30 species are economically important (Annonymous, 2004). The rice hispa, stem borer, plant hopper, and rice ear cutting caterpillar cause serious damage to rice crop every year. Major insect pests cause about 13% yield losses to Boro, 24% to Aus and 18% to Aman crops (Anonymous, 2004). The average loss due to insect pests in Bangladesh was estimated at 18% of the expected rice crop yield per year (Alam *et al.,* 1983). Widespread use of synthetic insecticides and subsequent killing of their natural enemies encouraged rapid population and outbreak of rice pests (Kobayashi, 1961). The beneficial fauna are categorized as predators and parasitoids, collectively known as natural enemies. In most of the cases, the natural enemies are able to interact with their prey or host populations and regulate them at reasonably lower level than would occur other wise (Karim, 1992). Ninety-nine species of parasitoids and 88 species of predators of rice insect pests have been recorded in Bangladesh (Annoymous, 2004). Parasitoids that are active in the rice fields mainly belong to the Hymenoptera and Diptera orders. To avoid the undesirable effects of synthetic chemicals, it is necessary to find out an alternative method for the control of rice pests and also to keep ecological balance intact including the preservation of natural enemies. Biological control might therefore be an effective alternate method to encourage the use of natural enemies. Use of natural enemies for regulating the density of rice pests below economic injury level. Zhenxiang (1987) reported that natural enemies have been observed to keep rice plant hoppers effectively below the crop damaging level in a integrated control, for three years.

[1]Asstt. Prof. , Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka-1207.

Therefore, the protection through reasonable utilization of the natural enemies should be given priority in rice. So, to develop an effective pest management for rice pests, the present study was conducted to find out the varietals performances of local improved Pajam and high yielding rice variety BR2 in reducing pest infestation and supporting abundance of natural enemies. The study would also find out seasonal pattern of pests and its damage effects on the growth phases of rice. Identification of the prevailing parasitoids and predators of rice pests would be another out comes of the study.

MATERIALS AND METHODS

The field experiment was conducted at Bangladesh Agricultural University farm in Mymensingh during Boro season. The soil of the study area was under Brahmmaputra alluvial tract with sandy loam soil texture. The climate was characterized by high rainfall and high temperature during the kharif season. The experiment was conducted with the rice variety Pajam and BR2. The factorial experiment was laid out in a $72m^2$ plot demarcated into six equal blocks and 3m x 4m with 0.5 m gap between main plots and blocks, and 2 m spaces in borders on all sides. At first land was ploughed with a rotavator and then with a country plough followed by laddering. Experiment plots were fertilized with nitrogen, phosphate and potash at the rate of 80-60-40 kg/ha. Urea, Triple super phosphate (TSP) and Murate of potash (MP) were used as sources of N.P.K. respectively. The entire amounts of TSP, MP and $1/3^{rd}$ of urea were applied at the time of final land preparation. The rest amount of urea was top dressed in two equal splits at maximum tillering and before panicle initiation stage (BRRI, 1998). The seedling age for transplanted variety was 25 days. Two seedlings were transplanted in each hill and water levels in the study plots were maintained at 8-10 cm for about 7 days with alternate drying and irrigation for another 15 days. During vegetative and reproductive phase irrigation were applied. No pesticide was used in the experimental fields. The major pests of rice and their natural enemies (Predators and parasitoids) were collected by a sweep net (diameter 30 cm) from the top portion of the plants as well as close to the basal region of the plants. Usually ten sweeps were made to collect the adult, nymphs and larvae of insect pests and predators. The sweeping was started from 20 days after transplantation (DAT) and continued weekly up to milking stage of rice plants. Collected insects were killed in killing jar provided with cotton (ball) soaked with chloroform. Then the soft bodied insect pests and predators were preserved in 80% alcohol and identified in the departmental laboratory using available keys (BRRI, 1991). Intercultural operations required as per recommendation for rice cultivation (BRRI, 1995). Ten random sweeps per plot were made to collect the rice green leafhopper and its predators. The sweeping started from 20 days after transplantation (DAT) and continued up to 77 DAT, with 7 days interval. Samples were taken to the laboratory for counting and identifications. The statistical packages used for the analyses were Mstat and path analysis programme. The analysis of variance (ANOVA) of the results on various insect pests abundance and prey-predator association were done on the square root ($Y= \sqrt{x+0.5}$) transformed values. Their mean were separated by Duncan's' Multiple Range Test (DMRT) on insect pest attack and their natural enemies associated with indigenous rice variety, Pajam and HYV BR2 separately but both in T. Aman season.

RESULTS AND DISCUSSION

Thirteen different species of rice insect pest's viz., short-horned grasshopper, yellow stem borer, dark-headed stem borer, pink borer, white- backed plant hopper, green leaf hopper, brown plant hopper, zigzag leaf hopper, whorl maggot, long-horned grasshopper, leaf roller, green semilooper and rice bugs were recorded (Table 1). Twelve species of natural enemies e.g., carabid beetle, damsel fly, *Micraspis discolor, Micraspis crocea, Coccinella transversalis, Menochilus sexmaculatus,* spiders like, *Tetragntha sp., Oxyopes sp. and Lycosa Pseudoannulata,*

Cnaphalocrosis medinalis, Cyrtorhinus sp. *Tetrastichus* sp. and *Telenomus* sp. were also recorded during the study period (Table 1).

The abundance of available rice insect pests along with their natural enemies are shown in Table-2 (a, b, c) and 3 (a, b, c).

Table 1. The rice pests and their natural enemies recorded in this study in rice field Bangladesh Agricultural University farm with Order: family intensity of attack and nature of damage

Name of the pest/natural Enemy	Order and family	Intensity	Nature of damage
A. Insect pests			
a. Stem borer			
i.*Scirpophaga incertulas*	Lepidoptera: Pyralidae	High	Larvae feed on leaves and tillers
ii. *Chilo polychrysa*	Lepidoptera: Noctuidae	Medium	Larvae feed on leaves and tillers
iii. *Sesamia inferens*	Lepidoptera: Pyralidae	Low	Larvae feed on leaves and tillers
b. Sap suckers			
i.*Nilaparvata lugens*	Homoptera: Delphacidae	High	Nymphs and adults suck plant juice as a result hopper burn occurs
ii. *Sogatella furcifera*	Homoptera: Delphacidae	High	Nymphs and adults suck plant juice as a result hopper burn occurs
iii. *Nephotettix virescens*	Homoptera: Delphacidae	High	Nymphs and adults suck plant juice and spread rice tungro virus
iv. Rice bug- *Leptocorisa oratorius* (Fabricus)	Homoptera: Aleyrodidae	High	Nymphs and adults feed on the panicle at milking stage
v. *Recilia dorsalis*	Homoptera: Deltocephalidae	Medium	Nymphs and adults feed on stem/tiller
c. Leaf-feeders:			
i.-*Cnaphalocrosis medinalis*	Lepidoptera: Pyralidae	Low	Larvae feed on leaves
ii. *Euscyrtus concinus*	Orthoptera: Gryllidae	Low	Attack leaves of rice plants
iii. *Naraga aenescens*	Lepidoptera: Noctuidae	Low	Larvae feed on leaves
iv.*Hieroglyphus banian*	Orthoptera: Acrididae	High	Nymph and adult feed on green leaves
v. *Oxya velox*	Orthoptera: Acrididae	High	Nymphs and adults feed on green leaves
vi. *Hydrella philipina*	Diptera: Ephydridae	High	Attack newly transplanted rice plants
B. Predators:			
1..*Agriocnemis famina famina*	Odonata: Agrionidae	High	Eggs and larvae of stem borer and green leafhopper
2.*Ophionea nigrofaciata*	Coleoptera: Carabidae	High	Eggs andnymph of green leafhopper
3. Lady bird beetle			
a. *Micraspis discolor*	Coleoptera: Coccinelidae	High	Nymph of green leafhopper
b. Micraspis crocea	Coleoptera: Coccinelidae	Low	Nymph of green leafhopper
c.Menochilus exmaculatus	Coleoptera: Coccinelidae	Low	Nymph of green leafhopper
d.*Coccinella transversalis*	Coleoptera: Coccinelidae	Low	Nymph of green leafhopper
4. Spiders:			
a. *Tetragnatha sp.*	Arachnida	High	Nymph of green leafhopper and brown plant hopper
b. *Oxyopes sp.*	Arachnida	Low	Nymph of green leafhopper and brown plant hopper
c. *Lycosa pseudoannulata*	Arachnida	Medium	Nymph of green leafhopper and brown plant hopper
5. Mirid bug-*Cyrtorhinus lividipennis*	Hemiptera: Miridae	High	Egg and nymph of green leaf hopper and brown Plant hopper,
6. Parasitoides:			
a. *Telenomus rowani*	Hymenoptera: celionidae	High	egg parasitoid of yellow stem borer
b. *Tetrastichus schoenobii*	Hymenoptera: Eulophidae	High	Egg parasitoid of yellow stem borer

Pest abundance in pajam variety

From the table 2 (a, b and c), it was observed that the short-horned grasshopper was more abundant from 42 to 56 DAT and the highest population (17.20) was recorded at 49 DAT. Among the borers, *Scirpophaga incertulas* (YSB) was present in the study plots from the vegetative to reproductive stages of rice plants at 21-77 DAT, but the maximum infestation (2.0) occurred during 49 DAT. The *Sesamia inferens* (PB) and *Chilo polychrysa* (whsb) were also abundant most of the time. However their main infestation occurred during the similar period (49 DAT) as of *S. incertulas*. Among the rice hoppers, the presence of white-backed plant hopper (WBPH) was observed all the time at vegetative stages of rice plants and also during most of the reproductive stages (up to 70 DAT). The incidence of green leafhoppers (GLH) and brown plant hopper (BPH) in rice was statistically comparable during the entire growing periods and the presence of zigzag leafhopper (Zglh) was dominant at vegetative phase i.e., at 28 DAT (Table 2c). The presence of whorl maggot (Wm) was highest at 28 DAT (9.80). The abundance of rice bug (Rb)was normally absent during the vegetative phase and highest presence (11.20) was recorded at 77 DAT (Table 2b). Long-horned grasshopper (Lhgh) *Euxcyrtus concinnus* was found to attack on young rice plants during 21-28 DAT (Table 2b).

Table 2(a). Rice insect pest infestation and their natural enemies collected by sweeping method from the study plot of BAU experimental farm in T. amon season recorded from Pajam variety at different days after transplanting (DAT)

Observation at Days after Transplanting (DAT)	Average number of insects per ten sweeps								
	SHGH	YSB	Dhsb	CarBt	Dfly	WBPH	GLH	BPH	PB
21 DAT	14.00ab (3.79)	0.80ab (1.09)	0.40a (0.91)	2.40a (1.68)	5.00a (2.33)	1.60a (1.37)	1.20a (1.26)	0.80a (1.90)	0.40b (0.91)
28 DAT	5.00c (2.34)	0.40b (0.91)	0.00a (0.71)	1.20abc (1.22)	1.20b (1.22)	1.00ab (1.16)	0.80a (1.06)	0.60a (0.99)	0.00 (0.71)
35 DAT	2.00d (1.57)	1.20ab (1.26)	0.60a (0.99)	0.00c (0.71)	1.40b (1.32)	2.40a (1.63)	2.00a (1.50)	1.00e (1.12)	2.00a (1.51)
42DAT	12.00b (3.51)	1.00ab (1.16)	0.60a (0.99)	1.20ab (1.26)	1.40b (1.37)	1.40a (1.37)	0.80a (1.09)	1.00a (1.16)	0.00b (0.71)
49 DAT	17.20a (4.18)	2.00a (1.49)	1.20a (1.22)	1.00abc (1.16)	1.80b (1.40)	1.00ab (1.16)	0.80a (1.09)	0.80a (1.09)	2.00a (1.44)
56 DAT	12.80ab (3.62)	1.40ab (1.32)	0.60a (1.02)	1.00abc (1.16)	0.80b (1.09)	1.00ab (1.19)	0.60a (0.98)	1.00a (1.16)	0.00a (0.71)
63 DAT	5.20c (2.36)	0.40b (0.91)	1.00a (1.15)	1.20ab (1.26)	1.60b (1.39)	1.00ab (1.12)	1.40a (1.37)	0.80a (1.09)	1.00ab (1.16)
70 DAT	4.60cd (2.14)	1.00a (1.15)	1.40a (1.27)	1.60ab (1.44)	1.40b (1.32)	1.40a (1.32)	1.00a (1.19)	0.40a (0.91)	0.20b (0.81)
77 DAT	3.20dc (1.90)	0.40b (0.88)	0.40a (0.91)	0.40bc (0.91)	2.20b (1.48)	0.00b (0.71)	1.40a (1.29)	0.00a (0.71)	0.00b (0.71)
Sx	0.192	0.167	0.177	0.167	0.219	0.174	0.178	0.163	0.158

Shgh = Short horned grasshopper, Ysb = Yellow stem borer, Dhsb = Dark-headed striped borer,
Carbtl= Carabid beetle, Dfly = Damselfly, Wph = White backed planthopper,
Glh= Green leafhopper, Bph = Brown plant hopper, Pb = Pink borer

In a column, the figures having different alphabets are significantly different at 5% level of Probability.
DAT= Days after transplantation
Original data were transformed into square root (Y=✓X+0.5) values before ANOVA and DMRT. The corresponding square roots are given in parenthesis.

Table 2b. Rice insect pest infestation and their natural enemies collected by sweeping method from the study plot of BAU experimental farm in T. amon season recorded from Pajam variety at different days after transplanting (DAT)

Observation at Days after Transplanting (DAT)	Average number of insects per ten sweeps							
	Lr	Cl	Gs	Ts	Tr	Wm	Lhgh	Rb
21 DAT	0.40a (0.91)	0.80a (1.09)	0.40a (0.91)	1.00bcd (1.15)	2.20a (1.61)	9.80a (3.20)	1.80ab (1.50)	0.00c (0.71)
28 DAT	0.40a (0.91)	0.00b (0.71)	0.00b (0.71)	0.80cd (1.09)	0.00b (0.71)	8.60a (2.99	0.00d (0.71)	0.00e (0.71)
35 DAT	0.60a (0.99)	0.00b (0.71)	0.00b (1.19)	0.00d (0.71)	0.00b (0.71)	3.80b (2.07)	0.00d (0.71)	0.00e (0.71)
42 DAT	0.20a (0.81)	0.40ab (0.91)	0.00b (0.71)	3.60a (1.95)	2.40a (1.63)	9.60a (3.15)	0.00d (0.71)	0.00e (0.71)
49 DAT	0.40a (0.91)	0.00b (0.71)	0.00b (0.71)	1.20bcd (1.22)	2.20a (1.57)	2.00c (1.45)	0.40c (0.91)	0.00e (0.71)
56 DAT	0.40a (0.88)	0.40ab (0.91)	0.00b (0.71)	2.20abc (1.63)	1.20ab (1.22)	4.60b (2.24)	2.40a (1.68)	1.80d (1.50)
63 DAT	0.20a (0.81)	0.20ab (0.81)	0.00b (0.71)	1.00bcd (1.16)	1.20ab (1.22)	3.80b (2.02)	1.00bc (1.16)	5.60c (2.43)
70 DAT	0.60a (1.02)	0.60a (0.99)	0.20ab (0.81)	2.80ab (1.76)	0.80ab (1.09)	3.00bc (1.86)	0.80cd (1.04)	15.60a (4.01)
77 DAT	0.60a (0.99)	0.00b (0.71)	0.00b (0.71)	1.80abc (1.40)	1.00ab (1.16)	0.00d (0.71)	0.00d (1.49)	11.20b (3.39)
Sx	0.141	0.111	0.053	0.204	0.188	0.172	0.133	0.118

LR = Leaf roller, Cl = *Cyrtorhinus lividipennis*, Gs = Green semilooper,
Ts = *Tetrastichus schoenobii*, Tr = *Telenomus rowani*, Wm= Whorl maggot,
Lhgh = Long horned grasshopper, Rb = Rice bug

In a column, the figures having different alphabets are significantly different at 5% level of Probability.
DAT= Days after transplantation

Original data were transformed into square root (Y=✓X+0.5) values before ANOVA and DMRT. The corresponding square root values are given in parenthesis.

Table 2c. Rice insect pest infestation and their natural enemies collected by sweeping method from the study plot of BAU experimental farm in T. amon season recorded from Pajam variety at different days after transplanting (DAT)

Observation at Days after Transplanting (DAT)	Average number of insects per ten sweeps							
	Zglh	Md	Mc	Ct	Ms	SP1	SP2	SP3
21 DAT	0.40 (0.91)	40.40a (6.38)	0.60ab (0.99)	0.00b (0.71)	0.00b (0.71)	0.80a (1.09)	1.20a (1.22)	0.00b (0.71)
28 DAT	1.60a (1.39)	10.40ab (3.27)	1.00a (1.19)	0.40ab (0.88)	0.00b (0.71)	0.40a (0.91)	0.40ab (0.91)	0.00a (0.71)
35 DAT	0.40bc (0.71)	4.40cd (2.21)	0.80a (1.09)	0.00b (0.71)	0.00a (0.71)	0.00a (0.71)	0.40bc (0.88)	1.00a (1.16)
42 DAT	0.80ab (1.12)	1.20e (1.22)	0.60ab (0.99)	0.40ab (0.91)	0.00b (0.71)	0.40a (0.91)	0.80ab (1.09)	0.80ab (1.09)
49 DAT	0.80abc (1.09)	2.40d (1.62)	0.00b (0.71)	0.00b (0.71)	0.80a (1.09)	1.00a (1.16)	0.80ab (1.09)	0.00b (0.71)
56 DAT	0.00c (0.71)	2.00c (1.56)	0.00b (0.71)	0.00b (0.71)	0.00b (0.71)	0.00a (0.71)	0.00b (0.71)	0.00b (0.71)
63 DAT	1.00ab (1.19)	0.60e (0.99)	0.00b (0.71)	0.00b (0.71)	0.00b (0.71)	0.60a (0.99)	0.40ab (0.91)	0.20ab (0.81)
70 DAT	0.00c (0.71)	5.20c (2.30)	0.00b (0.71)	0.80a (1.09)	0.00b (0.71)	0.60a (0.99)	0.60ab (1.02)	0.60a (0.97)
77 DAT	0.00c (0.71)	5.00c (2.31)	0.00b (0.71)	0.00b (0.71)	0.00b (0.71)	0.00a (0.71)	0.00b (0.71)	1.00ab (1.22)
Sx	0.124	0.206	0.108	0.091	0.057	0.142	0.141	0.133

N.B.

Zglh = Zigzag leafhopper, Md= *Micraspis discolor*,
Mc = *Micraspis crucea*, Ct = *Coccinella transversalis*,
Ms = *Menochellus sexmemulatus*, SP-1 = *Tetragnatha sp*,
Sp-2 = *Oxypes sp*, Sp-3 = *Lycosa sp*

In a column, the figures having different alphabets are significantly different at 5% level of Probability.

DAT= Days after transplantation

Original data were transformed into square root (Y=✓X+0.5) values before ANOVA and DMRT. The corresponding square root values are given in parenthesis.

PEST ABUNDANCE IN BR2 VARIETY

In the variety BR2, short-horned grasshopper was present in the fields and its highest infestation (31.00) was observed at 49 DAT (Table 3 a). The presence of yellow stem borer *(Scirpophaga incertulas)* was higher at vegetative and reproductive stages. The highest infestation (3.20) was found at 49 DAT (Table 3a). The abundance of Dark headed stem borer *Chilo polychrysa* was also highest (2.60) at 49 DAT, but it was abundant from 28 DAT to 77 DAT (Table 3a). The pink

borer infestation was low all over the period and the highest infestation (2.00) was recorded at 35 DAT. Brown plant hopper (BPH) was observed during 21 to 63 DAT and the highest incidence (3.20) was observed at reproductive phase (56 DAT). Arif (1976) reported that the population of brown plant hopper increases gradually from the vegetative phase, which might be in agreement with the present findings. The presence of whorl maggot was highest at 28 DAT (13.00) (Table 3c). The abundance of rice bug was normally absent during the vegetative phase and the highest presence (9.00) was recorded at 77 DAT. Long-horned grasshopper, was found to attack on young rice plants (21-28 DAT) (Table 3c).

In present experiment, three species of spiders were found in rice fields. These are *Lycosa pseudoannulata* (Sp_1), *Tetragnatha maxillosa* (Sp_2), and *Oxyopes sp.* (Sp_3) *Lycosa pseudoannulata* was more abundant with their prey brown plant hopper at reproductive phase 56 to 63 DAT followed by *Tetragnatha maxillosa.* Four species of ladybird beetle, namely *Micraspis discolor* (Md), *M. crocea(*Mc*), Menochilus sexmaculatus* (Ms) and *Coccinella transversalis*(Ct) were also recorded (Table 3b). The *Micraspis discolor* was abundant from early to late stage of rice crops. Carabid beetle(Carbt), green mirid bug(Mb) and damselfly (Dfly) were also recorded as predators in the rice fields (Table 3a)

Table 3(a). Rice insect pest infestation and their natural enemies collected by sweeping method from the study plot of BAU experimental farm in T. amon season recorded from Pajam variety at different days after transplanting (DAT)

Observation at Days after Transplanting (DAT)	Observation at Days after Transplanting (DAT)								
	SHGH	YSB	Dhsb	CarBt	Dfly	WBPH	GLH	BPH	PB
21 DAT	15.40bcde (3.97)	0.80bc (1.09)	0.00b (0.99)	1.80ab (1.40)	3.20b (1.86)	10.20a (3.22)	4.60a (2.20)	1.20bc (1.26)	0.60b (0.99)
28 DAT	24.40ab (4.91)	0.00c (0.71)	0.60ab (1.02)	2.40a (1.68)	0.00c (0.71)	4.60b (2.22)	2.40abc (1.68)	2.60ab (1.75)	1.20b (1.22)
35 DAT	12.00cde (3.53)	1.60ab (1.44)	0.60ab (1.02)	1.20abc (1.30)	6.00a (2.54)	2.0bcd (1.57)	1.00c (1.16)	0.80c (1.06)	2.00a (1.57)
24 DAT	15.20b (3.92)	0.60bc (1.02)	0.40ab (0.91)	0.00c (0.71)	3.40ab (1.94)	1.00cb (1.16)	1.40bc (1.37)	1.20cd (1.22)	0.00a (0.71)
49 DAT	20.00abc (4.44)	3.20a (1.80)	2.60a (1.71)	1.00abc (1.16)	1.80b (1.42)	1.60ed (1.39)	1.00c (1.16)	0.40cd (0.88)	0.00a (0.71)
56 DAT	31.00a (5.53)	1.40ab (1.34)	1.20ab (1.26)	2.20ab (1.48)	2.20b (1.63)	1.00cd (1.16)	1.20bc (1.22)	3.20a (1.87)	0.00e (0.71)
63 DAT	25.40ab (4.96)	1.20abc (1.26)	0.80ab (1.09)	01.80ab (1.09)	1.80b (1.48)	2.40bc (1.68)	3.0ab (1.83)	3.00a (1.82)	0.60b (0.99)
70 DAT	9.40dc (3.13)	2.40a (1.68)	1.20ab (1.22)	0.00c (0.71)	2.60b (1.72)	2.40ed (1.62)	1.00c (1.16)	0.00d (0.71)	0.00c (0.71)
77 DAT	8.20e (2.92)	1.20abc (1.26)	0.60ab (1.02)	0.40bc (0.91)	4.40bc (2.06)	0.60d (0.99)	1.20bc (1.26)	0.00d (0.71)	0.00c (0.71)
Sx	0.383	0.176	0.272	0.189	0.202	0.171	0.194	0.208	0.106

Shgh = Short horned grasshopper,
Dhsb = Dark-headed striped borer,
Dfly = Damselfly,
Glh= Green leafhopper,
Pb = Pink borer

Ysb = Yellow stem borer,
Carbtl= Carabid beetle,
Wph = White backed planthopper,
Bph = Brown plant hopper,

In a column, the figures having different alphabets are significantly different at 5% level of Probability. DAT= Days after transplantation
Original data were transformed into square root (Y=X+0.5) values before ANOVA and DMRT. The corresponding square roots are given in parenthesis.

Table 3b. Rice insect pest infestation and their natural enemies collected by sweeping method from the study plot of BAU experimental farm in T. amon season recorded from Pajam variety at different days after transplanting (DAT)

Observation at Days after Transplanting (DAT)	Average number of insects per ten sweeps							
	ZgZag	Md	Mc	Ct	Ms	SP1	SP2	SP3
21 DAT	0.80a (1.09)	12.00b (3.50)	0.80a (1.09)	0.00b (0.71)	0.00b (0.71)	1.20ab (1.26)	0.40ed (0.91)	0.40b (0.91)
28 DAT	0.40b (0.91)	34.00a (5.83)	0.00b (0.71)	0.80a (1.09)	0.40a (0.91)	0.00c (0.71)	1.00bcd (1.16)	0.00b (0.71)
35 DAT	0.40b (0.91)	31.00a (5.54)	0.00b (0.71)	1.00a (1.19)	0.00b (0.71)	0.40bc (0.91)	0.60bc (0.99)	0.00b (0.71)
42 DAT	0.40b (0.91)	3.60de (1.83)	0.00b (0.71)	0.00b (0.71)	0.40ab (0.91)	0.80bc (1.09)	0.40cd (0.91)	0.00b (0.71)
49 DAT	0.00b (0.71)	1.40e (1.32)	0.00b (0.71)	0.00b (0.71)	0.00b (0.71)	2.40a (1.62)	0.40cd (0.91)	0.00b (0.71)
56 DAT	2.20a (1.48)	3.00dc (1.83)	0.00b (0.71)	0.00b (0.71)	1.00a (1.12)	1.00abc (0.81)	3.00a (1.80)	0.00b (0.71)
63 DAT	0.80ab (1.09)	2.00dc (1.57)	0.00b (0.71)	0.80b (1.09)	0.40ab (0.91)	0.40bc (0.91)	2.00acb (1.55)	1.00a (1.19)
70 DAT	0.00b (0.71)	5.40cd (2.41)	0.00b (0.71)	0.00b (0.71)	1.20a (1.26)	0.40bc (0.91)	1.20bc (1.26)	1.00a (1.19)
77 DAT	0.00b (0.71)	10.00bc (3.68)	0.00b (0.71)	0.00b (0.71)	0.00b (0.71)	0.60bc (0.99)	0.00d (0.71)	0.00b (0.71)
Sx	0.159	0.281	0.057	0.095	0.117	0.163	0.148	0.08

Zglh = Zigzag leafhopper, Md= *Micraspis discolor*, Mc =*Micraspis crucea*,
Ct = *Coccinella transversalis*, Ms = *Menochellus sexmemulatus*, SP-1 =*Lycosa sp,*
Sp-2 = *Tetragnatha sp*, Sp-3 = *Oxypes sp*,

In a column, the figures having different alphabets are significantly different at 5% level of Probability.
DAT= Days after transplantation

Original data were transformed into square root (Y=✓X+0.5) values before ANOVA and DMRT. The corresponding square root values are given in parenthesis.

Table 3c. Rice insect pest infestation and their natural enemies collected by sweeping method from the study plot of BAU experimental farm in T. amon season recorded from Pajam variety at different days after transplanting (DAT)

Observation at Days after Transplanting (DAT)	Average number of insects per ten sweeps							
	Lr	Cl	Gs	Ts	Tr	Wm	Lhgh	Rb
21 DAT	80a (1.09)	0.20ab (0.81)	0.80a (1.09)	12.40a (3.55)	5.20a (2. 36)	9.20ab (3.10)	3.20a (1.79)	0.00c (0.71)
28 DAT	0.40a (0.91)	0.60ab (1.02)	0.00b (0.71)	1.20bc (1.26)	0.00c (0.71)	13.00a (3.56)	2.20a (1.83)	0.00c (0.71)
35 DAT	0.00a (0.71)	0.00b (0.71)	0.00b (0.71)	0.80bc (1.06)	0.00c (0.71)	12.40a (3.55)	0.00b (0.71)	0.00c (0.71)
42 DAT	0.60a (0.99)	0.40ab (0.91)	0.00b (0.71)	1.00bc (1.16)	2.00b (1.57)	2.40d (1.70)	0.00b (0.71)	0.00c (0.71)
49 DAT	0.20a (0.81)	0.00b (0.71)	0.00b (0.71)	0.60bc (1.02)	1.60b (1.43)	9.00ab (2.95)	0.00b (0.71)	0.00c (0.71)
56 DAT	0.80a (1.09)	0.40ab (0.91)	0.00b (0.71)	1.40bc (1.32)	1.00b (1.19)	7.00abc (2.69)	0.00b (0.71)	0.60c (1.02)
63 DAT	0.60a (0.99)	0.20ab (0.81)	0.00b (0.71)	0.00c (0.71)	1.20b (1.26)	3.40cd (1.94)	0.00b (0.71)	3.40b (1.94)
70 DAT	1.00a (1.16)	0.00b (0.71)	0.40ab (0.91)	1.80b (1.45)	1.40b (1.32)	4.60bcd (2.25)	0.00b (0.71)	0.00c (0.71)
77 DAT	0.00a (0.71)	0.80a (1.09)	0.00b (0.71)	0.00c (0.71)	4.40a (2.17)	3.40cd (1.83)	1.00b (1.16)	9.00a (3.06)
Sx	0.150	0.10	0.07	0.194	0.146	0.297	0.158	0.10

LR = Leaf roller, Cl = *Cyrtorhinus lividipennis*, Gs = Green semilooper, Ts = *Tetrastichus schoenobii*, Tr = *Telenomus rowani*, Wm= Whorl maggot, Lhgh = Long horned grasshopper, Rb = Rice

In a column, the figures having different alphabets are significantly different at 5% level of Probability.
DAT= Days after transplantation

Original data were transformed into square root (Y=✓X+0.5) values before ANOVA and DMRT. The corresponding square root values are given in parenthsis.

It may be concluded from the study that among the borer *Scirpophaga incertulas* occur abundantly followed by *Chilo polychrysa* with medium intensity and *Sesamia inferens* have low level of intensity. All the sap sucker viz. White-backed plant hopper (WBPH), Green leaf hopper (GLH) and Brown plant hopper (BPH) had high level of intensity except *Recilia dorsalis* with medium level of intensity of attack. Among the listed leaf feeder 50% of them had high level of intensity of attack. Two recorded parasitoids, *Telenomus rowani* and *Tetragnatha schoenobii* occurred with high intensity.

Incidence of predators like spiders and lady bird beetles appeared with high to low intensity. Numerically higher infestation of insect pests and their natural enemies recorded in HYV of rice (BR2) compared to those of indigenous rice variety Pajam.

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