Effects of habitats, growth stages and weather factors on arthropod insect pests and natural enemies

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Abstract: A study was conducted at Agricultural Farm of Patuakhali Science and Technology University during January to June 2012, to determine the effects of habitats, growth stages and weather factors on arthropods insect pests and natural enemies. Results revealed that **7** different insect pests and 7 different natural enemies were recorded from the rice habitats. Among the different habitats total number of insect pests was highest in rice-rice habitat (1045 insect pests/160 sweeps and was lowest in rice-sesame habitat (762 insect pests/160 sweeps). Total number of natural enemies was found highest in rice-tree habitat (636 natural enemies/160 sweeps) and lowest in rice-maize habitat (553 natural enemies/160 sweeps). In case of different rice growth stages, highest number of insect pests was found in panicle initiation stage (1808 insect pests/160 sweeps) and lowest number was in early tillering stage (131 insect pests/160 sweeps). Highest number of natural enemies was found in seedling stage (1026 natural enemies/160 sweeps) and lowest number was in early tillering stage (386 natural enemies/160 sweeps). Arthropod insect pest and natural enemy populations varied with different temperature (^{0}c) and relative humidity (%). Populations of rice bug and grasshoppers were maximum at 25.2^{0}C temperature while populations of leafhoppers and rice hispa were found to be higher at 29.3^{0}C. At 34.8^{0}C temperature, stink bug attained its peak population while at 35.3^{0}C temperature, grasshoppers had highest populations. In case of natural enemies, maximum populations of ichneumonids was at 25.2^{0}C temperature and again at 29.3^{0}C followed by ground beetle at 34.8^{0}C. Populations of lady bird beetle was maximum at 35.3^{0}C. Populations of rice bug, grasshoppers and stink bugs were maximum at lowest percent (46%) relative humidity while populations of leafhoppers grasshoppers and rice hispa were maximum at highest percent (77%) relative humidity. In case of natural enemies, populations of ichneumonids and ground beetle were maximum at 46% relative humidity while population of lady bird beetle was maximum at 77% and 74% relative humidity, respectively.

Key words: Growth stage, habitat, insect pest, natural enemies, weather factors.

Introduction

Bangladesh is an agricultural country and its agriculture is predominantly rice based. The average yield of rice in Bangladesh is quite low which is 2.5 Mt/ha (BBS, 2007) compared to other rice growing countries like China (6.23 Mt/ha), Korea (6.59 Mt/ha), Japan (6.79 Mt/ha) and USA (7.04 Mt/ha), respectively (FAO, 2004). The majority of rice growing area is covered by boro rice comprising 58% of the total rice area. Boro rice covers an area of 4.47 million hectares with a production of 18.06 million tons of rice (BBS, 2011). Rice is grown all the year round in Bangladesh, and so, rice is an ideal host for many insect pest species. So far, 175 species of insect pests have been identified on rice from the time of sowing to harvest (Kamal, 1998). Among them only 20 species are considered as pest (Pathak, 1968) and 20-30 species are economically important (Miah and Karim, 1984). Among these pest species, several of them were considered as minor pests, which have become major pests (Pathak and Pawar, 1982). Major pests cause about 13% yield losses to Boro, 24% to Aus and 28% to Aman crops (BRRI, 1985).

All of the fauna present in the rice fields are not harmful. Many of them are beneficial. These beneficial fauna categorized as predators and parasites, collectively known as natural enemies. In most of the cases, natural enemies are able to interact with their prey or host populations and regulate them at reasonably lower level than would occur otherwise. Ninety nine species of parasites and 88 species of predators of rice arthropods have been recorded in Bangladesh (Wahiduzzaman, 1993). Some studies have suggested that the size and composition of non-rice habitats adjacent to rice fields may have positive effects on natural enemies in rice fields (Xiaoping *et al*., 1995). As the population development of some species in rice fields seems to be related to non-rice habitats adjacent to rice fields (Chiu, 1979). Undoubtedly the biodiversity of fauna and flora exerts an important role in integrated pest management of rice (Way and Heong, 1994). Considering the above facts, the present study was undertaken to assess the incidence and population density of arthropod insect pest and natural enemies in relation to rice growth stages, habitat and weather factors.

Materials and Methods

Experiments were conducted to determine the incidence and population density of rice arthropod population in rice fields as influenced by neighboring crops and different rice growth stages in relation to weather factors at the experimental farm of Patuakhali Science and Technology University, Dumki under Patuakhali district during the period from January to June 2012 in Boro rice. The study site consisted of a diverse habitat. A variety of non-rice crops viz. Sesame, Maize etc. was grown widely adjacent to rice field. These were: (a) Rice field adjacent to Sesame field designated as rice-sesame habitat, (b) Rice field adjacent to Maize field designated as rice-maize habitat, (c) Rice field adjacent to trees designated as rice-tree habitat and (d) Rice field adjacent to rice field designated as rice-rice habitat. The rice variety BRRIdhan 29 was grown in all the experimental fields in boro season. Crop management was done properly by the farm labours of Patuakhali Science and Technology University.

Collection of insect samples and their identification: The insect pests of rice and their natural enemies were collected by a fine nylon cloth sweep net (30 cm diameter). Sweeping was done from the plant canopy level including the interspaces between plants as well as close to basal region of the plants as far as possible. In each field, l0 complete sweeps were made to collect the insect pests and their natural enemies. Sampling was done at four stages of rice viz. seedling, early tillering, maximum tillering and panicle initiation stage. Sampling was done during morning hours at all study fields on all sampling dates. The insect pests and nafural enemies of l0 complete sweeps from each field were collected separately in labeled container. The collected samples were properly preserved, identified, sorted and counted in the laboratory. The samples were identified under magnifying glass.

Statistical analysis: The data collected on different parameters used in the experiment were statistically analyzed to obtain the level of significance using the MSTAT-C computer package programme developed by Russell (1986). The analysis of variance (ANOVA) of the results on various insect pests and natural enemies was done after square root transformation ($y=\sqrt{x}$). The significant means were compared by LSD test.

Results and Discussion

Incidence of insect pests and natural enemies in rice habitat: The incidence of insect pests and natural enemies was observed from January to June 2012 i.e. boro season in the experimental rice fields of the study site. There were seven rice pests viz. grasshoppers (*Oxya and Ucirtus spp*.), ricebug (*Leptocorisa acuta)*, stink bug (*Nezara viridula*), leafhopper (*Nilaparvata lugens*), cricket (Grylidae, Orthoptera), rice hispa (*Dicladispa armigera*) rice yellow stem borer (*Scirpophaga incertulas*) and seven natural enemies namely, ladybird beetle (*Micraspis spp*.), damselfly (*Agriocnemis spp*), dragonfly (*Aeshna spp*), ichneumonid wasp (*Xanthopimpla spp*.), spider (*Araneus spp*.), ground beetle (*Calosoma spp*) and dipteran fly were recorded from the site during the study period. The insect pests and natural enemies recorded are given in Table 1.

Number of arthropod insect pest and natural enemies in rice and neighbouring plant habitat: Populations of arthropod insect pests and natural enemies in four rice habitats viz. rice-maize, rice-sesame, rice-tree and rice-rice are presented in Table 2. In case of habitats, significantly the highest number of insect pests was observed in rice-rice habitat (1045) which was statistically similar with rice-tree habitat (1021) and the lowest number was in rice-sesame habitat (762) followed by rice-maize habitat (769). In case of natural enemies, no significant difference was observed in all habitats while the highest number of natural enemies was in rice-tree habitat (636) followed by rice-sesame (620) and lowest was in rice-maize (553) followed by rice-rice (555) habitats (Table 2).

Table 1: Incidence of observed insect pests and natural enemies in rice habitat

Name of insect pest and natural enemies		Family	Order
Insect Pests			
1.	Grasshopper (short and long horned)	Acrididae and Tettigoniidae	Orthoptera
2.	Ricebug	Alydidae	Hemiptera
3.	Stink bug	Pentatomidae	Hemiptera
4.	Leafhopper	Cicadellidae	Homoptera
5.	Cricket	Gryllidae	Orthoptera
6.	Rice hispa	Chrysomelidae	Coleoptera
7.	Rice yellow stem borers	Pyralidae	Lepidoptera
Natural enemies			
1.	Lady bird beetle	Coccinelidae	Coleoptera
2.	Damselfly	Aeshnidae	Odonata
3.	Dragonfly	Coenagrioniidae	Odonata
4.	Ichneumonid wasp	Ichneumonidae	Hymenoptera
5.	Spider (Lynx, Longed jawed, Orab spider)	Araneidae	Araneae
6.	Ground beetle	Carabidae	Coleoptera
7.	Dipteran fly		Diptera

Number of insect pests and natural enemies in different growth stages of boro rice habitat: In case of rice growth stages, total number of insect pest was highest in panicle initiation stage (1808), followed by maximum tillering (908) while the lowest was in early tillering (131) stage followed by seedling (750) stage. On the other hand, significantly the highest number of natural enemies was in seedling stage (1026). No significant differences were observed in the number of natural enemies in maximum tillering (493), panicle initiation (459) and early tillering (386) stages (Table 3).

Table 2. Populations of insect pests and natural enemies in different rice and neighbouring plant habitats in Boro season

Habitats	No. of insect pests/ 160 complete sweeps	No. of natural enemies/ 160 complete sweeps
Rice – Maize	769b	553
Rice – esame	762b	620
Rice – Tree	1021a	636
Rice – Rice	1045a	555
LSD	8.75	NS
CV (%)	12.15	9.16

Effect of temperature on arthropods insect pests and natural enemies in rice habitat

Insect pests: Among insect pests, population of ricebug attained the maximum peak (16 ricebugs/10 sweeps) followed by grasshopper (12 grasshopper/10 sweeps), stink bug (9.5 stink bugs/10 sweeps), cricket (8 crickets/10 sweeps) and stem borer (7 stem boers/10 sweeps). The lowest population was of rice hispa (1 hispa/10 sweeps) followed by leafhoppers (5 leafhoppers/10 sweeps) at 25.2^{0}C temperature.

Table 3. Population of insect pests and natural enemies in different growth stages of boro rice habitat

Growth stages	Number of insect pests/ 160 complete sweeps	Number of natural enemies/ 160 complete sweeps
Seedling	750c	1026a
Early tillering	131d	386b
Maximum tillering	908b	493b
Panicle initiation	1808a	459b
LSD	10.15	7.69
CV (%)	8.15	6.11

At 29.3^{0}C temperature, leafhoppers showed the highest number of population (11 leafhoppers/10 sweeps) followed by grasshopper (8 grasshoppers/10 sweeps) and rice hispa (8 rice hispa/10 sweeps). The population of stem borer was lowest (1 stem borer/10 sweeps) followed by cricket (3 crickets/10 sweeps), stink bug (5 stink bugs / 10 sweeps) and rice bug (6 rice bugs/10 sweeps). At 35.3^{0}C temperature, Grasshoppers showed the highest number of population (12 crickets/10 sweeps) followed by

stink bug (4 stink bugs/10 sweeps) and rice bug (5 rice bugs/10 sweeps). The population was in cricket (2 crickets/10 sweeps) followed by leafhopper (3 hoppers /10 sweeps), rice hispa (3.5 rice hispa/10 sweeps) and stem borer (3.5 stem borer/10 sweeps) population. At 34.8^{0}C temperature, stink bug showed the highest number of population (11 bugs /10 sweeps) followed by grasshopper (7 grasshoppers/10 sweeps), leafhopper (7 leafhoppers/10 sweeps) and rice bug (6 rice bugs/10 sweeps). The lowest population was in stem borer (3 stem borers/10 sweeps) followed by rice hispa (4 rice hispa/10 sweeps) and cricket (5 crickets/10 sweeps) (Fig. 1).

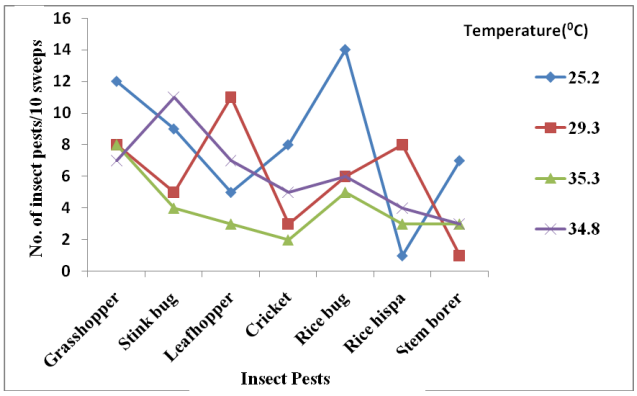

Fig. 1. Influence of temperature on arthropod insect pests

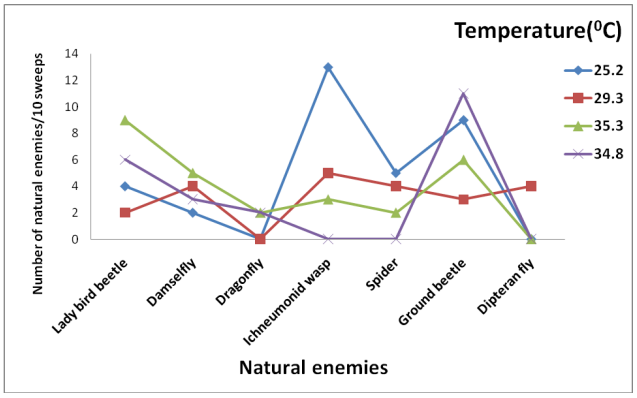

Fig. 2. Influence of temperature on arthropod natural enemies

Natural enemies: At 25.2^{0}C temperature, among different natural enemies ichneumonid wasp showed the highest number of population (13 wasps/10 sweeps) followed by ground beetle (9 ground beetles/10 sweeps) and spider (5 spiders/10 sweeps) while the lowest was in damselfly (2 damselflies/10 sweeps) followed by lady bird beetle (4 lady bird beetles/10 sweeps). No populations of dragonfly and dipteran fly were recorded in this temperature. At 29.3^{0}C temperature, among different natural enemies ichneumonid wasp also showed the highest number of population (6 wasps/10 sweeps) followed by spider (5 spiders/10 sweeps), dipteran fly (4 dipteran fly/10 sweeps) and damselfly (4 damselflies/10 sweeps) whereas the lowest population was in lady bird beetle (2 lady bird beetles/10 sweeps) followed by ground beetle (3 ground beetles/10 sweeps). No population of dragonfly was found in this temperature. At 35.3^{0}C temperature, among different natural enemies lady bird beetle showed the highest number of population (9 beetles/10 sweeps) followed by ground beetle (6 ground beetles/10 sweeps) and damselfly (5 damselflies/10 sweeps). Spider and dragonfly had lowest population (3 of each/10 sweeps) followed by ichneumonid (3.5/10 sweeps). At 34.8^{0}C temperature, among different natural enemies ground beetle showed the highest number of population (11 beetles/10 sweeps) followed by lady bird beetle (6 lady bird beetles/10 sweeps) and damselfly (3 damselflies/10 sweeps). The lowest number was in dragonfly (2 dragonflies/10 sweeps). No populations of spider, ichneumonid wasp and dipteran fly were found in this temperature (Fig. 2).

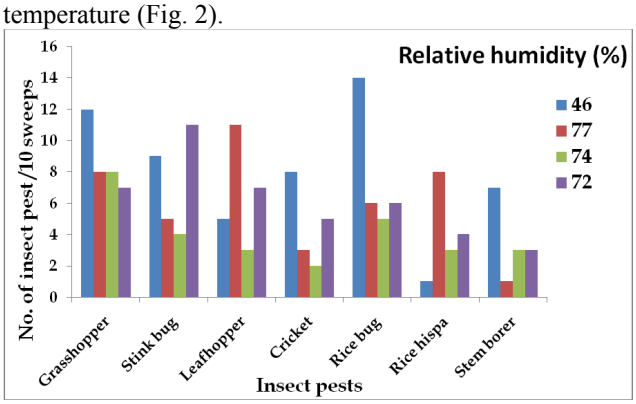

Fig. 3. Influence of relative humidity on arthropod insect pests

Effect of relative humidity on insect pest and arthropod natural enemies in rice field

Insect pests: At 46% relative humidity, population of ricebug was maximum (14 bugs/10 sweeps) followed by grasshopper (12 grasshoppers/10 sweeps), stink bug, cricket and stem borer. The lowest population was of rice hispa (1/10 sweeps) followed by leafhoppers (5/10 sweeps). At 77% relative humidity, leafhopper had highest population (11 hoppers/10 sweeps) followed by grasshopper (8/10 sweeps) which was identical to rice hispa (8/10 sweeps). Stem borer had lowest population (1/10 sweeps) followed by cricket (3/10 sweeps) and stink bug (5/10 sweeps). At 74% relative humidity, grasshopper had the highest population (8 grasshoppers/10 sweeps) followed by ricebug (5 bugs/10 sweeps) and stink bug (4/10 sweeps). Cricket showed the lowest population (2/10 sweeps) followed rice hispa (3/10 sweeps) which was similar to stem borer and leafhopper. At 72% relative humidity, stink bug had highest population (11 bugs/10 sweeps) followed by grasshopper (7 grasshoppers/10 sweeps), leafhopper (6/10 sweeps) and rice bug (5/10 sweeps). Stem borer had the lowest population (3/10 sweeps) followed by rice hispa (4/10 sweeps) and cricket (4.5/10 sweeps) (Fig. 3).

Natural enemies: At 46% relative humidity, ichneumonid wasp population showed the highest peak (13 wasps/10 sweeps) followed by ground beetle (9 beetles/10 sweeps) while lowest population was of damselfly followed by lady bird beetle and spider, respectively. No populations of dragonfly and dipteran fly were found in this humidity. At 77% relative humidity, the number of lady bird beetle was highest (12 beetles/10 sweeps) followed by ichneumonid wasp, spider, dipteran fly and damselfly while lowest population was of ground beetle. No dragonfly was found in this humidity. At 74% relative humidity, lady bird beetle population also showed the highest peak (9 beetles/10 sweeps) followed by ground beetle and damselfly while lowest population was of dragonfly which was similar to

spider followed by ichneumonid wasp. No dipteran fly was recorded in this humidity. At 72% relative humidity, ground beetle population showed the highest peak (12 beetles/10 sweeps) followed by lady bird beetle and damselfly. Dragonfly showed the lowest population. Populations of ichneumonid wasp, spider, and dipteran fly were not observed in this humidity (Fig. 4).

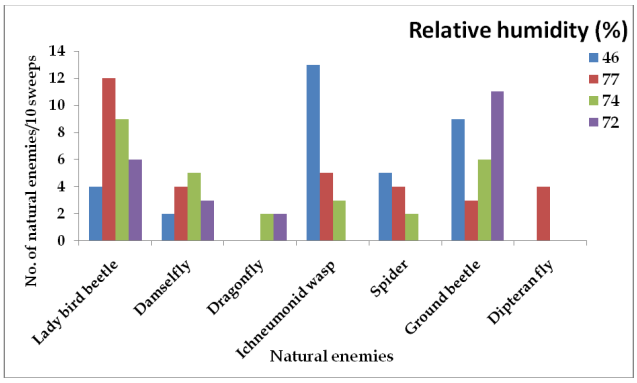

Fig. 4. Influence of relative humidity on arthropod natural enemies

In case of different rice growth stages, the present study indicated that, the abundance of most of the insect pests is high at reproductive (panicle initiation) stage where rice yellow stem borer population is highest at early tillering stage which is supported by Ragini *et al*. (2000) who found that yellow stem borer population was predominant from early tillering to maximum tillering stage. The highest rice bug population was found in panicle initiation stage and this result is agreed with Tsueda *et al*. (2002) who showed the ricebug abundance was peak at heading to early ripening stage. Some leaf feeders like grasshopper, rice hispa population showed highest abundance at seedling stage which is agreed with the result of BRRI (1985) but the result of rice hispa population of this study was not supported by Amit *et al.* (2001) who found the abundance of rice hispa population was highest in the mid tillering stage. The abundance of leafhopper population was highest in maximum tillering stage which was more or less similar with the result of BRRI (1985) where highest leafhopper population was found in early heading stage. In case of natural enemies, the abundance of natural enemies was highest in seedling stage where spider population was highest in early tillering stage which is supported by Luong (1987) who studied the population was highest at tillering stage. In case of ladybird beetle (*Micraspis spp*) the highest population was found in maximum tillering stage whereas Rahman *et al.* (1991) found that Lady bird beetle, *Micraspis discolor* was highest at the flowering stage. Arthropod insect pest and natural enemies population were varied with different temperature (^{0}c) and relative humidity (%). The result of this study indicated that, most of the insect pest differed significantly at maximum temperature and minimum relative humidity. Thus this study is supported by Lanjar *et al* (2002) who recorded from an experiment that the abundance of insect pest population was higher at a maximum range of temperature like 34.02-37.95^{0}C. In case of natural enemies, the present study showed that, the abundance of natural enemies was available at minimum temperature and maximum relative humidity that is also supported by Luong (1987) who studied population dynamics of the different predators and found that their abundance was available at a minimum range of temperature and a maximum range of relative humidity like 23-25°C and 89-94% respectively. The findings of the study may helpful in developing elements of Integrated Pest Management (IPM) program through ecological pest management designed for rice based cropping system.

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