J. Asiat. Soc. Bangladesh, Sci. **51**(2): 165-175, December 2025
DOI: http://doi.org/10.3329/jasbs.v51i2.86980

COMPARATIVE STUDY ON THE OCCURRENCE AND INCIDENCE OF INSECT PESTS DUE TO CLIMATE CHANGE IN COASTAL AND HAOR RICE ECOSYSTEM

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Abstract

The survey and assessment were carried out at three coastal and three haor districts of Bangladesh to know the occurrence and incidence of insect pests of rice due to climate change in coastal and haor rice ecosystem during June 2022 to July 2023. The infestations of insect pests in rice ecosystem are changing gradually with time due to changing in climate. Sixteen (16) insect pests of rice and six (6) natural enemies were recorded on rice field of coastal and haor ecosystem. Stem borer, rice leaf roller and Brown plant hopper were one of the major insect pests in coastal and haor rice ecosystems in survey areas. Among three coastal districts, the highest number of stem borer (4.5/30 hills) followed by leaf roller (4.4/30 hills) was observed on boro rice in Khulna followed by Noakhali and the lowest number in Bhola (3.4/30 hills) on T aman rice. Among three haor districts, the highest number of stem borer (3.4/30 hills) in Habigonj followed by Sunamgonj (3.1/30 hills) and the lowest number of stem borer in Kishoregonj (2.9/30 hills). In case of leaf roller, similar trend was also observed on boro rice. Major insect pests of rice is higher in boro season than those of T aman season. Stem borer, rice leaf roller, rice bug and brown plant hopper were one of the major insect pests of rice in coastal and haor rice ecosystems in survey areas. The incidence of 4 major insect pest species of rice crop was higher in coastal rice ecosystem compared to haor rice ecosystem.

Key words: Stem borer, leaf roller, BPH, T aman, Boro

Introduction

Rice is considered as the main unique food for most of the Asian and more than 50% of the globe's populations (IRRI, 2006). It is an essential food crop and more than 90% of world production occurs in tropical and semi tropical Asia (FAOSTAT, 2012). For decades rice crops have directly or indirectly played a key role in the livelihood of several billion people. In 2010, 154 million hectares of rice were cultivated worldwide, of

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which 137 million hectares were in Asia, with 48 million hectares harvested in Southeast Asia (FAOSTAT, 2012). In Bangladesh, eighty per cent of agricultural land is dedicated to rice cultivation (DAE, 2010). More than two hundred species of insects are known to be available in rice ecosystems of Bangladesh (Islam and Catling, 2012; Ali *et al*., 2017). Among these 20-33 species are considered as pest which cause yield losses (Ali *et al*., 2021). These insects make a complex food web within the rice ecosystem. In the rice agroecosystem 42 insect species are considered to be pests (Srivastava *et al*., 2004). Minor and major are recognized as status of pest insect species. These pests cause severe damage to rice crops at different growth stages. The degree of damage is dependent on the growing season and surrounding environment (Khaliq *et al*., 2014). The behavior as well as distribution and abundance of Yellow stem borer are influenced by changing in climate in southern Asia due to increasing winter survival rates and the number of generations per year, as well as inducing an earlier appearance in the crops after winter (Patel *et al*., 2017). Elevated winter temperature may not only reduce mortality rates for rice leaf folder and brown plant hopper, but also speed up their development, increasing their potential to accumulate and harm crops in subsequent generations (Kirtani, 1999 and 2007). Altering in climatic factors forced insect pests to move into new ecological niches for survival which is responsible for the invasion of foreign pest in the new habitat as well as threaten for food security (Skendzic *et al*., 2021). Increasing temperature had a positive effect on growth rate of yellow stem borer and the growth rate of yellow stem borer was found to be high at relatively low temperature and abundant rainfall (Ali *et al*., 2020). In addition, higher temperature affected the population dynamics of rice insect pests such as brown plant hopper, *Nilaparvata lugens* (Stal) and rice leaf folder, *Cnaphalocrosis medinalis* (Guen), by lowering the survival rate (Karuppaiah *et al*., 2012). Rice agro-ecosystems have evolved over the last 5,000 years under human management; for this reason human beings are considered to be an integral component. An abundance of insect species are supported through a series of complex interactions that comprise the food web that at its base is maintained by rice (Redfern *et al*., 2015). In this agroecosystem, the food web can serve as a tool to help improve natural ecosystem functions. However, function is dependent upon the continued propagation of predator insect species. Ecosystem function in a healthy rice agroecosystem can be improved through protecting and encouraging those insects that prey on pest species (Allara *et al*., 2012). In conventional pest management strategies the role of predator species is minimized or even eliminated by heavy pesticide application. In China, 889 insect species that prey on pest insects have been identified. These predator insect species account for 64.74% of all naturally occurring enemies of pest species (Lou *et al*., 2013). Increased pesticide use has led to an increase in soil, water and air pollution. These increases have in turn had an adverse impact on human health and rice quality (Sattar *et al*., 2013). The misuse or excessive use of pesticides can harm plants, livestocks, aquatic organisms, and humans. Jacobsen and Hjelmso (2014) reported that pesticide use has a higher cost to benefit ratio with respect to yields and can have negative impacts on beneficial microbes. One hundred fifty-nine rice insect species are recorded in the rice agroecosystem (Alam, 1977). Among these species, 20–23 species have been found to be most damaging in Bangladesh (Alam, 1977). Farmers often apply pesticides at higher rates and at inappropriate times due to lacking of knowledge relating to insect pest species and insect's life cycle. Farmers are using modern high yielding rice varieties, fertilizers, pesticides, water and other technologies intensively for producing more rice which ultimately changed the ecology and accelerate pest proliferation (Parvin, 2010). A majority of farmers are not concerned with the negative impacts of pesticide use may have on fish, wildlife, humans, soil, and beneficial insect species (Jepson *et al*., 2014). For this reason, previously designated minor insect pests have attained the status of major pests and some major pests have become minor status causing minimum damage and few may be disappeared or extinct from the agro-ecosystem. Hence this study was designed to know the occurrence and incidence of insect pest in coastal and haor rice ecosystem.

Materials and Methods

Survey studies were carried out in the farmers' rice fields of three selected coastal districts such as Khulna, Bhola, Noakhali and three selected haor districts such as Kishoreganj, Habiganj, Sunamganj of Bangladesh to collect data on occurrence and incidence of insect pests of rice and to know the status of insect pests during 2022-23 growing season. Studies were conducted in two locations of each coastal and haor districts. A total 12 upazila viz., Koyra (22.3515^{0}N and 89.2859^{0}E), Paikgachha (22.5931^{0}N and 89.3168^{0}E) upazila of Khulna district, Bhola sadar (22.6855^{0}N and 90.6439^{0}E), Char Fasson (22.1860^{0}N and 90.7603^{0}E) upazila of Bhola district, Noakhali sadar (22.8653^{0}N and 91.0971^{0}E), Subarnachar (22.6756^{0}N and 91.1257^{0}E) upazila of Noakhali district, Itna (24.5278^{0}N and 91.0958^{0}E) and Mithamain (24.4196^{0}N and 91.0634^{0}E) upazila of Kishoreganj district, Ajmiriganj (24.54890N and 91.23620E) and Baniachong (24.5063^{0}N and 91.3566^{0}E) upazila of Habiganj district, Bishwamvapur (25.1209^{0}N and 91.3135^{0}E) and Tahirpur (25.0990^{0}N and 91.1755^{0}E) upazila of Sunamganj district were selected as study sites for survey. Three rice fields owned by different farmers were selected from each location. Thirty (30) hills of rice plant from each field of each upazila comprising 90 hills of rice plant were selected randomly. A total 1080 hills of rice plant from 12 locations were observed for taking data on occurrence and incidence of rice insect pests. Data were recorded through observation of individual tillers of rice plant in each location.

Meteorological data: Simultaneously, the meteorological data such as maximum and minimum temperature, relative humidity and rainfall were collected from the meteorological office of study areas. The average minimum and maximum temperature of Sunamganj district were 18 and 31^0C, Kishoreganj district were 22 and 32^0C, Habiganj district were 17.4 and 36^0C, Noakhali district were 20.3 and 32^0C, Bhola district were 21 and 23 ^{0}C and Khulna district were 24 and 34ºC.

Statistical analyses: The data obtained were statistically analyzed by using WASP 1.0 (Web Agri Stat Package) software and means were separated by CD (critical difference) values.

Results and Discussion

Occurrence of insect pests in coastal and haor rice ecosystem: The occurrence of insect pests and natural enemies observed in coastal and haor rice ecosystem is presented in Table 1. Sixteen (16) insect pests of rice and six (6) natural enemies were recorded on rice field of coastal and haor ecosystem. Out of 16, six species were under the order Hemiptera, five species were under the order Lepidoptera, two of them were under Orthoptera, two under Diptera and one was under Thysanoptera. Among 16 insect pests, 12 insect pests were found in both coastal and haor rice ecosystem. Three insect pests viz., rice thrips, rice mealybug and whorl maggot were recorded from coastal ecosystem and rice case worm was recorded from haor rice ecosystem in T aman season.

Incidence of major insect pests in coastal rice ecosystem: The mean number of four major insect pests per 30 hills on T aman and boro rice in three coastal districts is presented in Figure 1. Among three coastal districts, the highest number of stem borer (4.5/30 hills) followed by leaf roller (4.4/30 hills) was observed on boro rice in Khulna followed by Noakhali and the lowest number in Bhola (3.4/30 hills) on T aman rice. Likewise, similar trend was also observed in case of brown plant hopper (BPH) (3.1/ 30 hills) and rice bug (2.8/ 30 hills) where BPH was higher than rice bug in boro rice but in T aman, rice bug (2.6/ 30 hills) was higher than BPH (1.6/ 30 hills). From this figure it was found that major insect pests of rice is higher in boro season than those of T aman season.

Table 1. Occurrence of insect pests and natural enemies observed in coastal and haor rice ecosystem.

Rice ecosystem	Insect pests	Scientific name	Family	Order
Coastal & haor	Stem borer	*Scirpophaga incertulas*	Crambidae	Lepidoptera
Coastal & haor	Brown plant hopper	*Nilaparvata lugens*	Delphacidae	Hemiptera
Coastal & haor	Rice leaf roller	*Cnaphalocrosis medinalis*	Pyralidae	Lepidoptera
Coastal & haor	Green rice leafhopper	*Nephotettix nigropictus* *N. virescence* *Recilia dorsalis*	Cicadellidae	Hemiptera
Coastal & haor	Short horned grasshopper	*Oxya velox* *O. chinensis*	Acrididae	Orthoptera
Coastal & haor	Long horned grasshopper	*Conocephalus longipennis*	Tettigoniidae	Orthoptera
Coastal & haor	Rice bug	*Leptocorisa acuta*	Coreidae	Hemiptera
Coastal & haor	White backed planthopper	*Sogatella furcifera*	Delphacidae	Hemiptera
Coastal & haor	Rice gall midge	*Orseolia oryzae*	Cecidomyiidae	Diptera
Coastal	Rice thrips	*Stenchaetothrips biformis*	Thripidae	Thysanoptera
Coastal & haor	Rice ear cutting caterpillar	*Mythimna separata*	Noctuidae	Lepidoptera
Haor	Rice caseworm	*Nymphula depunctalis*	Pyralidae	Lepidoptera
Coastal	Small brown planthopper	*Laodelphax striatellus*	Delphacidae	Hemiptera
Coastal	Rice mealybug	*Brevennia rehi*	Pseudococcidae	Hemiptera
Coastal & haor	Swarming caterpillar	*Spodoptera mauritia*	Noctuidae	Lepidoptera
Natutal enemies				
Coastal & haor	Spiders	Species was not identified		
Coastal & haor	Dragonfly	Species was not identified	Libellulidae	Odonata
Coastal & haor	Carabid beetle	Species was not identified	Carabidae	Coleoptera
Coastal & haor	Mirid bug	Species was not identified	Miridae	Hemiptera
Coastal & haor	Lady bird beetle	Species was not identified	Coccinellidae	Coleoptera
Coastal & haor	Damselfly	Species was not identified	Coenagrionidae	Odonata

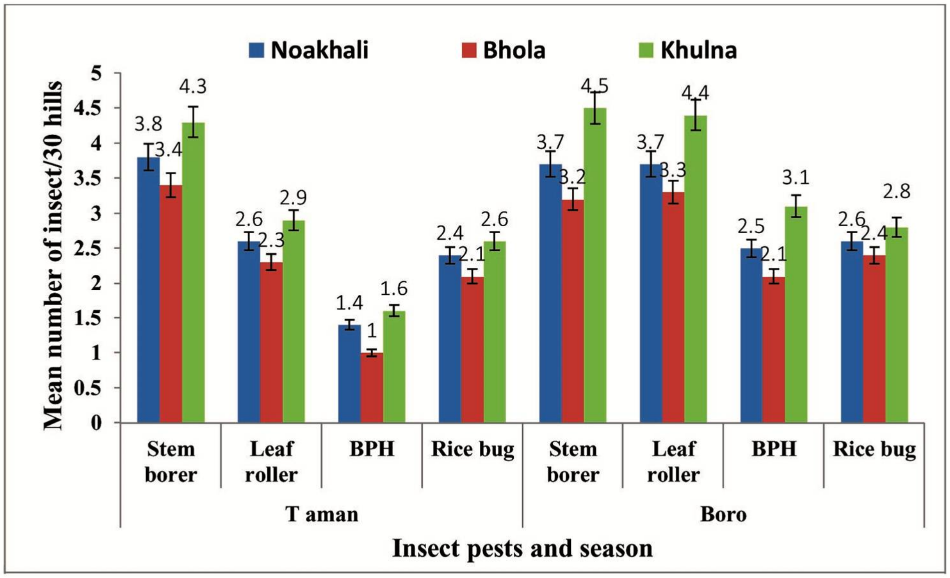

Fig. 1. Mean number of major insect pests at T aman and boro season in coastal rice ecosystem during July 2022 to June 2023

*Incidence of major insect pests in haor rice ecosystem***:** The mean number of four major insect pests per 30 hills on T aman and boro rice in three haor districts is presented in Fig. 2. Among three haor districts, the highest number of stem borer (3.4/30 hills) in Habigonj followed by Sunamgonj (3.1/ 30 hills) and the lowest number of stem borer in Kishoregonj (2.9/30 hills). In case of leaf roller, similar trend was also observed on boro rice. The number of brown plant hopper (BPH) (2.4/ 30 hills) and rice bug (2.4/ 30 hills) were identical on boro rice in Habigonj which was followed by Sunamgonj and Kishoregonj. In T aman rice, the highest number of stem borer (2.7-3.1) was recoreded in three coastal districts followed by leaf roller (1.9-2.4) while the lowest number of BPH (1-1.2) was recorded in Habigonj and Sunamgonj districts followed by rice bug (1.5-2.1). No BPH was recorded on T aman in Kishoregonj district. From this figure it was evident that major insect pests of rice is higher in boro season than those of T aman season.

*Major insect pests on T aman in haor and coastal rice ecosystem***:** The incidence of four major insect pest species on T aman in haor and coastal rice ecosystem is presented in Fig. 3. The incidence of stem borer was maximum in Khulna district followed by Noakhali and Bhola while the lowest incidence was observed in Kishoregonj followed by Sunamgonj and Habigong. In case of leaf roller and rice bug, similar trend was also found. The incidence of BPH was maximum in Khulna district followed by Noakhali and Habigonj while the lowest incidence was observed in Sunamgonj followed by Habigong. No BPH was found in Kishoregonj. The incidence of 4 major insect pest species of rice crop was higher in coastal rice ecosystem compared to haor rice ecosystem.

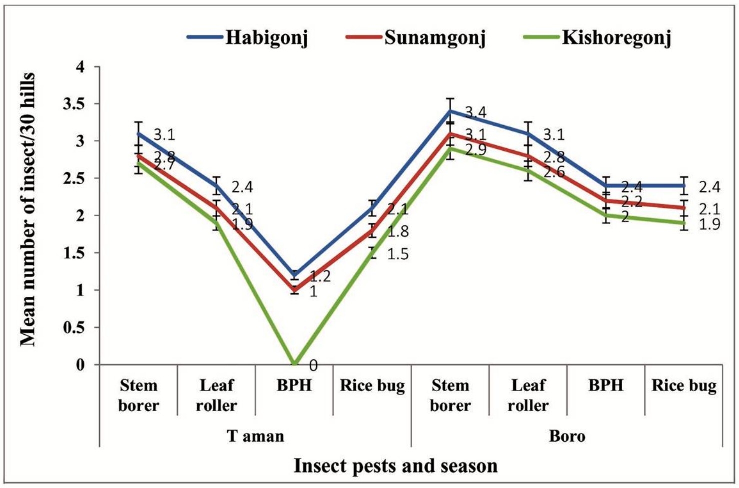

Fig. 2. Mean number of major insect pests at T aman and boro season in haor rice ecosystem during July 2022 to June 2023

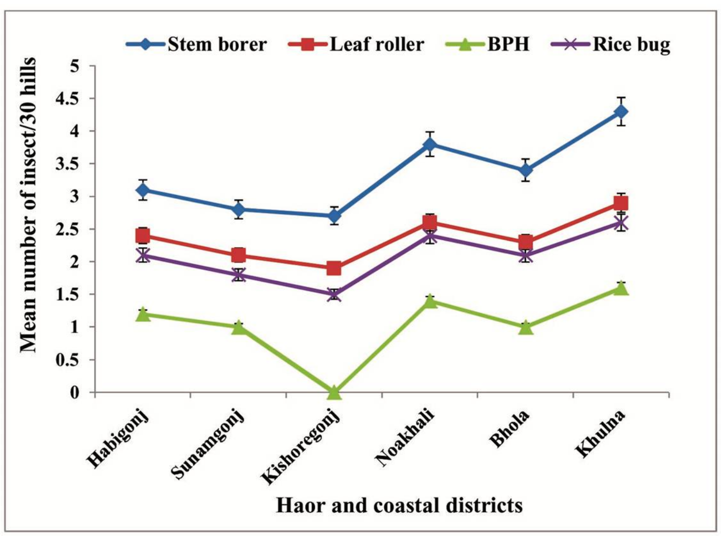

Fig. 3. Comparison of major insect pests on T aman rice in haor and coastal rice ecosystem

*Major insect pests on boro in haor and coastal rice ecosystem***:** The incidence of four major insect pest species on boro in haor and coastal rice ecosystem is presented in Fig. 4. The incidence of stem borer and leaf roller was maximum in Khulna district followed by Noakhali and Bhola while the lowest incidence was observed in Kishoregonj followed by Sunamgonj and Habigong. In case of rice bug, similar trend was also observed. The incidence of BPH was maximum in Khulna district followed by Noakhali and Habigonj while the lowest incidence was observed in Kishoregonj followed by Bhola and Sunamgonj.

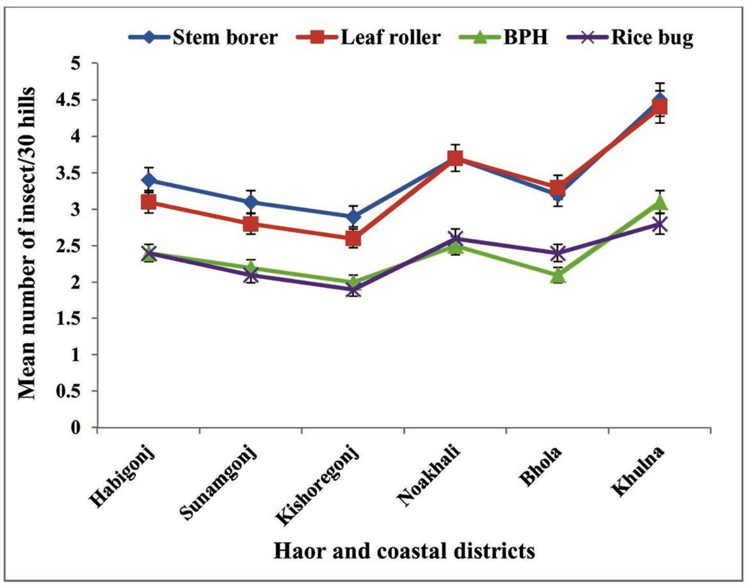

Fig. 4. Comparison of major insect pests on boro rice in haor and coastal rice ecosystem

The findings of the present study revealed that different species of insect pest were affecting the rice crop which was supported by Paramasiva *et al*. (2024) who stated that over one hundred insect pest species consume rice. Twenty of these species were significant pests that seriously harm the economy. The brown planthopper, *Nilaparvata lugens* (Stal), rice yellow stem borer *Scirpophaga incertulas* (Walker), leaf folder, *Cnapalocrocis medinalis* (Linnaeus), gall midge (GM), *Orseolia oryzae* (Wood-Mason), panicle mite, and *Steneotarsonemus spinki* were the main insect pests of recent years that have regional significance. Among these pests, leaf folder, rice stem borer and brown plant hopper were very important economically to cause great losses in yield of rice (Barley and Butter, 2008). BPH was a severe pest in rice crop, which was harming to rice plant with heavy damage (Madhuri *et al.*, 2017). The rice leaf folder, *Cnaphalocrocis medinalis*, was shown in several lab experiments to be affected by high temperatures in terms of growth rate, reproduction rate, survival, adult longevity, population size, and sexual behavior (Liao *et al*., 2014). Though there were several possible reasons for the abundance/shifts in insect pests viz., growing varieties lacking resistance to major pests, extensive cultivation of high yielding varieties, intensified rice cultivation throughout the year providing niches for pest multiplication, imbalance use of fertilizers and indiscriminate use of insecticides, harmful cultural practices, evolution of biotypes, changes in temperatures or rainfall patterns had profound influence on pest scenario of rice crop. Majority of the researchers opined that the infestation of BPH increased due to the miss use and overuses of nitrogenous fertilizers which favours to excrete more honeydew by BPH (Rashid *et al*., 2017), the plants become more vulnerable to BPH by using more amount of nitrogen. Along with the rice production using modern rice varieties, the insects/pests attack was also increased and loss of rice was continuously going on. These attacks always demanded more care for the rice plant (Horgan *et al*., 2018). Due to the insects/ pests at the global level the rice yield has decreased (Horgan *et al*., 2007). A tropical monsoon climate of Bangladesh was characterized by wide seasonal variations in rainfall, high temperatures, and high humidity which influenced the multiplication of pest. Haq *et al.* (2008) observed a decline in the number of *S. incertulas* during the past thirty years, which could be attributed to mortality brought on by increased rainfall and temperatures. Global warming might theoretically lead to an increase in the number of generations of rice insect pests and their potential to do harm, although this isn't necessarily the case. It is undoubtedly a significant impact in the population rise, even though many other causes might also be involved (Paramasiva *et al.*, 2024).

Conclusion

Sixteen (16) insect pests of rice and six (6) natural enemies were recorded on rice field of coastal and haor ecosystem. Major insect pests of rice is higher in boro season than those of T aman season. Stem borer, rice leaf roller, rice bug and brown plant hopper were one of the major insect pests of rice in coastal and haor rice ecosystems in survey areas. The incidence of 4 major insect pest species of rice crop was higher in coastal rice ecosystem compared to haor rice ecosystem.

Acknowledgements

The author is grateful to Research and Training Centre, Patuakhali Science and Technology University for providing financial support to carry out this research.

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(Revised copy received on 27/7/2025)