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Md. Niaz Morshed
Scientific Officer, Adaptive Research Division, Bangladesh Rice Research Institute (BRRI), Gazipur-1701, Bangladesh

Mohammad Tofazzal Hossain Howlader
Professor, Department of Entomology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

Md. Rafiqul Islam
Principle Scientific Officer, Adaptive Research Division, Bangladesh Rice Research Institute (BRRI), Gazipur-1701, Bangladesh

Naznin Sultana
MS, Department of Entomology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

Md. Hasibur Rahaman Hera
Scientific Officer, Plant pathology Division, Bangladesh Rice Research Institute (BRRI), Gazipur-1701, Bangladesh

Corresponding Author:
Md. Niaz Morshed
Scientific Officer, Adaptive Research Division, Bangladesh Rice Research Institute (BRRI), Gazipur-1701, Bangladesh

Effect of abiotic factors on the seasonal incidence of Rice yellow stem borer, *Scirpophaga incertulas* (Walker) and rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) population at the south-east coastal region of Bangladesh

Md. Niaz Morshed, Mohammad Tofazzal Hossain Howlader, Md. Rafiqul Islam, Naznin Sultana and Md Hasibur Rahaman Hera

Abstract
An experiment was carried out under field conditions at the Bangladesh Rice Research Institute, Regional station Sonagazi, Feni, to study the effect of abiotic factors on the seasonal incidence of rice yellow stem borer (RYSB), *Scirpophaga incertulas* (Walker) and rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) population at the south-east coastal region of Bangladesh during Kharif-2 (T. Aman), 2019 season. This study aimed to determine the effect of abiotic factors on the incidence of the pest population and to forewarn & plan for timely management of RYSB and rice leaf folder. Insects were collected from the experimental plot by using sweep net method and weather data was recorded simultaneously from the meteorological observatory. Observations on *S. incertulas* incidence revealed that the highest per cent of dead hearts (10.51) and white heads (9.38) were occurred during the 2nd week of October and 1st week of November, respectively. Per cent, dead hearts incidence were observed highest during the vegetative phase and per cent of white heads were highest during the reproductive phase of the plant. The correlation studies with abiotic factors revealed that temperature showed a negative significant impact on the population of *S. incertulas* (white heads) and negative non-significant impact on dead hearts. Relative humidity showed a positive significant impact on dead hearts but the negative non-significant impact on white heads. Rainfall showed a positive non-significant impact on dead heart but it showed a negatively significant impact on white heads. Leaf folder infestation attained its peak during 2nd fortnight of October and didn't get significantly affected by rainfall, relative humidity & temperature. So it is better to take preventive measures for leaf folder from the start of September month. These findings will be helpful for proper and timely management of the rice yellow stem borer & leaf folder in the south-east coastal region of Bangladesh.

Keywords: Insect, pest, abiotic factors, rice yellow stem borer, rice leaf folder

Introduction
Bangladesh with its topography, fertile soil, abundant water and subtropical climate constitutes a favorable environment for the rice plant. Rice (*Oryza sativa* L.) is one of the world's most important crops providing staple food for nearly half of the global population [8]. Rice is the staple food of about 150 million people of Bangladesh. Despite its small size Bangladesh is the fourth largest rice producer of the world after China, India and Indonesia [3]. Agricultural production system depends on the environment for utilization of land, rainfall, temperature, relative humidity, daylight, insect pests and diseases etc. The pest problem is one of the major constraints for achieving higher production in agriculture crops. Bangladesh loses about 30% of its crops due to pests and diseases each year [4]. In producing more rice, farmers are using modern varieties, fertilizers, pesticides, water and other technologies intensively which have eventually changed the ecology and escalated pest proliferation [26]. Among various constraints for good rice production, the infestation of different insect species is very important. The rice plant is attacked by more than 100 species of insects and 20 of them can cause serious economic loss [24]. Yield loss due to insect pests of rice has been estimated about 30- 40% [10]. Rice crop is highly sensitive for several insect pests [28, 30] and among them, yellow stem borer

(YSB), *Scirpophaga incertulas* (Walker) is one of the most destructive pest and is widely distributed monophagous pest in the Indian subcontinent and has assumed the number one pest status and attacks the rice crop at all growth stages [22]. The extent of rice yield losses due to YSB has been estimated as 20–70% [6]. It causes dead hearts at active tillering stage and white ears at harvest stage, which can lead to complete failure of the crop [13]. The rice leaf folder *Cnaphalocrocis medinalis* (Guenee), so far, was considered as a minor pest, has assumed major pest status during the last two decades [19]. Use of more nitrogenous fertilizers and misuse of insecticides have been attributed as the causes of this minor pest gaining major pest status [7]. The yield loss caused by leaf folder reported to the extent of 5 to 25 per cent [15]. These are two major insect pests among the lepidopteran pests infesting rice. Recently, the emphasis is being given on ecological based pest management strategies. The main components of any pest management program are to study the incidence period of the pest, population distribution on crop and regular monitoring or survey of the field. Seasonal incidence studies help in planning need-based application of insecticides as it reveals the insect's peak activity as well as insect free periods during crop growth. The insect pest population shows fluctuations depending on various abiotic factors (rainfall, relative humidity, temperature etc.) and biotic (natural enemies) factors of an area [31]. Keeping these points in view the following experiment is mainly aimed to study the effect of abiotic factors on the population build-up of lepidopteran pests.

Materials and Methods

The experiment was conducted during the Kharif-2 (T. Aman), *2019* season at the Bangladesh Rice Research Institute (BRRI), Regional Station, Sonagazi, Feni, Bangladesh. The experimental plot was located at 22.88° North (latitude) and 91.43° East (longitude) at an average elevation of 11m above from the sea level belonging to the Chittagong Coastal plain (i.e., Agro-Ecological Zone-14). Mean maximum temperature experienced during the experiment was 35.360 C during the 3rd week of September and the mean minimum temperature was 22.070 C during 1st week of November. The maximum rainfall experienced was16.57mm during 3rd week of September. Seasonal incidence of insect pests on rice was studied on a separate plot of 33 decimal (1 bigha). The nursery was raised adjacent to the main experiment plot to study the population build-up of the pests. BRRI dhan71 rice variety was used as an experimental crop for this study. It is one of the most popular T. Aman high yielding rice varieties in Bangladesh having 110-115 days growth duration and grown in irrigated and medium upland condition having a special feature of good grain quality. Thirty days old seedlings were transplanted to the main field with a spacing of 20×15 cm2 in hills (2 seedlings/hill) and all the agronomical practices viz. irrigation, fertilizer application and intercultural operations were followed as recommended for rice crop in this area to raise the crop. No chemical pesticides were applied throughout the crop period to get a natural pest incidence on the crop. The pest population was recorded in this unprotected plot at 7 days interval from the occurrence or initiation of pest infestation and was continued up to maturity. The incidence of pests was recorded on 10 randomly selected hills, in case of each insect. Weather data was also recorded simultaneously from the meteorological observatory available at the Bangladesh Rice Research Institute (BRRI), Regional Station, Sonagazi, Feni, Bangladesh and correlated with the per cent incidence of the pest population. Correlation coefficient method was adopted to work out the relationship between the occurrence of the pest incidence and the weather parameters.

Observation and Analysis:

The infestation of yellow stem borer was observed in two phases, one at vegetative phase as per cent dead hearts and second at reproductive phase as per cent white heads from 10 randomly selected hills. Population counts were taken on the number of dead hearts/white heads and a total number of tillers/panicle from 10 randomly selected hills [11]. The per cent incidence (dead heart/ white heads) was calculated as follows:

$$\text{Percent Incidence (\%)} = \frac{\text{Number of dead hearts/white heads}}{\text{Total number of tiller/ panicles}} \times 100$$

In the case of leaf folder, *Cnaphalocrocis medinalis* the number of damaged leaves and total leaves from 10 randomly selected hills were observed in each plot [27]. The percentage of leaf damage was calculated as follows.

$$\text{Percent Incidence (\%)} = \frac{\text{Number of damaged leaves}}{\text{Total number of leaves}} \times 100$$

Weekly data of pest population were correlated with the prevailing climatic factors such as maximum temperature, minimum temperature, morning and evening relative humidity prevailing in the field. The correlation coefficient (r) analysis was carried out by using IBM SPSS Statistics 20.

Results

The major insect pests of rice show specific symptoms in the field through which we can identify the affected field. Each observation was done very minutely and the damage plants & damage-causing insect were collected from the field and properly preserved. These pests or insects were identified with the help of [2, 25]. The seasonal occurrence of rice yellow stem borer (*S. incertulas*) and rice leaf folder (C. *medinalis*) population during present investigation indicates that there is a relation between the abiotic factors *viz.*, relative humidity, temperature & rainfall and insect population incidence. In the present study, *S. incertulas* incidence first appeared in T. Aman season during the first week of September (i.e. 25th August days after transplantation) & damaging activities first appeared after 2nd week of September. The pest population reached its peak level during the second week of October (10.51) (Table 1, Fig 1). Thus, the maximum activity of pest is observed from September - October. However, in the case of white heads the rise was gradual and reached its highest level during first week of November (9.38). The correlation analysis revealed that the yellow stem borer incidence (i.e. % dead heart) showed a positive significant correlation with evening and average relative humidity (r = 0.799 & 0.773) and a positive non-significant correlation observed with morning relative humidity and rainfall (r = 0.656 & 0.617) (Table 2). A positive non-significant correlation was observed with minimum & mean temperature (r = 0.423 & 0.105) and a negative non-significant correlation was observed with maximum temperature (r = -0.246). High *S. incertulas* incidence was observed during the vegetative stage of the crop compared to the reproductive stage when the atmosphere

is cloudy with evenly distributed rains. However, the per cent white heads are found to be in a negative significant correlation with rainfall (r = -0.891) and minimum temperature (r= -0.776). A non-significant negative correlation was observed with morning, evening & average RH and average temperature. And a non-significant positive correlation was observed with maximum temperature.

The incidence of leaf folder infestation was commenced during first fortnight of September and the larval population increased gradually till 40th week with 8.00% (Table 1, Fig 1). And the pest populations reached its highest level during the third week of October (11.31%). Later, the population started declining when the crop attained maturity**.** The correlation coefficient (r) analysis between weather factors and rice leaf folder incidence revealed that, there was no significant correlation between leaf folder infestation and maximum temperature (r = -0.256), minimum temperature (r = 0.235), rainfall (r = -0.305), morning relative humidity (r = 0.561), evening relative humidity (r = 0.507) and average relative humidity (r = 0.522). A negative non-significant correlation **(**-0.305) was observed with rainfall and leaf folder infestation.

Leaf folder showed positive non-significant correlation with morning **(**0.561), evening (0.507) and average (0.522) relative humidity.

Table 1: Influence of abiotic factors on the population dynamics of rice yellow stem borer and leaf folder (Aman, 2019)

Standard Week	Respective Months and Dates	Temperature (^{0}C)			Rainfall (mm)	Relative Humidity (%)			RYSB % incidence/ 10 hills		Larva /10 hills
		Max.	Min.	Avrg.		9 a.m.	3 p.m.	Avrg.	%DH	%WH	LR
38	Sept. 17-23	35.36	26.37	30.87	16.57	89.86	70.29	80.08	5.19	-	2.00
39	Sept. 24-30	31.84	24.96	28.40	10.67	92.00	80.57	86.29	7.45	-	6.15
40	Oct. 01-07	31.79	25.53	28.66	7.57	95.43	88.14	91.79	8.22	-	8.00
41	Oct. 08-15	32.74	24.24	28.49	6.13	94.50	84.38	89.44	10.51	3.39	10.20
42	Oct. 16-22	34.19	25.14	29.67	0.00	90.71	70.29	80.50	-	7.19	11.31
43	Oct. 23-29	31.66	23.91	27.79	1.43	92.71	76.14	84.43	-	7.92	5.41
44	Oct. 30- Nov. 05	33.47	22.07	27.77	0.00	89.71	66.29	78.00	-	9.38	1.80

**DH= Dead Heart; WH= White heads; RYSB= Rice yellow Stem borer; LR= Leaf Roller;

Table 2: Correlation coefficient (r) of rice yellow stem borer and leaf folder with prevailing weather parameters during T. Aman, 2019

Insect Pests		Weather Parameters						
		Rainfall (mm)	Relative Humidity			Temperature		
			9 a.m.	3 p.m.	Average	Maximun	Minimum	Average
RYSB	% DH	0.617	0.656	**0.799***	**0.773***	-0.246	0.423	0.105
	% WH	**-0.891****	-0.367	-0.590	-0.456	0.036	**-0.776***	-0.459
Leaf folder		-0.305	0.561	0.507	0.522	-0.256	0.235	-0.016

*Correlation is significant at the 0.05 level, **Correlation is significant at the 0.01 level

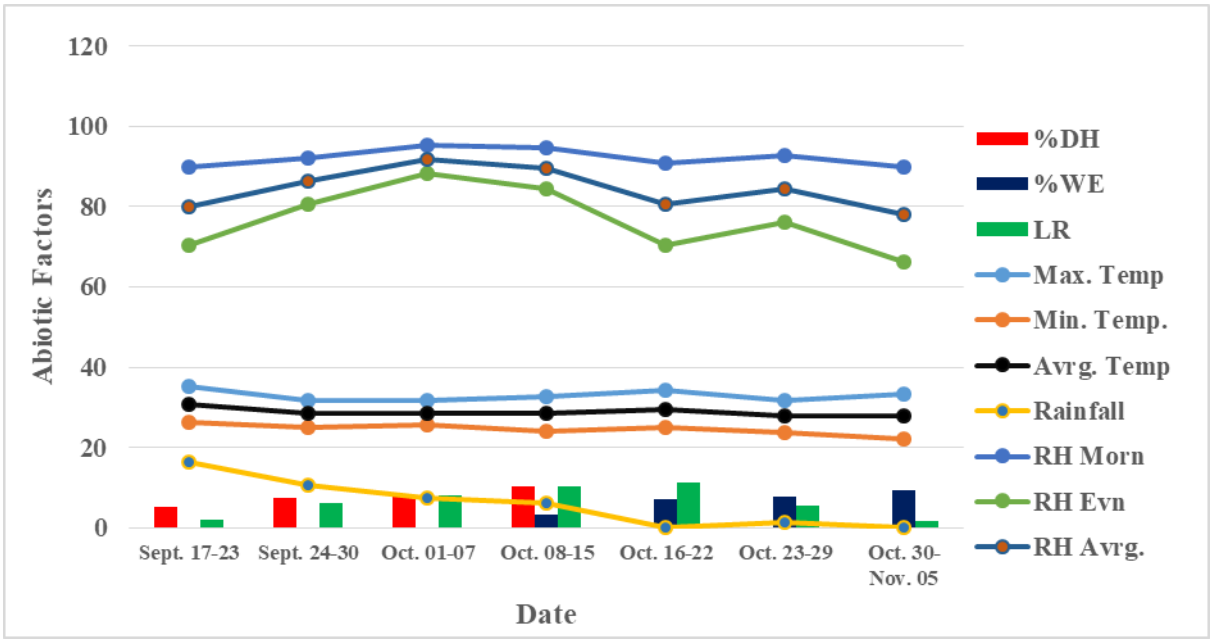
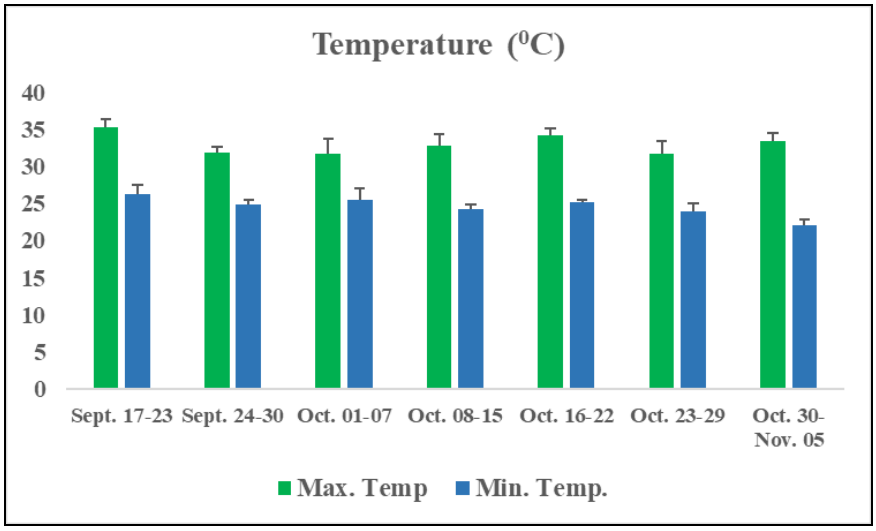
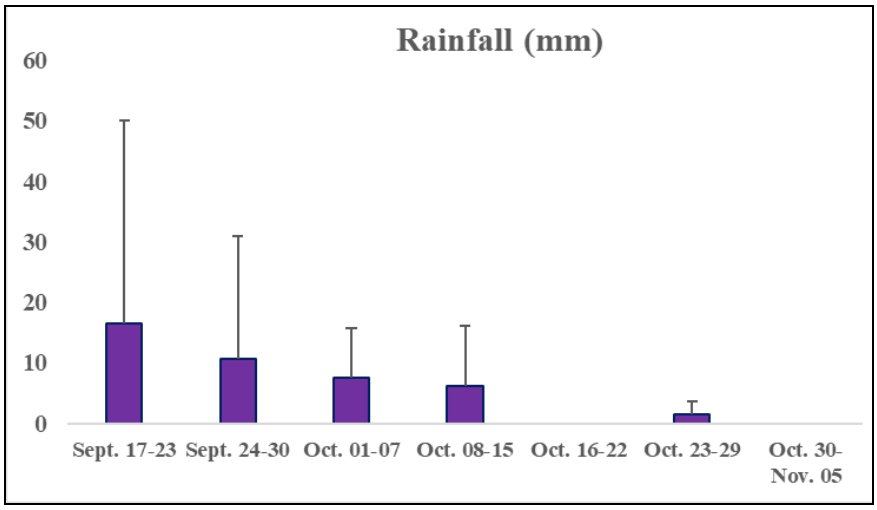


Fig 1: Population dynamics of rice yellow stem borer and leaf folder influenced by abiotic factors



A



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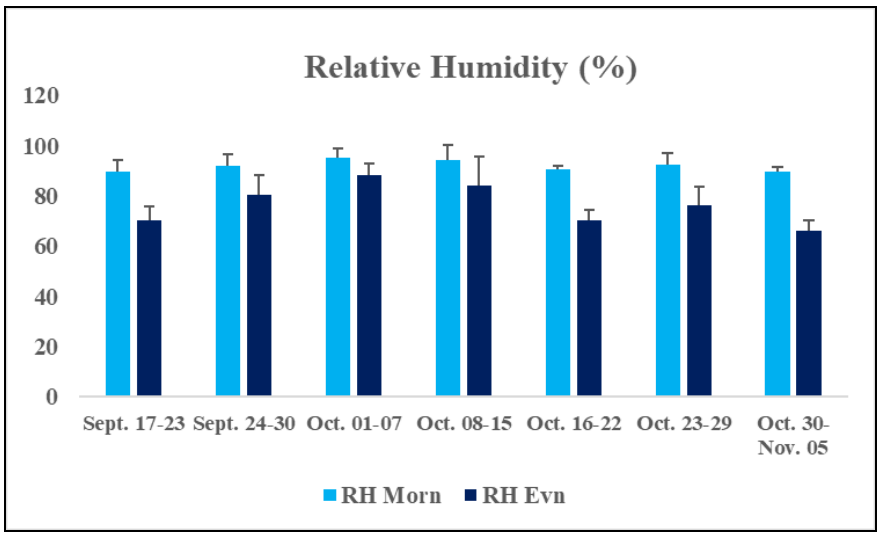

C

Fig 2: Weekly averages (±SD) of (A) Minimum and maximum temperatures; (B) Daily rainfall; and (C) Daily Relative humidity. Data from Bangladesh Rice Research Institute (BRRI), Regional station, Sonagazi, Feni

Discussion

The incidence of rice insect population during present investigation indicate that abiotic factors *viz.*, relative humidity, temperature and rainfall play an important role to oscillate the insect population in rice ecosystem during the *Kharif-2* (T. Aman) season [31]. *S. incertulas* incidence first appeared in during 1st week of September and the pest population reached its peak with damaging symptoms i.e.

dead heart during the 2nd week of October. Thus, the maximum activity of pest was observed from September - October. This result is similar to the findings of [31, 32] who reported that the maximum activity of *S. incertulas* was observed during September – October. The present findings of this research concerning abiotic factors with rice yellow stem borer conforms with the results of [21, 32, 25, 12] who reported that the activity of the stem borer is peak during the vegetative stage of the crop. The correlation studies with abiotic factors and *S. incertulas* revealed that temperature showed a negative non-significant impact on dead hearts. The present results differed from [31] who found negatively significant impact and [32] found positively significant impact with temperature and *S. incertulas* incidence. These variations may be due to variation in weather parameters in different locations and their influence on the activity of the pest. *S. incertulas* (dead heart) showed positive non-significant impact with rainfall and positive significant impact with relative humidity. This result is similar to the result of [32]. Even, [11] also obtained a positive significant correlation of yellow stem borer with relative humidity. *S. incertulas* (white head) showed a negative significant impact with both temperature & rainfall and non-significant negative impact with relative humidity. These results were in close accordance with [16], who reported that the drop in mean temperature in association with a prolonged spell of rainy days was most congenial for pest growth and multiplication. Similar results of incidence of white ear heads with rainfall, relative humidity & temperature was also found by [31].

Leaf folder (*C. medinalis*) populations reached its highest level during the third week of October (11.31%) and later it was declined up to maturity [32] found the pick level of leaf folder infestation during 01-07 October. Other scientists also reported the infestation of *C. medinalis* varied from 1.4 to 33.2 per cent in rice from July to October [27]. The correlation studies with abiotic factors and *C. medinalis* revealed that there is no significant correlation between temperature and incidence of *C. medinalis* population. These observations are similar to the results of [1, 31] who reported that maximum, minimum and average temperature had no impact on leaf infestation by leaf folder. These results are almost also similar to the results of [5, 14] reported that minimum temperature, temperature gradient had a negative influence on leaf folder population [32] reported a positive non-significant correlation with leaf folder and temperature. *C. medinalis* showed a negative non-significant correlation with rainfall and positive non-significant correlation with relative humidity [31] were also found a negative non-significant correlation with rainfall. [32] reported that a positive non-significant correlation was obtained between rice leaf folder morning relative humidity. But [14] stated that maximum relative humidity and average relative humidity had a negative influence on leaf folder population. These variations due to variation in weather parameters in different locations and their influence on the activity of the pest.

Conclusion

From the above findings, it may conclude that the peak period of *S. incertulas* population (10.51%) were recorded in 2nd week of October (42nd standard week) at vegetative stage (Dead hearts) and at the reproductive stage (White ears) the *S. incertulas* arrived at peak during 1st week of November (45th standard week). The above research revealed that the incidence of yellow stem borer or the per cent dead hearts were observed highest during the vegetative phase and per cent white ears were highest during the reproductive phase of the plant. So if it is controlled at an early stage it will not have a loss in the reproductive phase. The correlation studies with abiotic factors revealed that temperature showed a negative significant impact on the population of *S. incertulas* (white heads) and negative non-significant impact on dead hearts. Relative humidity showed a positive significant impact on dead heats but the negative non-significant impact on white heads. Rainfall showed a positive non-significant impact on dead heart but it showed a negatively significant impact on white heads. The incidence of leaf folder infestation commenced after the first forth night of September and attained its peak population during 2nd fortnight of October. The leaf folder population didn't get significantly affected by rainfall, relative humidity and temperature, so it is better to take preventive measures from the start of September month. These findings could be helpful for proper and timely management of the rice yellow stem borer & leaf folder in south-east coastal region of Bangladesh and show the relation of insect pest population affected by weather factors which help to plan a proper pest management technique for paddy field in this area. Further study required to confirm our findings.

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