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Influence of environmental factors on seasonal incidence of lepidopteran pests of rice

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Abstract

Rice is one of the most important cereal crops grown throughout the world. Despite of using improved agronomic practices, we cannot get optimum production and productivity. Several factors are responsible for low productivity in rice. A wide range of insect pests are reported to attack rice plant at different stages of life cycle. Among several insect pests, lepidopteran pests such as yellow stem borer, rice leaf folder are considered as most destructive and responsible for severe yield losses. The incidence pattern of lepidopteran pests at different standard weeks was studied. Then effect of various environmental factors like rainfall, morning RH, evening RH, maximum temperature, minimum temperature, average temperature was established by calculating correlation coefficients. It provides as a reference for selecting suitable management practices for reducing pest population.

Keywords: Lepidopteran pest, Yellow stem borer, Rice leaf folder, Seasonal incidence, Environmental factors

Introduction

Rice (*Oryza sativa* L.) is one of the most importantly grown crops consumed throughout the world (Khush, 1997)^[8]. It is cultivated in all the tropical, sub-tropical and calm nations of the world. Several factors affect getting improved yields in rice, from which insect-pests infestation is the most restraining factor in the successful cultivation of rice. More than 100 species of insects attack rice and among them 20 have potential to cause economic damage throughout world, causing more than 30 per cent yield loss from seedling to maturity (Cramer, 1967; Pathak and Dhaliwal, 1981 and Athwal and Dhaliwal, 2005)^[1, 2, 9]. Most important insect pests of rice are Yellow stem borer (*Scirpophaga incertulas*), Leaf folder (*Cnaphalocrocis medinalis*), Gall midge (*Orseolia oryzae*), Brown plant hopper (*Nilpravata lugens*), Green leaf hopper (*Nephotettix nigropictus*, *Nephotettix virescens*), Gundhi bug (*Leptocoris acuta*), Case worm (*Nymphula depunctalis*) and several others.

Among quite a few insect pests linked with rice, pests of lepidopteran order are considered to be highly destructive. Among them yellow stem borer is the most destructive and widely occurring insect pest of rice at all stages of crop growth due to its monophagy nature. It is the most abundant stem borer in tropical low land and deep water rice due to its adaptive characteristics for the aquatic environment. Newly emerged larvae enter into the stem for feeding on inner tissue at vegetative and reproductive stage of the crop. As a result of their feeding inside the stem around the nodes, central leaf whorl remains unfold, turn brownish, dry up and easily be pulled out, while lower leaves remain green and healthy. This condition is known as dead heart. The affected tillers do not produce panicles. If the infestation continues to the ripening stage of crop then plant bear panicles without grains. This condition is known as white ear. Severe yield loss is caused by this pest by formation of both white ear as well as dead heart. Yield loss is found to be positively correlated with dead heart and/or white ear formation (Rehman *et. al.*, 2005)^[11].

Seasonal incidence is the study of how and why fluctuation in population occurs with respect to time and space in the agro-ecosystem. Understanding of pest seasonal incidence in relation to weather parameters can help forecasting capability for appropriate management decision. Successful forecasting model are those that are based on knowledge of the biology, ecology and distribution pattern of insect-pest and their natural enemies along with their host.

The present investigation was carried out to estimate seasonal incidence of lepidopteran pests of rice.

Materials and Methods

The experiment was carried out during the *kharif* season of 2018-19 at the Agricultural Research Farm, Banaras Hindu University, Varanasi (Uttar Pradesh) which is situated at latitude of 24° 56' N to 25° 35' N and longitude of 82° 14' E to 83° 24' E with an altitude of 82 m above the mean sea level (MSL). The place is situated in the center of Indo-gangetic belt, falling under the sub-humid and sub-tropical climate zone.

A bulk plot of 100 m² area was raised up neighboring to the main test plot in order to study the population fluctuation of the inset-pests of rice. During experimentation all the recommended agronomic practices were followed to raise the healthy crop except the plant protection measures applied to manage the insect-pest for assessment of yield losses in protected plots.

The quantitative study of insect pest of rice was carried out by regular monitoring to explore the biodiversity of the insect pests. The incidence of various insect pests as well as their natural enemies was recorded right from seedling stage to harvesting of the crop at weekly interval. The weekly average data on weather conditions during the period of study (2018-2019) was obtained from the meteorological observatory located at Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi.

Observation

Yellow stem borer

Yellow stem borer incidence on rice was recorded at weekly interval in two phases, first during vegetative stage from tillering to PI stage as per cent dead hearts and second phase in reproductive stage from PI till harvest as per cent white ears. Total number of tillers and total number of infested tillers (dead hearts and white ear head) from each hill were counted. The mean value of total number of infested tillers for each plot of investigation for respective week was worked out from the collected data. Finally data so obtained were converted into per cent dead heart and per cent white ear with the following formulae.

$$\text{Percent incidence} = \frac{\text{Number of dead hearts/ white ears}}{\text{Total number of tillers/ panicles}} \times 100$$

Leaf folder

Leaf folder incidence on rice was recorded at weekly interval as per cent leaf damage. Total number of tillers and total number of infested tillers (folded leave with leaf folder damage symptoms) from each hill were counted. The mean value of total number of infested tillers for each plot of investigation for respective week was work out from the collected data. Finally data so obtained were converted into per cent leaf damage with the following formulae.

$$\text{Percent incidence} = \frac{\text{Number of damaged leaves}}{\text{Total number of leaves}} \times 100$$

Statistical analysis

Correlation coefficients were calculated between the weekly data of pest population with the prevailing climatic factors like maximum temperature, minimum temperature, average temperature, morning and evening RH, average RH and rainfall.

Result and Discussion

Seasonal incidence of yellow stem borer (*Scirpophaga incertulas*) and impact of environmental factors on it:

The observations regarding occurrence of yellow stem borer were taken at weekly intervals and these were correlated with corresponding meteorological factors like temperature, relative humidity, rainfall etc. to find out correlation coefficients and conclusions were derived.

The yellow stem borer incidence was noted in two phases, first during vegetative stage (from tillering to panicle initiation as per cent dead hearts) and second during reproductive stage from panicle initiation to harvesting as per cent white ears. During 34th standard week i.e., one week after transplanting, the incidence and damage symptoms (dead hearts) were observed for the first time (Table- 1 & Figure- 1). The maximum and minimum temperatures at the time of initial infestation were recorded as 31.1 °C and 24.0 °C correspondingly with 91 per cent morning and 81 per cent evening RH. There was successive increase in incidence of per cent dead hearts during subsequent standard weeks and reached a maximum during 40th SW which was 10.56 per cent. The maximum and minimum temperatures prevailed during highest infestation were 34.2 °C and 20.8 °C respectively with 83 per cent morning and 51 per cent evening RH. The per cent dead hearts were reduced subsequently as panicle initiation started. The incidences of white ear head were observed for the first time during 43rd standard week (0.83 per cent). The per cent white ears increased at steady rate and the 47th standard week witnessed highest per cent incidence of dead hearts (Table- 1 & Figure- 1). The maximum and minimum temperatures during highest incidence were 27.9 °C and 10.1 °C respectively with 88% morning relative humidity and 44% evening relative humidity.

Correlation coefficients were calculated to find out the relationship between the per cent occurrence of dead hearts and different weather parameters like temperature, rainfall, relative humidity (Table- 2). From the results, it was perceived that incidence of dead hearts had significant positive correlation with minimum temperature ($r = 0.559$) and average temperature ($r = 0.516$). Also significant negative correlation was found with rainfall ($r = - 0.440$), morning relative humidity ($r = - 0.474$), evening relative humidity ($r = - 0.554$). The incidence of dead hearts has positive non-significant correlation with maximum temperature ($r = 0.410$). Similarly the per cent occurrence of white ear heads were correlated with major weather parameters and the results indicated that there is significant negative correlation of per cent white ears with maximum temperature ($r = - 0.663$), minimum temperature ($r = - 0.861$), average temperature ($r = - 0.850$), rainfall ($r = - 0.425$), evening RH ($r = - 0.621$), average RH ($r = - 0.499$). The per cent white ears occurrence has positive non-significant correlation with morning RH ($r = 0.285$). (Table- 2).

Table 1: Influence of abiotic factors on seasonal incidence of lepidopteran insect pests of rice (*Kharif*, 2018)

S.W.	Month & Date	RAINFALL (mm)	Temperature °C			Relative humidity			Yellow Stem Borer Per cent incidence per 10 hills		Leaf folder (larvae/ 10 hills)
			Max.	Min.	Average	Morn.	Even.	Average	DH	WEH	
WEEK 27	July 02-08	8	35.5	27.9	31.7	77	57	67	0.00	0.00	0.00
WEEK 28	09-15	11.6	35.5	26	30.75	83	58	70.5	0.00	0.00	0.00
WEEK 29	16-22	78.4	33.3	25.4	29.35	86	66	76	0.00	0.00	0.00
WEEK 30	23-29	91.4	28.4	23.6	26	88	87	87.5	0.00	0.00	0.00
WEEK 31	30-05	86.8	28.1	22.8	25.45	93	88	90.5	0.00	0.00	1.11
WEEK 32	Aug 06-12	26.6	31.8	24.7	28.25	92	77	84.5	0.00	0.00	1.67
WEEK 33	13-19	20.4	33.3	25.3	29.3	88	70	79	0.00	0.00	3.61
WEEK 34	20-26	154.8	31.1	24	27.55	91	81	86	0.28	0.00	5.00
WEEK 35	27-02	118.4	32	24.3	28.15	93	77	85	2.50	0.00	4.44
WEEK 36	Sep 03-09	94.6	30.6	23.6	27.1	91	79	85	3.61	0.00	6.94
WEEK 37	10-16	0	32.4	23.6	28	88	68	78	3.89	0.00	9.44
WEEK 38	17-23	53.4	30.5	22.8	26.65	88	65	76.5	6.11	0.00	11.11
WEEK 39	24-30	0	33.4	25.9	29.65	88	63	75.5	6.67	0.00	10.00
WEEK 40	Oct 01-07	0	34.2	20.8	27.5	83	51	67	10.56	0.00	11.39
WEEK 41	08-14	0	31	20	25.5	89	61	75	8.89	0.00	8.61
WEEK 42	15-21	0	33.4	16.5	24.95	84	40	62	9.72	0.00	6.67
WEEK 43	22-28	0	31.5	14.4	22.95	89	41	65	10.56	0.83	6.39
WEEK 44	29-04	0	31.1	16.7	23.9	91	48	69.5	0.00	5.28	4.17
WEEK 45	Nov 05-11	0	28.2	12.2	20.2	87	44	65.5	0.00	4.72	3.61
WEEK 46	12-18	0	29	11.7	20.35	89	45	67	0.00	5.83	1.67
WEEK 47	19-25	0	27.9	10.1	19	88	44	66	0.00	6.94	1.11
WEEK 48	26-02	0	26.4	10.1	18.25	93	48	70.5	0.00	5.56	0.00
WEEK 49	Dec 03-08	0	24.8	7.1	15.95	94	46	70	0.00	5.00	0.00

S.W.- Standard week, D.H.- Dead Hearts, W.E.- White ear, Max.- Maximum, Min.- Minimum, Morn.- Morning, Even.- Evening,

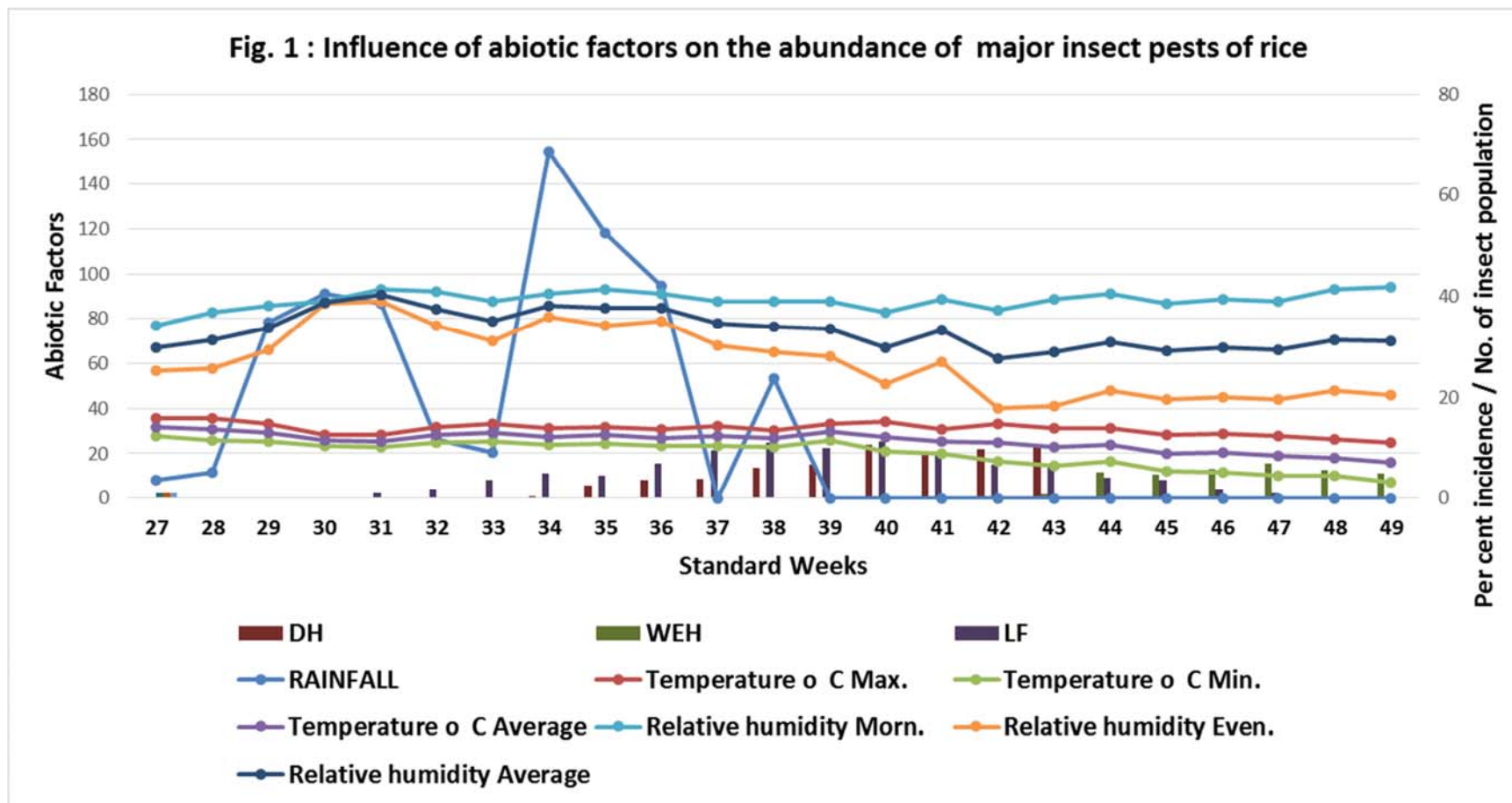


Table 2: Correlation coefficient (r) of insect pest population on rice with prevailing weather parameters during *Kharif* 2018

Insect Pests		Weather parameter						
		Rainfall (mm)	Temperature			Relative Humidity		
			Maximum	Minimum	Average	Morning	Evening	Average
Yellow stem borer	%DH	-0.440*	0.410	0.559**	0.516*	-0.474*	-0.554**	-0.542**
	%WE	-0.425*	-0.663**	-0.861**	-0.850**	0.285	-0.621**	-0.499*
Leaf folder		-0.474*	0.434*	-0.103	0.059	-0.558**	-0.525**	-0.586**

*. Correlation is significant at the 0.05 level

** . Correlation is significant at the 0.01 level.

Seasonal incidence of Leaf folder (*Cnaphalocrocis medinalis*) and impact of environmental factors on it:

Incidence of rice leaf folder (*C. medinalis*) was recorded as per cent leaf damage per 10 hills out of total number of leaves and the first occurrence of rice leaf folder in terms of folded leaves was during 31st standard week stage with 1.11 per cent damaged leaves per 10 hills (Table-1 & Fig.-1). The per cent leaf damage increased progressively and maximum leaf damage of rice was recorded during 40th standard week stage of the year. The maximum and minimum temperatures at the time of peak incidence were recorded as 34.2 °C and 20.8 °C respectively, whereas the morning RH was 83 per cent and evening RH 51 per cent, correspondingly. After that, the per cent leaf damage started to decline. During 47th standard week when the crop attained maturity only 1.11 per cent leaf damage per 10 hills were recorded (Table- 1 & Fig-1).

The correlation analysis (Table- 2) revealed that per cent leaf damage showed significant negative correlation with morning humidity ($r = - 0.558$), evening RH ($r = - 0.525$), average relative humidity ($r = - 0.586$), rainfall ($- 0.474$). However, a negative non-significant correlation of *C. medinalis* population with minimum temperature ($r = - 0.103$) was observed during cropping season. A positive significant correlation was observed with maximum temperature ($r = 0.434$) and positive non-significant correlation with average temperature ($r = 0.059$).

Conclusion

The incidence of yellow stem borer, *S. incertulas* was first noticed during 3rd week of August and the peak level of pest incidence was noticed during first week of October. The increasing trend of pest activity was observed during September to October. White ears were first observed during 3rd week of October with peak levels noticed during 2nd week of November. The occurrence of pest was mostly during vegetative stage which received most of the rains. These results are found to be closely related with Kakde and Patel (2014), who reported pest incidence reached peak during first week of September (5.58% DH) and 1st week of October (5.79% WE). Similar results were also reported by Kalitha *et al.* (2015).

From the experiment the infestation of yellow stem borer in terms of per cent dead hearts showed positive and significant correlation with minimum temperature and average temperature. Negative significant correlations were found with rainfall, morning relative humidity, evening relative humidity and average relative humidity. Positive non-significant correlation was obtained between incidence of dead hearts and maximum temperature. However, negative significant correlation was found between the infestation in terms of per cent white ears with rainfall, maximum temperature, minimum temperature, average temperature, evening RH and average RH. Morning RH was found to be positive, but non-significantly correlated with white ears occurrence. The results are in close accordance with Kathirvelu *et al.* (2007) [6] who reported stem borer incidence was significant and negatively correlated with all the weather factors except rainfall. Similarly, Somashekara and Javaregowda (2015) reported that stem borer incidence had negative correlation with evening RH and rainfall.

It was found that, the occurrence of rice leaf folder was first noticed during 4th week of July and the peak level of pest incidence in terms of folded leaves were observed during 1st week of October. The leaf folder infestation gained speed during 4th week of August to 4th week of September and this

trend remained till 1st week of October. The results were found to be concurrent with Kakde and Patel (2014) [3] who observed that leaf folder incidence attained peak during 4th week of September. Khan and Ramamurthy (2004) [7] also revealed that the pest incidence of leaf folder attained peak during first week of October.

From the correlation studies, it was conferred that incidence of leaf folder has significant negative correlation with rainfall, morning RH, evening RH and average RH. Positive significant correlation was found with maximum temperature. However, non-significant negative correlation was found with minimum temperature and non-significant positive correlation with average temperature. The results are in accordance with Rai *et al.* (2000) [10] who reported temperature, relative humidity and rainfall were negatively correlated with leaf folder incidence.

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