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Seasonal variation in major insect pests incidence on rice and impact of various abiotic factors on their incidence under Varanasi conditions

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Abstract
An experiment was carried out under field conditions at the Agricultural Research farm of Institute of Agricultural Sciences, Banaras Hindu University, Varanasi to study the seasonal abundance of major insect pests of rice, during *kharif,* 2014-15. Incidence of yellow stem borer was started from last of July with its peak during second week of October and showed a positive significant correlation with evening and average humidity and a positive non-significant correlation with morning humidity and rainfall. BPH appeared in rice crop during first week of August and reached at highest level during 2nd week of October. Later on the population decreased as the crop reached the harvesting stage. The correlation analysis of Brown plant hopper revealed a positive non-significant correlation with rainfall, temperature and relative humidity. The incidence of leaf folder infestation was commenced during first fort night of August and the larval population increased gradually till 38th week with 10 larvae/ 10 hills. Gundhi bug was first observed during 2nd week of September and showed a positive non-significant correlation with morning RH and negative non-significant correlation with temperature.

Keywords: Rice insect pests, seasonal incidence, abiotic factors, Varanasi

1. Introduction
Rice, *Oryza sativa* (Linnaeus) is one of the important cereal crops, being the staple food for more than 65 per cent of the world population [1]. It is cultivated in almost all the tropical, sub-tropical and temperate countries of the world. One of the major constraints of rice production and low productivity in India is the occurrence of insect pests at various stages of the crop growth. The rice plant is subject to attack by more than 100 species of insects and 20 of them can cause economic damage [2].

The rice crop is subjected to sustain damage by considerable number of pests among them the yellow stem borer *Scirpophaga incertulas* (Walker) is the principle devastator causing 'dead heart' and 'white ear' leading to major economic damage [3]. 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 [4]. The larvae fold the leaves and scrape the green tissues of the leaves and cause scorching and leaf drying. The yield loss caused by leaf folder reported to the extent of 5 to 25% [5]. There are sucking pests like brown plant hopper (BPH) *Nilaparvata lugens* (Stål) Rice gundhi bug, *Leptocorisa acuta* (Thunberg) which cause damage by sucking cell sap. The brown plant hopper (BPH) is economic important pest and they damage plants directly by sucking the plant sap and by ovipositing in plant tissue causing plant wilting or hopper burn [6]. Damage to the rice crop is caused directly by feeding on the phloem [7] and indirectly by transmitting plant viral disease like grassy stunt viruses [8]. The rice Gundhi bug sucks the sap from the peduncle, tender stem and milking grains turning them chaffy.

Recently, emphasis is being given on ecological based pest management strategies. The main components of any pest management programme is to study the incidence period of the pest, population distribution on crop and regular monitoring or survey of field. Seasonal incidence studies helps in planning need based application of insecticides as it clearly 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 (environmental factors) and biotic (natural enemies) factors of an area.

In the current experiment an attempt was made to know the effect of abiotic factors on the pest population trend on rice crop during *kharif* 2014.

2. Materials and methods

2.1 Experimental layout

The experiment was conducted during the *kharif*, 2014-15, at the Agricultural Research Farm, B.H.U., Varanasi. India. In the experiment, the variety under supervision 'Malviya Dhan-36' was grown for this study. Later the seedlings of sufficient age were transplanted to main field with a spacing of 20 × 15 cm^2 in hills 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.

2.2 Collection of Insects

Seasonal incidence of insect pests on rice was studied on a separate bulk plot of $100m^2$. The nursery was raised adjacent to the main experiment plot so as to study the population build up of the pests. 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 Agricultural Research farm, B.H.U., Varanasi, to work out relationship between the occurrence of insect pests and weather parameters.

2.3 Observation and Analysis

In case of yellow stem borer (YSB), *Scirpophaga incertulas*, the population counts were taken on number of dead hearts/white ears and total number of tillers/panicle from 10 randomly selected hills [9]. The per cent incidence (dead heart/ white ears) was calculated as follows:

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

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

$$\text{Percent Incidence} = \frac{\text{Number of damaged leaves}}{\text{Total number of leaves}} \text{ X } 100$$

The number of motile (adult and nymphs) stages of brown plant hoppers (BPH), *Nilaparvata lugens* on all the 10 hills was recorded and total count was averaged and expressed in per hill basis [11]. And for the observations of gundhi bug (*Leptocorisa acuta*), the population was recorded by sweeping insect colleting nets five times across each treatment and the numbers of nymphs and adults were counted [12].

Weekly data of pest population were correlated with the prevailing climatic factors such as maximum Temperature, minimum temperature, morning and evening relative humidity, rainfall and natural enemy population prevailing in the field. The correlation coefficient (r) analysis was carried out by using Microsoft Excel software 2013.

3. Results and Discussion

In the present study, Yellow stem borer appeared in rice crop during last week of July (i.e. 30th July days after transplantation) and the pest population reached its peak level during the second week of October (8.05) (Table 1, Fig 1). But the actual shootout was started from first week of September. Thus, the maximum activity of pest is observed from September - October. However, in case of white ears the rise was gradual and reached its highest level during first week of November (8.42). 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 = 0.609 & 0.558) and a positive non-significant correlation observed with morning relative humidity and rainfall (r = 0.045 & 0.53) (Table 2). A positive significant correlation was observed with temperature with r = 0.732. The incidence of borers was higher in the vegetative stage as compared to reproductive stage. Similar result was earlier obtained as the incidence of borers was higher in the vegetative than in the reproductive stage in both seasons on rice [2, 13]. However, the per cent white ears are found to be in a negative significant correlation with rainfall, evening and average RH and temperature. And anon-significant positive correlation was observed with morning RH. Further, similar result regarding white ear head was obtained i.e. significant positive correlation with relative humidity and negative correlation with minimum temperature and rainfall.

The incidence of leaf folder infestation was commenced during first fortnight of August and the larval population increased gradually till 38th week with 10 larvae/ 10 hills (Table 1, Fig 1). And the pest populations reached its highest level during first week of October (15 larvae/10 hills). Later, the population started declining when the crop attained maturity. Other scientists also reported the infestation of *C. medinalis* varied from 1.4 to 33.2 per cent in rice from July to October [10]. The correlation analysis revealed a positive significant correlation with evening (r =0.580) (Table 2) and average Relative humidity (r =0.565). Similar result of incidence of leaf folder in relation to RH was declared by other scientists [14, 15, 16]. A positive non-significant correlation was obtained with temperature (r =0.366), rainfall (r =0.236) and morning relative humidity (r =0.182). These results are in close association with finding of some scientists, who reported that minimum temperature, temperature gradient, morning relative humidity and average relative humidity had a positive influence on leaf folder population. Others also reported a positive non-significant correlation between rainfall and *C. medinalis* [17].

In the present studies, BPH appeared in rice crop during first week of August (2/ 10 hills) and its activity gained momentum during the third week of August and reached highest level during 2nd week of October (32/ 10 hills) (Table 1). Later on the population of Brown plant hopper decreased as the crop reached the harvesting stage around 3rdweek of November. The correlation analysis of *N. lugens* revealed a positive non-significant correlation of pest population with rainfall (r =0.292), temperature (r =0.295) and relative humidity (r =0.543) (Table 2). A similar influence of daily relative humidity and mean temperature on *N. lugens* was also obtained by various researchers [18, 19, 20].

Gundhi bug was first observed during 2nd week of September (1 bug/ 5 sweep nets) and its activity gained momentum during the third week of September and reached highest level during 4th week of October (16 bugs/ 5 sweep nets) (Table 1, Fig 1). The pest was observed on the crop from tillering stage

to harvest of crop [21, 22, 23]. The correlation analysis revealed a positive non-significant correlation with morning Relative humidity (r =0.168) and negative non-significant correlation with temperature (r =-0.459), while the remaining weather parameters are negative and non-significantly correlated with the population (Table 2).

Table 1: Influence of abiotic factors on seasonal incidence of major insect pests on rice (*Kharif*, 2014)

Standard Week	Respective Month and Dates	Rainfall (mm)	Temperature (^{0}C)			Relative Humidity (%)			*S. incertulas* Percent incidence/ 10 hills		*C. medinalis* (larvae/10 hills)	*L. acuta* (No. of insects/5 sweep nets)	*N. lugens* (No. of insects/ 10 hills)
			Max.	Min.	Avrg.	Morn.	Even.	Avrg.	% DH	% WE			
30	July 23-29	4.6	33.3	26.6	29.95	82	65	73.5	0	-	0	0	0
31	July 30- Aug 05	46.0	32.8	27.7	30.25	87	74	80.5	0.5	-	0	0	0
32	Aug 06-12	142.7	32.9	26.4	29.65	87	74	80.5	1.10	-	1	0	2
33	Aug 13-19	42.4	23.6	27.6	25.6	86	79	82.5	2.33	-	3	0	5
34	Aug 20-26	14.0	35.1	27.5	31.3	77	60	68.5	3.45	-	4	0	7
35	Aug 27- Sep 02	6.5	33.0	27.1	30.05	84	71	77.5	4.02	-	6	0	10
36	Sep 03-09	34.9	32.7	26.4	29.55	85	69	77	4.55	-	7	0	14
37	Sep 10-16	11.0	31.9	25.8	28.85	91	80	85.5	5.21	-	9	1	18
38	Sep 17-23	13.7	33.3	26.0	29.65	87	72	79.5	6.12	-	10	3	21
39	Sep 24-30	2.1	33.4	24.3	28.85	85	56	70.5	6.82	-	12	5	27
40	Oct 01-07	0.0	32.2	24.2	28.2	79	64	71.5	7.29	-	15	7	30
41	Oct 08-14	50.7	31.2	24.0	27.6	88	68	78	8.05	3.12	13	11	32
42	Oct 15-21	0.0	29.8	19.8	24.8	88	69	78.5		7.14	11	15	27
43	Oct 22-28	6.2	29.8	19.2	24.5	83	58	70.5	-	7.78	9	16	17
44	Oct 29- Nov 04	0.0	30.4	18.0	24.2	85	41	63	-	8.25	6	11	13
45	Nov 05-11	0.0	31.4	16.3	23.85	86	39	62.5	-	8.42	3	6	5
46	12-18	0.0	27.5	13.6	20.55	83	37	60	-	8.51	1	1	1

Legends: YSB- Yellow stem borer, BPH- Brown plant hopper, DH- Dead heart, WE- White ear head

Table 2: Correlation coefficient (r) of insect pest population on rice with prevailing weather parameters during *Kharif*, 2014

Insect Pests		Weather parameters						
		Rainfall (mm)	Relative Humidity			Temperature		
			Morning	Evening	Average	Maximum	Minimum	Average
Scirpophaga incertulas	%DH	0.53	0.045	0.609*	0.558*	0.603*	0.756**	0.732**
	%WE	-0.346	0.112	-0.718**	-0.617*	-0.824**	-0.942**	-0.935**
Cnaphalocrocis medinalis		0.236	0.182	0.580*	0.565*	0.204	0.421	0.366
Leptocorisa acuta		-0.087	0.168	-0.133	-0.078	-0.478	-0.431	-0.459
Nilaparvata lugens		0.292	0.272	0.531	0.543	0.143	0.349	0.295

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

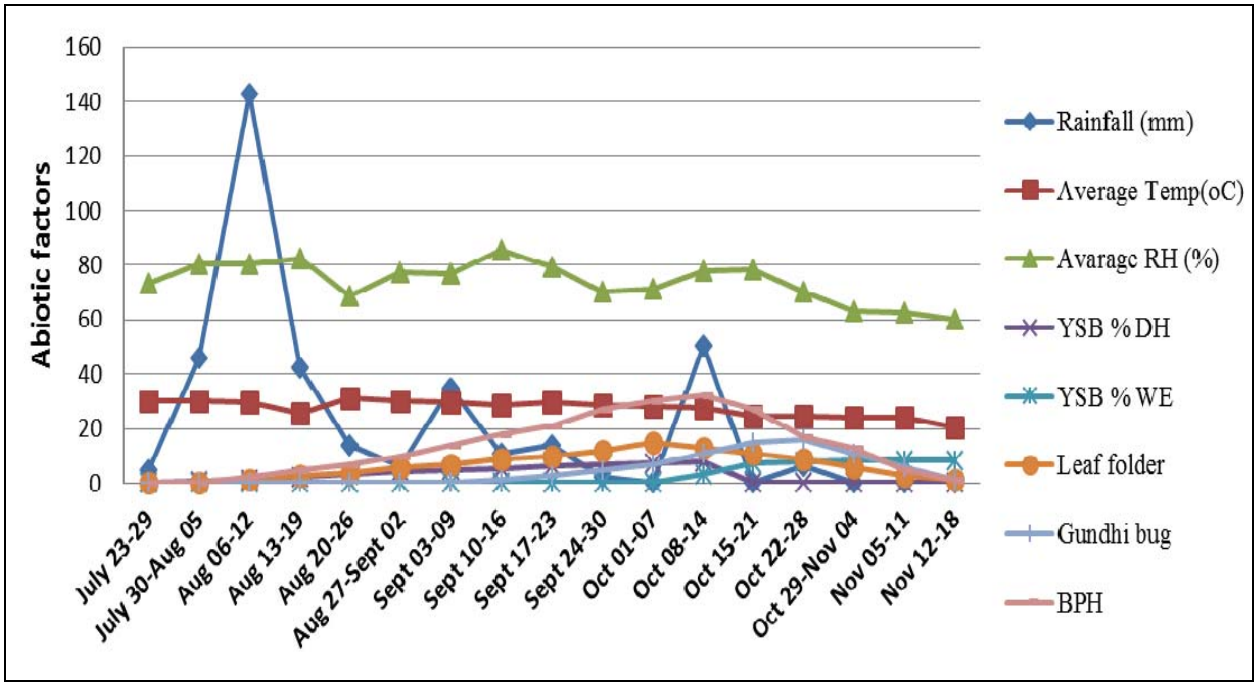

Fig 1: Influence of abiotic factors on the abundance of various insect pests on rice

4. Conclusion

The above research on major insect pests of rice revealed that the incidence of yellow stem borer or the per cent dead hearts were observed highest during at vegetative phase of plant and per cent white ears were highest during reproductive phase of the crop. So if it was controlled at early stage it would not have loss in reproductive phase. The incidence of leaf folder infestation commenced during first forth night of August and attained its peak population during October month. The leaf folder population didn't get affected by rainfall, morning RH and temperature, so it was better to take preventive measures from the start of August month. The seasonal incidence revealed that the population of BPH was appeared in rice crop during first week of August *i.e.* after getting medium shower of rain and the population increase with increase in rainfall as positive correlation was observed with rainfall. Gundhi bug seems to attack the crop mostly during grain filling to milking stage of crop and causes greater loss by producing chaffy grains. The bugs can be easily controlled by collecting adults through sweep nets during early September or by dusting pesticides on field. The unusual winter rainfall caused great reduction of bug population, so the bugs showed positive but non-significant correlation with the rainfall. These findings could be helpful for proper and timely management of the major pests of rice in Varanasi regions.

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