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Seasonal incidence of insect pests on rice and impact of various abiotic factors on their incidence

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Abstract
The incidence of brown plant hopper (*Nirparvata lugens* (Stal.) was started from 32nd MW i.e. first week of September with its peak during 42nd MW i.e. third week of October. The continuous increase in population of brown plant hopper was recorded since 36th MW to 42nd MW. Incidence of brown plant hopper showed significant negative correlation with rainfall (r = -0.488), morning relative humidity (r = -0.614) and positive correlation with maximum temperature. The incidence of stem borer was commence during 34th MW and increased gradually 37th MW. The incidence of leaf folder was initiated in 37th MW and reached to its peak in 40th MW. The correlation analysis regarding leaf folder and stem borer revealed a significant positive correlation with maximum temperature and significant negative correlation with evening humidity, respectively.

Keywords: Rice insect pests, seasonal incidence, abiotic factors, brown plant hopper, yellow stem borer, leaf folder

Introduction
India is world's second largest rice producer and consumer next to China. In India total area under rice 43.79 million hectors with production of 109.70 million tonnes with productivity of 2494 kg/ha (Anonymous, 2018) [1]. However, in Maharashtra state it is cultivated over an area about 14.66 lakh/ha with production about 34.19 lakh tonnes having productivity 1.84 tonnes/ha (Anonymous, 2018) [2]. Major Rice growing districts in Maharashtra are Thane, Ratnagiri, Raigad, Sindhudurg Kolhapur and Nashik.

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 (Mathur *et al*., 1999) [3]. It is cultivated in almost all the tropical, subtropical 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 crop is subject to attack by more than 100 species of insects and 20 of them can cause economic damage (Pathak and Khan, 1994) [4]. The rice crop is subjected to sustain damage by considerable number of pests among them. 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 (Turner *et al*., 1999) [8]. Damage to the rice crop is caused directly by feeding on the phloem (Sogava, 1992) [9] and indirectly by transmitting plant viral disease like grassy stunt viruses (Powell *et al*., 1995) [10]. The yellow stem borer *Scirpophaga incertulas* (Walker) is the principle devastator causing 'dead heart' and 'white ear' leading to major economic damage (Satpathi *et al*., 2012) [5]. 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 (Nanda *et al*., 2000) [6]. 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% (Kulgagod *et al*., 2011) [7]. 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* 2019.

Materials and Methods

The experiment was conducted during the *kharif*, 2019, at the Agricultural Research Station Farm, Igatpuri Maharashtra India. In the experiment, the variety Indrayani was grown for this study. Later the seedlings of sufficient age were transplanted to main field with a spacing of 20 × 15 cm2 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.

Seasonal incidence of insect pests on rice was studied on a separate 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 Station, Igatpuri farm, to work out relationship between the occurrence of insect pests and weather parameters.

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 (Justin and Preetha, 2013) [11]. In case of leaf folder, *Cnaphalocrocis medinalis* the number of leaf folder larvae/10 hills were recorded by selecting 10 hills randomly (Powell *et al*., 1995) [10]. 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 (Sogava, 1992) [9]. The per cent incidence (dead heart/white ears) was calculated as follows:

$$\text{Percent incidence} = \frac{\text{No. of dead hearts (DH)/ white ear heads (WE)}}{\text{Total number of tillers/ panicals}} \text{ x } 100$$

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.

Results and Discussion

In the present studies, BPH appeared in rice crop during first week of August (5.8/hills) and reached highest level during 2nd week of October (38.5/hills) (Table 1). Later on the population of Brown plant hopper decreased as the crop reached the harvesting stage around 3rd week of November. The correlation analysis of *N. lugens* revealed a significant negative correlation with rainfall (r = -0.488) and morning relative humidity (r = - 0.614). A significant positive correlation with maximum temperature (r = 0.519) was observed (Table 2). A similar influence of daily relative humidity and mean temperature on *N. lugens* was also obtained by various researchers (Krishnaiah *et al*., 2005, Khan and Misra, 2003, Jiang *et al*., 2009) [19, 20, 21].

The incidence of leaf folder infestation was commenced second week of September and the larval population increased gradually till 40th week with 6.5 larvae/ 10 hills and the pest populations reached its highest level during first week of October (6.5 larvae/10 hills) (Table 1). 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 (Pawan *et al*., 1996) [12]. The correlation analysis revealed that a positive significant correlation with maximum temperature (r =0.529) (Table 2) and negative non significant correlation minimum temperature (r = -0.0179), evening relative humidity (r = -0.314), morning relative humidity (r = -0.281) and rainfall (r = -0.337). Similar result of incidence of leaf folder in relation to RH was declared by other scientists (Sabir *et al*., 2006, Khan and Ramamurthy, 2004, Hafeez *et al*., 2010) [15, 16, 17]. 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 influence on leaf folder population. Others also reported a positive non-significant correlation between rainfall and *C. medinalis* (Boopathi, 2012) [18].

In the present study, Yellow stem borer appeared in rice crop during third week of August and the pest population reached its peak level during the second week of September (14.00) (Table 1). Thus, the maximum activity of pest is observed from August to September. However, in case of white ears the rise was gradual and reached its highest level during first week of November (5.71). The correlation analysis revealed that the yellow stem borer incidence (i.e. % dead heart) showed a positive non significant correlation with morning and minimum temperature (r = 0.339 & 0.195) (Table 2). A negative non significant correlation was observed with maximum temperature with r = 0.373. 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 (Pathak and Khan, 1994, Pujari and Bora, 2007) [4, 14]. However, the per cent white ears are found to be in a negative non significant correlation with rainfall, morning RH and minimum temperature. A negative significant correlation was observed with evening relative humidity. Further, similar result regarding white ear head was obtained i.e. significant negative correlation with relative humidity and negative correlation with minimum temperature and rainfall.

The incidence of yellow hairy caterpillar, long horn caterpillar and semilopper were also recorded on rice crop in low to medium intensity. The incidence of yellow hairy caterpillar, long horn caterpillar and semilopper was starter in 37th, 36th and 36th MW and reached to its peak in 38th MW (1.8), 39th MW (1.2) and 37th MW (1.0), respectively. The incidence of natural enemies as spiders were not observed. The correlation analysis regarding yellow hairy caterpillar, long horn caterpillar and semilopper showed non significant correlation with various weather factors.

Table 1: Seasonal incidence of various pests infesting rice (Kharif 2019)

MW	Period	No. of BPH / hill	No. of Leaf folder larvae / hill	% Infestation of yellow stem borer		No. of Hairy catter piller/ hill	No. of Long horn catter piller/ hill	No. of semi looper/ hill	Temperature (°C)		Humidity (%)		Rain fall (mm)	Rainy Days
				% DH	% WE				Max	Min	Mor	Eve		
30	23 -29.7.19	0	0	0	0	0	0	0	25.5	22.2	98	95	724.8	5
31	30.7-5.8.19	0	0	0	0	0	0	0	23.3	21.5	100	100	1210.8	7
32	6-12.8.19	5.8	0	0	0	0	0	0	23.8	22.1	99	93	444.5	7
33	13-19.8.19	9.6	0	0	0	0	0	0	25.1	22.0	98	94	112.4	7
34	20-26.8.19	10.6	0	7.0	0	0	0	0	25.6	21.9	97	84	101.5	6
35	27-2.9.19	7.7	0	9.0	0	0	0	0	25.9	21.8	96	85	180.4	7
36	3-9.9.19	9.0	0	10.0	0	0	0.8	0.6	24.6	21.7	100	99	278.7	7
37	10-16.9.19	10.5	1.3	14.0	0	1.4	1.0	1.0	23.7	21.4	99	96	279.4	7
38	17-23.9.19	14.2	3.7	12.0	0	1.8	1.0	0	27.3	21.7	92	78	80.2	5
39	24-30.9.19	27.4	4.1	0	0	1.4	1.2	0	27.6	22.0	94	87	96.1	5
40	1-7.10.19	31.9	6.5	0	0	0	0	0	28.5	20.9	95	79	74.4	4
41	8-14.10.19	33.5	6.2	0	0	0	0	0	30.4	21.7	78	59	0.0	0
42	15-21.10.19	38.5	1.0	0	0	0	0	0	28.9	19.9	70	63	14.0	2
43	22-28.10.19	12.5	0	0	1.42	0	0	0	26.7	20.8	88	77	104.8	4
44	29-4.11.19	0	0	0	4.61	0	0	0	29.7	21.8	88	63	51.1	4
45	5-11.11.19	0	0	0	5.71	0	0	0	28.8	19.8	88	60	1.8	0

Table 2: Correlation coefficient (r) of insect pest population on rice with prevailing weather factors during *kharif* 2019

Insect pest	Weather factors				
	Rainfall (mm)	Relative Humidity %		Temperature (0C)	
		Morning	Evening	Maximum	Minimum
Brown Plant Hopper	*-0.488	*-0.614	-0.387	*0.519	-0.289
Leaf folder	-0.337	-0.281	-0.314	*0.529	-0.0179
Stem borer (WE%)	-0.275	-0.234	*-0.578	0.4547	-0.4468
Stem borer(DH%)	-0.088	0.339	0.323	-0.373	0.195
Yellow Hairy caterpillar	-0.135	0.129	0.145	-0.064	0.1674
Long horn caterpillar	-0.1100	0.2397	0.3046	-0.1673	0.2124
Semi looper	0.0520	0.3061	0.3989	-0.4289	0.0321

*Correlation is significant at 0.5 level when value of r is greater than 0.497

**Correlation is significant at the 0.1 level when value of r is greater than 0.426

Conclusion

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. 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 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 September and attained its peak population during October month.

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