Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(3): 822-825
Received: 21-03-2020
Accepted: 25-04-2020

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

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Abstract
Rice is one of the most important cereal crops grown throughout the world. Sometimes we do not get optimum production and productivity despite of using improved agronomic practices for rice cultivation. A great range of insect pests cause damage to rice plants at different stages of life cycle starting from seedling stage upto maturity. Among several insect pests, sucking pests such as brown plant hopper, green leaf hopper, gundhi bug are considered as most destructive and responsible for severe yield losses as both nymphs and adults suck plant sap, thereby devitalizing plants. These also act as vectors of several plant diseases. The incidence pattern of sucking 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 on pest incidence was established by calculating correlation coefficients. It provides as a reference for selecting suitable management practices for reducing pest population.

Keywords: Sucking pest, Brown plant hopper, Green leaf hopper, Gundhi bug, Seasonal incidence, Environmental factors

Introduction
Rice (*Oryza sativa* L.) is one of the most important crops grown throughout the world and is staple foods for the half of the world's population (Khush, 1997) [10]. It is cultivated in different regions of the world ranging from, all the tropical, sub-tropical nations to calm nations as well. Several factors are responsible for reduced yields in rice, from which insect-pests infestation is the most important factor in the successful cultivation of rice. Rice plant is attacked by more than 100 species of insects and among them 20 have ability 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) [3, 12, 1]. From these, most prevalent are Yellow stem borer *(Scirpophaga incertulas),* Leaf folder (*Cnaphalocrocis medanalis),* Gall midge *(Orseolia oryzae),* Brown plant hopper *(Nilpravata lugens),* Green leaf hopper *(Nephotettix nigropictus, Nephotettix virescens*), Gundhi bug (*Leptocorisa acuta*), Case worm (*Nymphula depunctalis*) and several others.
Seasonal incidence is the study of how and why population fluctuates temporally and spatially in the agro-ecosystem. Understanding of seasonal incidence of pests 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 incidenceof sucking 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 centre of Indo-gangetic belt, falling under the sub-humid and sub-tropical climate zone.
A bulk plot of 100 m^2 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

Hoppers

The number of nymphs and adults of brown plant hoppers as well as green leaf hoppers per ten randomly selected hills were counted at seven days interval.

Gundhi bug

The number of nymphs and adults of gundhi bug per five sweep net were counted at seven days' interval during panicle formation stage.

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 Brown Plant Hopper (*Nilaparvata lugens)* and impact of environmental factors on it

The number of adults and nymphs of brown plant hopper were counted per 10 hills and the initial occurrence of BPH was observed during 33rd standard week as 1 insect per 10 hills (Table-1). At the time of initial infestation of brown plant hopper, maximum and minimum temperatures prevailed were 33.3 °C and 25.3 °C respectively with 88 per cent morning and 70 per cent evening RH. The population of brown plant hopper increased at steady rate and highest population of 17.33 insects per 10 hills were observed during 40th standard week with corresponding maximum temperature, minimum temperature, morning RH and evening RH of 34.2°C, 20.8 °C, 83 and 51 per cent, respectively. Later the downfall of the pest population was started from 41st standard week with 14.33 insect per 10 hills. During 46th standard week when the crop attained maturity only 0.67 insects per 10 hills were recorded (Table- 1).

Correlation coefficients were calculated between population of brown plant hopper and different abiotic factors (Table- 2), which indicated that the population of BPH had significant and negative correlation with morning relative humidity (r = - 0.439). Further, the population of brown plant hopper has significant positive correlation with maximum temperature (r =0.568). Non-significant positive correlation was obtained with minimum temperature (r = 0.299), average temperature (r= 0.406), whereas non-significant negative correlation was obtained with rainfall (r = -0.207), evening relative humidity (r= -0.113) and average relative humidity (r = - 0.181). (Table-2)

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

S.W.	Month & Date	RAINFALL (mm)	Temperature ° C			Relative humidity			BPH (No. of insects/ 10 hills)	GLH (No. of insects/ 10 hills)	GB (No. of insects/ 5 sweep nets)
			Max.	Min.	Average	Morn.	Even.	Average			
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	0.00
WEEK 32	Aug 06-12	26.6	31.8	24.7	28.25	92	77	84.5	0.00	0.00	0.00
WEEK 33	13-19	20.4	33.3	25.3	29.3	88	70	79	1.00	0.00	0.00
WEEK 34	20-26	154.8	31.1	24	27.55	91	81	86	3.33	0.00	0.00
WEEK 35	27-02	118.4	32	24.3	28.15	93	77	85	6.33	2.00	0.00
WEEK 36	Sep 03-09	94.6	30.6	23.6	27.1	91	79	85	10.33	4.00	0.00
WEEK 37	10-16	0	32.4	23.6	28	88	68	78	12.33	5.00	0.00
WEEK 38	17-23	53.4	30.5	22.8	26.65	88	65	76.5	15.67	8.33	0.00
WEEK 39	24-30	0	33.4	25.9	29.65	88	63	75.5	16.67	9.33	0.00
WEEK 40	Oct 01-07	0	34.2	20.8	27.5	83	51	67	17.33	10.67	0.00
WEEK 41	08-14	0	31	20	25.5	89	61	75	14.33	12.67	0.00
WEEK 42	15-21	0	33.4	16.5	24.95	84	40	62	11.00	12.67	0.67
WEEK 43	22-28	0	31.5	14.4	22.95	89	41	65	9.00	15.67	4.33
WEEK 44	29-04	0	31.1	16.7	23.9	91	48	69.5	7.33	14.67	7.33
WEEK 45	Nov 05-11	0	28.2	12.2	20.2	87	44	65.5	2.33	10.67	10.33
WEEK 46	12-18	0	29	11.7	20.35	89	45	67	0.67	6.33	13.00
WEEK 47	19-25	0	27.9	10.1	19	88	44	66	0.00	2.67	14.67
WEEK 48	26-02	0	26.4	10.1	18.25	93	48	70.5	0.00	0.00	12.00
WEEK 49	Dec 03-08	0	24.8	7.1	15.95	94	46	70	0.00	0.00	5.67

S.W.- Standard week, Max.- Maximum, Min.- Minimum, Morn.- Morning, Even.- Evening, BPH- Brown plant hopper, GLH- Green leaf hopper, GB- Gundhi bug

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
Brown plant hopper	-0.207	0.568*	0.299	0.406	-0.439*	-0.113	-0.181
Green leaf hopper	-0.457*	0.135	-0.278	-0.159	-0.121	-0.540**	-0.520*
Gundhi bug	-0.428*	-0.613**	-0.850**	-0.825**	0.217	-0.642**	-0.534**

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

Seasonal incidence of Green Leaf Hopper (*Nephotettix virescens)* and impact of environmental factors on it

The number of adults and nymphs of green leaf hopper were counted per 10 hills basis. Early pest population appeared on 35th standard week as 2 insects per 10 hills (Table- 1). During this period of initial infestation, the maximum and minimum temperatures prevalent were 32°C and 24.3°C respectively with 93 per cent morning relative humidity and 77 per cent evening relative humidity. The peak populations of 15.67 insects per 10 hills were noticed during 43rd standard week. The maximum and minimum temperatures during initial occurrence of pest are 31.5 °C and 14.4 °C while the morning RH of 89 per cent and evening RH of 41 per cent respectively. From 44th standard week, the insect population began to fall subsequently with 14.67 insects per 10 hills and during 47th standard week population decreased to 2.67 insects per 10 hills. This week witnessed maximum and minimum temperatures of 27.9 °C and 10.1 °C with morning RH of 88 per cent and evening RH of 44 per cent respectively (Table- 1).

The correlation analysis between the population of GLH and abiotic factors indicated that there exists significant negative correlation with rainfall (r = - 0.457), evening relative humidity (r = - 0.540) and average relative humidity (r = - 0.520). There exists non-significant negative correlation with minimum temperature (r = - 0.278), average temperature (r = - 0.159) and morning relative humidity (r = - 0.121). Further, the occurrence of green leaf hopper showed a positive non-significant correlation with maximum temperature (r = 0.135). (Table- 2)

Seasonal incidence of gundhi bug (*Leptocrosia acuta)* and impact of environmental factors on it

The occurrence of *L. acuta* on rice was noted as number of insects (adults and nymphs) per 5 sweepings of sweep nets. Insect population was detected during 42nd standard week when the crop was in milking stage as 0.67 insect per 5 sweep nets. At this time of initial occurrence, the prevailing maximum and minimum temperature were 33.4° C and 16.5° C with 84 per cent morning RH and 40 per cent evening RH (Table- 1). The population was gradually increased and attained its peak on 47th standard week as 14.67 insects per 5 sweep nets. The maximum and minimum temperatures prevailed during peak infestation were 27.9 °C and 10.1 °C respectively with 88 per cent morning and 44 per cent evening RH. There after the population started to decline and reached to 5.67 insect per 5 sweep nets on 49th standard week (Table-1).

The correlation analysis between incidence of rice gundhi bug and abiotic factors (Table-2) revealed that the incidence of gundhi bug has significant negative correlation with evening relative humidity (r = - 0.642), average relative humidity (r = - 0.534), rainfall (r = - 0.428), maximum temperature (r = - 0.613), minimum temperature (r = - 0.850) and average temperature (r = - 0.825). Further, the incidence of gundhi bug showed a positive non-significant correlation with morning relative humidity (r = 0.217).

Conclusion

Brown plant hopper was noticed during 2nd week of August and attained peak level during first week of October. Similar results were reported by Khan and Misra (2003) [9], who reported that the BPH population attained peak during October. Further, Firake *et al.* (2010) [4] found out that the population of brown plant hopper was noticed from last week of August up to third week of September.

The correlation analysis of incidence of brown plant hopper with abiotic factors indicated that there was negative significant correlation with morning RH. Significant positive correlation was obtained with maximum temperature. Also, non-significant negative correlation was obtained with rainfall, evening RH and average RH. Positive non-significant correlation was found with average temperature and minimum temperature. Chaudhary *et al.* (2014) [2] also reported that temperature has positive impact on BPH population. Khan and Misra (2003) [9] also reported positive correlation between temperature and BPH population.

The population of green leaf hopper was first noticed during 4th week of August. Maximum population was observed during 3rd week of October and the pest remained till two weeks before crop harvest. The results are in concurrence with Firake *et al.* (2010) [4] and Kakde *et al.* (2015) [7].

In the present correlation studies of green leaf hopper, negative significant correlation was observed with rainfall, evening RH and average RH. A negative non-significant correlation was obtained with morning RH, minimum temperature and average temperature. A positive non significant correlation was observed with maximum temperature. Kakde *et al.* (2015) [7] also reported that minimum temperature and relative humidity had significant negative correlation with occurrence of green leaf hopper.

Gundhi bug incidence was first observed during first week of September and its population increased rapidly from October 3rd week to November 1st week. The pest was observed on the crop from panicle initiation stage to harvesting stage of crop. Girish *et al.* (2012) [5] emphasizing that the pest appeared during reproductive stage of crop, but on the other hand Parwez *et al.* (2012) [11] reported that the activity of pest is started from 15th week crop stage and remained infested throughout the crop period. The crop attained milking stage by 1st week of November, and then the pest population reached its peak during 3rd week of November. Similarly, Kalita *et al.* (2015) [8] also reported that maximum gundhi bug population was noticed during milking stage.

Gundhi bug population showed a negative significant correlation with minimum temperature, rainfall, maximum temperature, average temperature, evening RH and average RH, whereas positive non-significant correlation was found with morning relative humidity. These results were in close accordance with Parwez *et al.* (2012) [11] who reported a

negative correlation of maximum temperature and wind velocity with pest incidence, while Gupta *et al.* (2018) [6] reported minimum temperature, rainfall and evening RH has negative impact upon gundhi bug population, which is in close resemblance with our results.

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