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Seasonal incidence of brown plant hopper infesting rice

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Abstract
The present investigation was carried out to study the seasonal incidence of brown plant hopper infesting rice during two consecutive seasons, *viz.*, *Kharif* 2022 and *Kharif* 2023 at Agricultural Research Station Shirgaon Dist. Ratnagiri, under Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. The results revealed that the seasonal incidence of BPH started during the 33rd SMW (0.30) BPH/hill, and reached its peak level in the 39th SMW (19.05) BPH/hill. The weather parameters such as maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, bright sunshine, wind speed, and rainfall play an important role in the abundance of BPH. The investigation revealed that the weather parameters contributed to 58.0 percent in 2022 and 50.0 percent in 2023 of the total variation in the population of BPH on rice.

Keywords: Brown plant hopper, rice, seasonal incidence, weather parameters, relative humidity, *Kharif*, correlation, regression

Introduction

Rice sustains two-thirds of the world's population, which is the main diet for more than 65% of the world's population (Mathur *et al.*, 1999) [9]. The annual production of milled rice grains is nearly 480 million metric tons. People of the Asia Pacific region, parts of the Caribbean and Latin America largely depend on rice for caloric supply and nutrition. Day-to-day consumption of rice is increasing in Africa also (Muthayya *et al.*, 2014) [12].

India ranks 2nd in production followed by China. India has the largest area of land under rice cultivation in the world. In India, the area occupied under rice cultivation is 413.15 lakh hectares with production of 1114.58 lakh tonne and productivity is 2698 kg/ha (MOA&FW, Govt. of India. 2023-24).

In Maharashtra, rice is cultivated over an area of 15.29 lakh hectares with a production of 34.97 lakh tonnes and productivity of 2287 kg/ha. (MOA&FW, Govt. of India. 2023-24). The average productivity of the Maharashtra state is low as compared to other rice-growing states *viz.*, West Bengal, Uttar Pradesh, Punjab, Odisha, Tamil Nadu, Haryana, Andhra Pradesh, etc. West Bengal is the highest rice-producing state in India.

In Konkan, rice is cultivated over an area of 3568.86 hundred hectares with a production of 9465.35 tons and productivity of around 2652.21 kg/ha. The area, production, and average productivity of the Konkan region are more as compared to Western Maharashtra, Marathwada, and Vidarbha. The Konkan region comprises five districts *viz.*, Palghar, Raigad, Thane, Ratnagiri and Sindhudurg. The area under rice cultivation in Raigad district is 960.40 hundred hectares with a production of 2542.23 hundred tonnes, which is the highest in the Konkan region and the productivity of the Konkan region is 2647.05 kg/ha. The area under rice cultivation in Ratnagiri district is 668.76 hundred hectares with a production of 2018.52 hundred tonnes and productivity is 3018.33 kg/ha which is the highest productivity in Konkan region. The area of rice cultivation in Sindhudurg district is 601.65 hundred hectares with a production of 1655.14 hundred tonnes and productivity is 2751.00 kg/ha The area under rice cultivation in Palghar district is 782.02 hundred hectares with a production of 1849.47 hundred tonnes and productivity is 2365.00 kg/ha. Thane is supposed to be the lowest area of rice cultivation at 556.04 hundred hectares with production of 1399.99 hundred tonnes and productivity of 2517.80 kg/ha (Third Advance Estimate

Govt. of Maharashtra 2023-24) [10].

In India, Rice *Oryza sativa* L. is a staple food for over 55% population and is grown in almost all the states. Despite having the largest area of rice cultivation, its yield is among the lowest in the world (Rangi, 1993) [17]. The insect pests constitute one of the major yields limiting biotic stresses for rice crops throughout the world. About 300 species of insects have been reported that attack rice crops in India, of which twenty species have been found to be major including the brown plant hopper, White Backed Plant Hopper, Yellow stem borer and some other insect pests (Singh and Dhaliwal, 1994).

Materials and Methods

To study the seasonal incidence of brown plant hopper infesting rice, the field experiment was conducted at Agricultural Research Station Shirgaon Dist. Ratnagiri, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli during *Kharif* 2022 and *Kharif* 2023. Seedlings of the rice (Ratnagiri-8) were transplanted in the well prepared field. All recommended cultivation practices were followed.

The experimental plot was kept unsprayed throughout the cropping season. For recording the seasonal incidence of brown plant hopper on rice, a separate plot of 500 m^2 area was sown and observations were recorded from transplanting at 7 days intervals till the harvest of the crop. The observation of 10 hills was recorded randomly. (Standard Meteorological Week) and total count was averaged and expressed on per hill basis in the cropping season. The data on the population of *Nilaparvata lugens* (Stål) were correlated with meteorological parameters during the experimental period. The data on BPH infested rice were averaged. The correlation and regression were worked out between the population of BPH and weather parameters by using Microsoft Excel.

Results

Seasonal incidence of BPH infesting rice

The overall mean data of both years revealed that the incidence of the BPH population was in the range of 0.30 to 19.05/hill. The pest incidence started from the 33rd SMW (13th August to 19th August) *i.e.* 0.30 BPH per hill, then incidence increased continuously up to the 39th SMW (24th September to 30th September) and then it showed a declined trend but remained till maturity of the crop. The maximum pest incidence (19.05/hill) was in the 39th SMW (24th September to 30th September) and the minimum pest incidence (0.30/hill) was in the 33rd SMW (13th August to 19th August). The data on seasonal incidence of BPH on rice during *Kharif* 2022, *Kharif* 2023 and overall mean are presented in (Table 1) and graphically depicted in Figure 1.

Table 1: Seasonal incidence of brown plant hopper infesting rice during *Kharif* 2022, *Kharif* 2023 and Mean

Period	SMW	Mean population of BPH/hill		
		2022	2023	Mean
16-July-2022	29	0.00	0.00	0.00
23-July-2022	30	0.00	0.00	0.00
30-July-2022	31	0.00	0.00	0.00
06-Aug-2022	32	0.00	0.00	0.00
13-Aug-2022	33	0.60	0.00	0.30
20-Aug-2022	34	1.20	0.80	1.00
27-Aug-2022	35	3.80	3.60	3.70
03-Sep-2022	36	8.90	6.90	7.90
10-Sep-2022	37	16.20	12.30	14.25
17-Sep-2022	38	21.00	15.40	18.20
24-Sep-2022	39	20.10	18.00	19.05
01-Oct-2022	40	18.20	16.00	17.10
08-Oct-2022	41	15.30	14.10	14.70
15-Oct-2022	42	13.00	11.20	12.10
22-Oct-2022	43	9.10	7.40	8.25
29-Oct-2022	44	5.50	4.80	5.15
05-Nov-2022	45	1.00	0.80	0.90
SD(±)		7.89	6.63	7.24

SMW- Standard Meteorological Week

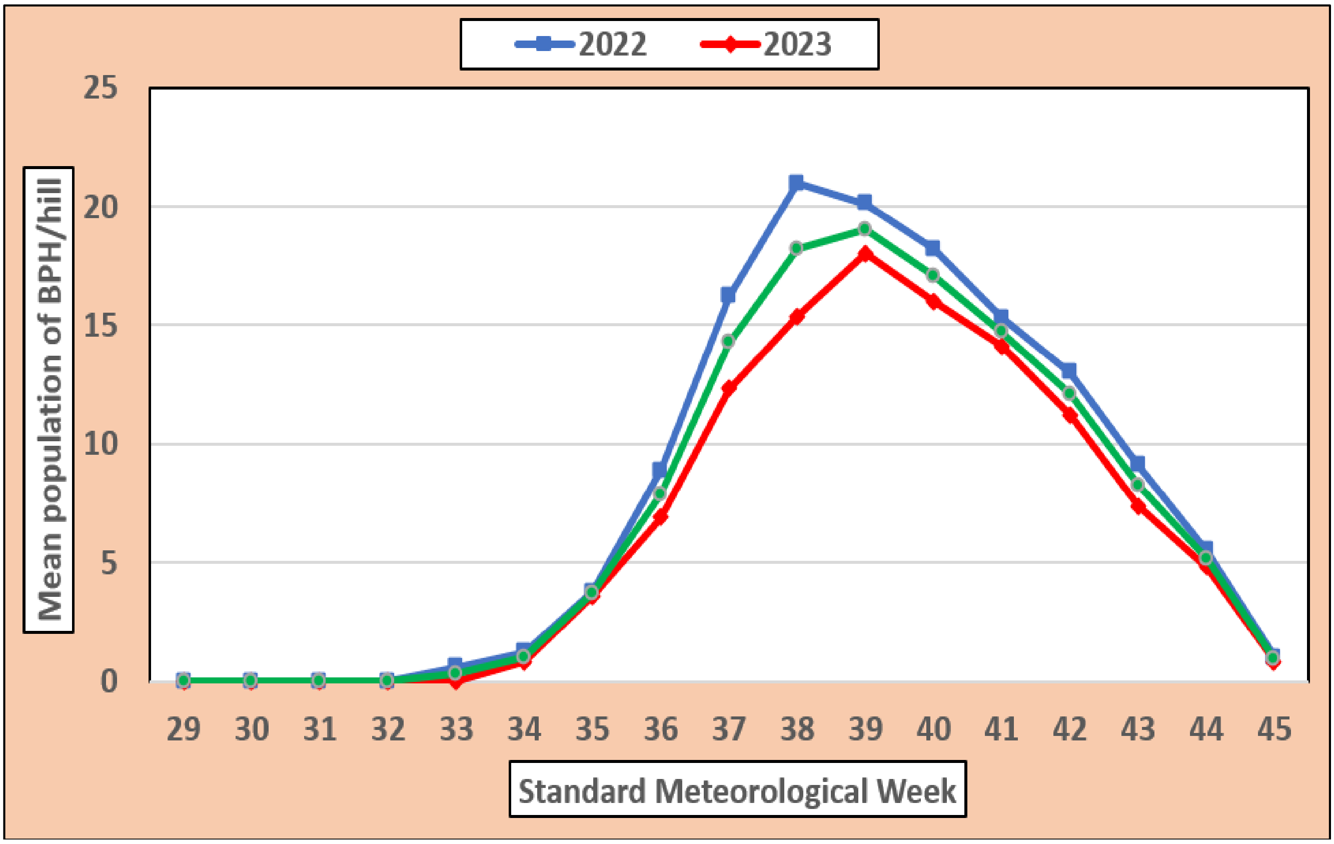

Fig 1: Seasonal incidence of brown plant hopper infesting rice during *Kharif* 2022, *Kharif* 2023 and Mean

Correlation and regression between weather parameters and BPH on rice

Correlation studies

The data on the correlation between weather parameters and BPH population during *Kharif* 2022 and *Kharif* 2023 are presented in (Table 2)

During *Kharif* 2022 the BPH population had a positive non-significant correlation with bright sunshine (r = 0.220) and minimum temperature (r = 0.021). A negative non-significant correlation was recorded between the BPH population and wind speed (r = -0.377), morning relative humidity (r = -0.119), rainfall (r = -0.114), evening relative humidity (r = -0.091) and maximum temperature (r = -0.022).

During *Kharif* 2023 the BPH population showed a positive non-significant correlation with morning relative humidity (r = 0.408), bright sunshine (r = 0.267), and evening relative humidity (r = 0.054). A negative non-significant correlation was recorded between the BPH population and wind speed (r = -0.506), minimum temperature (r = -0.315), rainfall (r = - 0.155) and maximum temperature (r = -0.006).

Table 2: Correlation coefficient of the mean population of brown plant hopper infesting rice in relation to different weather parameters during (*Kharif* 2022, *Kharif* 2023)

Weather parameters	Correlation coefficient (r)	
	2022	2023
Temp. Max.	-0.022	-0.006
Temp. Min.	0.021	-0.315
RH-I	-0.119	0.408
RH-II	-0.091	0.054
BSS	0.220	0.267
WS	-0.377	-0.506
Rainfall	-0.114	-0.155

* Significant at 0.05 level N=17 r = 0.482

Multiple Linear Regression Studies

The multiple regression was worked out between weather parameters and the BPH population during *Kharif* 2022 and regression coefficient (b) and intercept (a) are presented in (Table 3)

The regression equation worked out during *Kharif* 2022 is as follows.

$$Y = 132.873 - 3.871(X1) + 0.712 (X2) + 0.344 (X3) - 0.502 (X4) + 0.356 (X5) - 6.433 (X6) + 0.052 (X7)$$

The coefficient of determination (R^2) represents the proportion of common variation in the two variables. The investigation revealed that the weather parameters contributed to 58.0 percent of the total variation in the population of BPH on rice.

Table 3: Multiple linear regression between weather parameters and population of BPH on rice during *Kharif* 2022

Sr. No.	Weather parameters	Regression coefficient (b)	S.E. (b)	't' values
(X_1)	Temp. Max.	-3.871	2.604	-1.486
(X_2)	Temp. Min.	0.712	1.482	0.480
(X_3)	RH-I	0.344	1.013	0.340
(X_4)	RH-II	-0.502	0.385	-1.305
(X_5)	BSS	0.356	2.153	0.165
(X_6)	WS	-6.433	2.655	-2.422
(X_7)	Rainfall	0.052	0.030	1.730
Intercept (a) =132.873, N=17, F value =1.842, R^2 = 0.58				

During *Kharif* 2023, multiple regression was worked out between weather parameters and the BPH population, and regression coefficients (b) and intercept (a) are presented in (Table 4)

The regression equation worked out during *Kharif* 2023 is as follows.

$$Y = -19.737 + 0.033 (X1) -3.988 (X2) + 1.201 (X3) + 0.114 (X4) + 0.429 (X5) - 1.222 (X6) - 0.005 (X7)$$

The coefficient of determination (R^2) represents the proportion of common variation in the two variables. The investigation revealed that the weather parameters contributed to 50.0 percent of the total variation in the population of BPH on rice.

Table 4: Multiple linear regression between weather parameters and population of BPH on rice during *Kharif* 2023

Sr. No.	Weather parameters	Regression coefficient (b)	S.E. (b)	't' values
(X_1)	Temp. Max.	0.033	2.877	0.011
(X_2)	Temp. Min.	-3.988	2.831	-1.408
(X_3)	RH-I	1.201	1.535	0.782
(X_4)	RH-II	0.114	0.416	0.274
(X_5)	BSS	0.429	1.350	0.318
(X_6)	WS	-1.221	2.073	-0.589
(X_7)	Rainfall	-0.005	0.020	-0.280
Intercept (a) = -19.737, N=17, F value =1.284, R^2 = 0.50				

Discussion

Seasonal incidence of BPH on rice

The mean data of both years revealed that the incidence of the BPH population was in the range of 0.30 to 19.05/hill. The pest incidence started from the 33rd SMW (13th August to 19th August) *i.e.* 0.30 BPH per hill, then incidence increased continuously up to the 39th SMW (24th September to 30th September) and then it showed a declined trend but remained till maturity of the crop. The maximum pest incidence (19.05/hill) was recorded in the 39th SMW (24th September to 30th September) and the minimum pest incidence (0.30/hill) was recorded in the 33rd SMW (13th August to 19th August).

The results of the present findings are discussed here with earlier research workers, the present findings are more or less similar to the following research worker's findings. Verma *et al.*, (2021) [24] recorded the observation of brown plant hopper in rice from 29 th to 45th standard metrological week. The population of BPH was first reported on the 33rd (fourth week of August) standard week with 1.23 BPH/hill. The rice BPH increased gradually and reached a peak level (15.17 BPH/hill) during the 38th standard week (third week of September) when maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity and rainfall were recorded at 33.5 ℃, 23.2 ℃, 93.7, 62.2 percent and 2.3 mm respectively. Mohanta *et al.*, (2020) [11] found that the number of adults and nymphs of brown plant hopper were counted per 10 hills and the initial occurrence of BPH was observed during the 33rd standard week as 1 insect per 10 hills. The population of brown plant hopper increased at a steady rate and the highest population of 17.33 insects per 10 hills was observed during the 40th standard week. Later the downfall of the pest population started from the 41st standard week with 14.33 insects per 10 hills. During the 46th standard week when the crop attained maturity only 0.67 insects per 10 hills were recorded

Kumar *et al.*, (2019) [6-7] showed that the population of BPH, *Nilaparvata lugens* (Stål.) in the rice crop during *Kharif*-2018. The data showed that infestation of brown plant hopper appeared during the first week of August (31st Standard week) and remained in the field till the harvest of the crop (46th Standard week). The abundance of the BPH was low from the 31st week of the year and ranged between 0.78 to 4.64 BPH per hill. Some favorable climatic conditions increased the abundance of rice brown plant hopper in the field from the first week of September (36th Standard week) and reached its peak of 15.87 BPH per hill in the 38th Standard week of the year. The rice brown plant hopper infestation gradually decreased after the middle of September i.e. 38th and 39th standard week. This is caused due to the starting of maturity of rice crops. Varsha *et al.*, (2022) [5] revealed that the initial incidence of BPH was noticed on 1st fort Night of August with 0.02 hoppers/hill and gradually increased where the highest number of hopper/hill was observed during the 1st fort Night of October (4.97 hoppers/hill) followed by 2nd fort Night of September (4.66 hoppers/hill). Sreelatha *et al.*, (2022) [21] reported that brown plant hopper appeared in rice crops during 1st week of August i.e. 32nd S.W. (1/ 10 hills) and its activity gained actual shootout during the 1st week of September i.e. 36th S.W. (5/10 hills) and reached highest level during 1st week of October i.e. 41st S.W. (13/ 10 hills). Later on the population of brown plant hoppers decreased as the crop reached maturity.

Correlation studies

During *Kharif* 2022, the BPH population had a positive non-significant correlation with bright sunshine (r = 0.220) and minimum temperature (r = 0.021). A negative non-significant correlation was recorded between the BPH population and wind speed (r = -0.377), morning relative humidity (r = -0.119), rainfall (r = -0.114), evening relative humidity (r = -0.091) and maximum temperature (r = -0.022).

During *Kharif* 2023, the BPH population showed a positive non-significant correlation with morning relative humidity (r = 0.408), bright sunshine (r = 0.267) and evening relative humidity (r = 0.054). A negative non-significant correlation was recorded between the BPH population and wind speed (r = -0.506), minimum temperature (r = -0.315), rainfall (r = -0.155) and maximum temperature (r = -0.006).

The present findings are more or less similar to following research workers findings. Kumar *et al.*, (2020) [8] observed that the correlation analysis showed that the rice brown plant hopper population showed a non-significant negative correlation with rainfall (r = -0.42) and a non-significant positive correlation with RH (r = 0.13), a non-significant negative correlation for the highest temperature (r = -0.01), lowest temperature (r = -0.11) and temperature average (r = -0.06). Verma *et al.*, (2021) [24] reported that mean BPH population and their correlation with abiotic factors. The infestation of the brown plant hoppers population was correlated non-significant positive with abiotic factors *viz.*, maximum temperature, minimum temperature, R.H. max, R.H. min, (r = +0.0186), (r = +0.175), (r = +0.417), (r = +0.301), whereas were negatively correlated with rainfall (-0.427). Nirala *et al.*, (2015) [13] revealed that there was a non-significant negative correlation with minimum temperature (r = -0.281), evening relative humidity (r = -0.406) and average rainfall (r = -0.339). Similarly, a non-significant positive relationship was noticed with maximum temperature (r = +0.068) and sunshine hours (r = +0.372). The regression equation for morning relative [y = 1779 + (16828); R^2 = 0.245].

Sulagitti *et al.*, (2017) [22] found that the correlation analysis of *N. lugens* had a positive non-significant correlation of pest population with rainfall (r =0.292), temperature (r =0.295) and relative humidity (r =0.543). Varsha *et al.*, (2022) [5] recorded that the results of the correlation between BPH and abiotic factors as a positive non-significant correlation with maximum temperature (0.422), minimum temperature (0.450), morning relative humidity (0.184), evening relative humidity (0.323) and rainfall (0.123). Sreelatha *et al.*, (2022) [21] showed that a negative non-significant correlation with rainfall, morning, evening, average relative humidity, minimum and average temperature (r =-0.064, -0.326, -0.294, -0.311, -0.153 and -0.072 respectively).

Multiple linear regression studies

The regression equation worked out during *Kharif* 2022 is as follows.

$$Y = 132.873 - 3.871(X1) + 0.712 (X2) + 0.344 (X3) - 0.502 (X4) + 0.356 (X5) - 6.433 (X6) + 0.052 (X7)$$

The regression equation worked out during *Kharif* 2023 is as follows.

$$Y = - 19.737 + 0.033 (X1) - 3.988 (X2) + 1.201 (X3) + 0.114 (X4) + 0.429 (X5) - 1.222 (X6) - 0.005 (X7)$$

The present findings are in close agreement with earlier research workers. Yadav *et al.*, (2019) [7] reported that multiple linear regression models (pest-weather models) were developed between monthly mean brown planthopper (BPH), *N. lugens* light trap catches and monthly mean values of minimum temperature (Tmin), maximum temperature (Tmax), morning relative humidity (RH1) and evening relative humidity (RH2) observed at Maruteru, Andhra Pradesh during 2000-2007 *kharif* seasons. Lower coefficient of determination (R^2) values in these models suggested the importance of Tmax, Tmin and RH2 in influencing LTCs of BPH. Therefore, PWRM involving all three weather factors showed a significant influence on BPH LTCs. Eventual PWRM between BPH LTCs and three weather parameters was found to be the best-fit model as logBPH = 27.961 – 0.266 Tmax - 0.507 Tmin – 0.056 RH ($R^2 = 0.674$)

Prasannakumar and Chander, (2014) [25] revealed that the relationship of weather parameters was explored with peaks of brown planthopper (BPH) light trap catch data collected at Mandya (Karnataka) during 1990-2006. Peaks of BPH trap catches, observed between October 4th week and November 3rd week during different years, exhibited significant correlation with Tmax, RH1 and RH2 of October 2nd week, rainfall (RF)of July 2nd week, SSH of October 1st week and Tmin of August 2nd week. Weather-based prediction model for BPH was developed by regressing peaks of BPH light trap catches on mean values of different weather parameters. Of the weather parameters, only Tmax, RF and RH2 were found to be relevant through stepwise regression. The model was validated through 5-year (2002-2006) independent data with R^2 =0.845 and RMSE=7.64%.

Conclusion

The finding of the present investigations, is concluded that the seasonal incidence of BPH started during the 33rd SMW (0.30) BPH per hill, and reached its peak level in the 39th SMW (19.05) BPH per hill. The weather parameters such as maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, bright sunshine, wind speed, and rainfall play an important role in the abundance of BPH. The present investigation would help in monitoring the peak level incidence of major pests like BPH on rice, which is helpful for management of pests. The correlation of weather parameters with rice pests could be helpful in getting information about pest incidence well in time.

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