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Investigation on the Abiotic Influences on Amplitude Fluctuation in the Incidence of Major Pest of Rice in Eastern Uttar Pradesh, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted at Students Instructional Farm, Acharya Narendra deva University of agriculture and technology Kumarganj, Ayodhya (U.P.). during *Kharif* season 2021. The incidence that, the yellow stem borer, leaf folder, green leaf hopper, BPH and gundhi bug were recorded. The

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highest dead heart per cent of yellow stem borer was recorded on rice at 36th SMW (12.97 per hill) and white ear per cent (7.41 per hill) in 44th SMW, leaf folder 41st and 32nd SMW (6.75 & 0.10 per hill), green leaf hopper 43th and 32nd SMW (3.25 & 0.20 nos./hill), BPH 44th and 34th SMW (9.84 & 0.15 nos./hill) and gundhi bug 45th and 40th SMW (1.37 & 0.20 per hill).
Yellow stem borer (dead heart) was showed non-significant positive correlation with rainfall, minimum, maximum temperature and sun shine however, relative humidity showed significant positive correlation with dead heart. White ear showed that non-significant negative correlation with rainfall while, minimum, maximum temperature and relative humidity significant negative correlation however, sun shine showed non- significantly positive correlation with white ear. Leaf folder incidence showed non- significant positive correlation with rainfall and relative humidity, maximum and minimum temperature showed non-significant negative correlation, however sun shine showed significant positive correlation. Relative humidity and rainfall exhibited non-significant negative correlations with the incidence of green leaf hopper, although substantial positive correlations with sun shine and minimum and maximum temperatures were observed. Minimum and maximum temperatures, relative humidity, and rainfall all exhibited non-significant negative correlations with the population of BPH; however, sunshiny days revealed a substantial positive link. The incidence of gundhi bug, showed significant negative correlation with minimum, maximum temperature and relative humidity correlation while rainfall and sun shine showed non-significant negative correlation and non-significant positive correlation respectively.

Keywords: Rice; dead heart; population; correlation; abiotic factors.

1. INTRODUCTION

"Rice (*Oryza sativa* L.) is one of the most important stable food crops in the world. It belongs to the family Poaceae and genus Oryza. Around 70% of people worldwide eat rice as a staple diet, and in Asia alone, more than two billion people get 60–70% of their energy from rice" Kumar et al. [1]. It is crucial to our nation's ability to provide enough food for its citizens. It is primarily a food with high caloric content or energy. It has a starch content of around 77%, a protein content of 8% to 10%, and trace amounts of fat, minerals, and crude fiber. According to information made public by the Indian government, 115.63 million tons of rice were produced there annually in 2018–19 (Anonymous, 2019). "It is cultivated all over the tropics, sub-tropics, and temperate countries all over the world. Rice is of two types aromatic and non-aromatic. Out of this, aromatic rice contributes a tiny low portion in rice production. Rice is cultivated besides Pakistan, Iraq, Iran, Afghanistan, Bangladesh, Myanmar, Indonesia and Vietnam together with India. Haryana, Punjab, Uttarakhand and Western U.P. are the most basmati rice producing state of India" [2].

Major and minor pests are defined as insects that harm the paddy plant from the seedling stage till harvest. Stem borers, leaf folders, hoppers, Gandhi bugs, and other dangerous pests are listed among the primary pests. In all regions where rice is grown, including India, Pakistan, Burma, Sri Lanka, China, Japan, the Philippines, and Indonesia, the stem borer is a significant pest of the paddy crop. The larvae of stem borers are harmful stages that solely feed on the internal tissue of the stem and create symptoms in plants such as a dead heart and a white ear head during the vegetative and reproductive stages of the crop, respectively. The stem borer (moth) mature stage never causes any harm. In the life cycle of a stem borer, there are four stages: egg, larva, pupa, and adult.

"Five species of rice stem borers have been identified which are available in South East-Asia namely; Dark headed stem borer *Chilo polychrysus* (Meyrick), Yellow stem borer *Scirpophaga incertulas* (Walker), Pink stem borer *Sesamia inferens* (Walker), Stripped stem borer *Chilo supressalis* (Meyrick) and White borer *Scirpophaga innotata* (Walker)" (DRR, 2006). "Yellow stem borer is the most destructive insect pests of rice crop (Mahar *et al.*, 1985) and responsible for an annual yield loss of 10-15% with local catastrophic outbreaks causing up to 60% damage" [3].

The yellow stem borer *Scirpophaga incertulas,* which causes an annual output loss of between 27 and 34 percent, is regarded as the most significant and damaging pest of rice Prasad et al. [4]. During the vegetative and reproductive stages of rice, the larval feeding of stem borer and their subsequent inter nodal penetration

provide the recognizable symptoms of dead hearts and white ears, respectively Sherawat et al. [5]. In rice fields around the world, YSB alone results in yield losses of 10 mt, or 50% of all insecticide consumption [6].

2. MATERIALS AND METHODS

The field experiment was conducted during *Kharif* season 2021 at student's instructional farm, A.N.D. University of agriculture and Technology, Kumarganj, Ayodhya (U.P.) with the entitles "Investigation on the Abiotic Influences on Amplitude Fluctuation in the Incidence of Major Pest of Rice in Eastern Uttar Pradesh.

2.1 Experimental Site

Geographical location of experiment site fall under subtropical climatic zone of Indo-Gangetic plains and situated at 26.47 °N latitude and 82.12 °E longitude at an altitude of 113 meters above mean sea level. The region receiving mean rainfall about 1200 mm, about 80% of total rainfall is received from mid-June to end of September and periods is known as monsoon months. The winter months are very cold, whereas summer months are hot and dry. Westerly hot winds start from end of April and continue till the onset of monsoon.

2.2 Experimental Layout

It was laid out in randomized block design (RBD). Twenty-four days old seedlings were transplanted in the main field of NDR 2065 at the spacing of 20x15 cm. The plot size 4×3 m, the variety was NDR 2065 and spacing is 20×15 cm.

2.3 Determination of Incidence of Major Insect Pests of Rice

2.3.1 Yellow stem borer

For the purpose of estimating the percent damage, the total number of tillers and panicles as well as the damaged tillers and panicles (DH/WE) were counted on 10 randomly chosen hills in each plot. The observation was begun ten days after the crop was transplanted and maintained at weekly intervals until the crop was harvested. Infestation levels peaked throughout the rice crop's vegetative and reproductive stages, when the incidence of dead hearts (%DH) and white ears (%WE) was highest. The relevant formula from before was used to convert the data into percent (DH/WE).

$$\text{(a) DH \%} = \frac{\text{No.of dead hearts in 10 hills}}{\text{Total number of tillers (dead hearts + healthy tillers) in 10 hills}} \times 100$$

$$\text{(b) WE (\%)} = \frac{\text{Total no.of WE in 10 hills}}{\text{Total no.of panicles (WE+ healthy panicles) in 10 hills}} \times 100$$

2.3.2 Observations on leaf folder

In case of leaf folder, total number of leaves and number of damaged leaves caused by leaf folder were counted on 10 randomly selected plants (hills) with observed in each plot in 7 days interval to calculate percentage of leaf-damage caused by the respective pest species. Mean of 10 plants was calculated.

$$\text{\% Leaf damage (LDLF)} = \frac{\text{Total no.of damaged leaves (LDLF) in 10 hills}}{\text{Total no.of leaves (damaged + healthy) in 10 hills}} \times 100$$

2.3.3 Observations on green leaf hopper, brown plant hopper and gundhi bug

In case of Brown plant hopper (BPH) and Green leaf hopper (GLH) the number of motile (adult and nymph) stages of BPH on all the 10 randomly hills was recorded and total count was averaged and expressed in per hill and for the observations of Gundhi bug, the population was recorded by sweeping insect colleting nets five times across each treatment and the number of nymphs and adults were counted.

2.4 Determination the Correlation Between the Abiotic Factors

The incidence of Major Insect pest of rice will be correlated with the meteorological observation. Meteorological data will obtain from Meteorological department of Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya.

2.5 Determination of Correlation Coefficient

In order to calculate the correlation coefficient between the occurrence of insect pests and weather variables, the data on insect pest occurrence were statistically evaluated.

3. RESULTS AND DISCUSSION

3.1 Incidence of Major Insect Pests of Rice

3.1.1 Incidence of yellow stem borer

The incidence of dead hearts (DH %) and white ear heads (WE %) due to yellow stem borer were recorded from one week after transplanting at weekly interval according to standard weeks till before harvesting. The data presented in Table no.1 revealed that, the incidence of stem borer was initiated from 32nd standard meteorological week (SMW) i.e. second week of August with 0.67 percent dead hearts and gradually attained peak infestation at 36th SMW (12.97% DH) i.e. first week of September. The incidence of stem borer fluctuated, and it again peaked at the 39th SMW during the last week of September with the highest percentage of dead hearts (10.62% DH). The incidence of yellow stem borer then changed and fell once more. Thereafter, incidence of yellow stem borer was continued till harvesting up to 44th SMW (7.41% WE). Similarly, 3.66 percent white ear head was recorded before harvesting during 45th SMW. The present findings on seasonal incidence were agreement with the results, Kharat [7]; Adiroubane and Raja [8]; Kakde and Patel (2014), Patel and Singh [9]; Sulagatti et al. [10]; Samrit et al. [11,12].

3.1.2 Incidence of leaf folder

Periodic measurements on the occurrence of folded/damaged leaves due to leaf folder were made at weekly intervals in accordance with conventional metrological weeks. The data presented in Table no.1 revealed that the incidence of leaf folder was initiated from second week of August (32rd SMW) with 0.10 percent damaged leaves and reached peak level during third week of September i.e., 37th SMW with 3.80 percent damaged leaves. Furthermore, the fluctuation in the incidence were recorded, which again reached second peak infestation during second week of October (41th SMW) with 6.75 percent damaged leaves. Then damage of leaf folder was gradually declined to 0.5 percent at the maturity of crop (45th SMW).The present results are in accordance with the result of Alvi et al. [13]; Subhash et al. [14]; Sankpal [15]; Boopathi [16]; Kakde and Patel [17]; Patil et al. [18].

3.1.3 Incidence of green leaf hopper

The data presented in Table no.1 revealed that the green leaf hopper population initiated from 32nd SMW and remain continued till harvesting (45th SMW). The population of green leaf hopper was very low (0.2 nos./hill) at initiation in second week of August (32nd SMW) and then it gradually increases to attained peak during last week of October (43th SMW) with population of 3.25 nos./hill. Further, the population of green leaf hopper was declined and observed till harvesting i.e., second week of November (45th SMW) with population of 1.13 nos./hill. The present study is in accordance with Kumar and Patil [19]; Shamim et al. [20]; Bisen et al. [21].

3.1.4 Incidence of brown plant hopper

The information in Table No. 1 showed that the brown plant hopper population started on the 34th SMW and remained until the 45th SMW harvest. The brown plant hopper population started off extremely low (0.15 no./hill) in the final week of August (34th SMW), then progressively increased until it reached its peak during the first week of November (44th SMW) with a population of 9.84 no./hill. The population is then monitored through harvest, which occurs in the second week of November (45th SMW), with a population of 4.68 people per hill.The present findings are in accordance with the finding of Choudhary et al. [22]; Soni & Tiwari [23]; Patil et al. [18].

3.1.5 Incidence of gundhi bug

The data presented in Table no.1 revealed that the incidence of gundhi bug was initiated from first week of October (40th SMW) with population of 0.20 nos./hill. Then it gradually increases and attained peak during first week of November (44th SMW) with population of 0.75 nos./hill. Thereafter, the incidence observed till harvest of the crop (45th SMW) with population of 1.37 nos./hill. The present study is in accordance with Krishnhaiah et al. [24]; Sulagitti et al. [10]; Gupta et al. [25].

3.2 To Find out the Correlation between Incidence of Major Insect Pest with Abiotic Factors

3.2.1 Yellow stem borer with weather parameters

The correlation co-efficient analysis data (Table 2) of stem borer (dead heart) incidence

Table 1. Incidence of major insect pests of rice crop during *kharif* 2021

SMW	Yellow stem borer		Leaf folder % damage	GLH (No./hill)	BPH (No./hill)	Gundhi bug (No./hill)	Abiotic factor				
	DH%	WE%					Temprature (ºC)		RH (%)	Rainfall (mm)	Sun Shine (hrs)
							Min (ºC)	Max. (ºC)			
28	0.00	0.00	0.00	0.00	0.00	0.00	27.1	34.8	74.3	00.00	6.7
29	0.00	0.00	0.00	0.00	0.00	0.00	26.8	34.1	80.9	38.0	3.0
30	0.00	0.00	0.00	0.00	0.00	0.00	27.2	34.4	79.6	37.4	4.2
31	0.00	0.00	0.00	0.00	0.00	0.00	26.1	33.2	76.0	3.0	5.9
32	0.67	0.00	0.10	0.20	0.00	0.00	26.2	32.2	85.9	125	3.4
33	4.65	0.00	0.21	0.28	0.00	0.00	26.2	33.8	80.8	18.8	5.4
34	6.25	0.00	0.35	1.36	0.15	0.00	25.5	32.2	87.8	24.6	2.6
35	10.25	0.00	0.68	0.28	0.25	0.00	26.1	32.7	81.2	1.0	5.5
36	12.97	0.00	1.35	0.57	0.66	0.00	26.2	33.7	79.4	42.4	3.9
37	8.91	0.00	3.80	0.87	2.33	0.00	25.5	32.1	78.8	206.0	5.6
38	8.95	0.00	2.15	1.75	2.86	0.00	25.0	31.1	85.8	41.0	6.7
39	10.63	0.00	3.25	1.85	4.33	0.00	25.1	32.2	84.5	63.0	7.3
40	9.53	0.00	5.40	2.35	4.70	0.20	24.5	32.7	82.8	18.0	8.1
41	7.57	0.00	6.75	2.78	5.65	0.30	24.0	34.0	84.5	00	9.0
42	8.16	0.00	4.85	2.85	7.46	0.15	23.6	31.8	81.3	24	6.9
43	0.00	5.48	2.68	3.25	8.50	0.23	18.2	31.1	68.0	00	6.5
44	0.00	7.41	1.7	2.13	9.84	0.75	15.0	27.7	68.3	00	6.6
45	0.00	3.66	0.5	1.13	4.68	1.37	13.7	29.7	69.4	00	6.5

Table 2. Correlation between incidences of major insect pest with abiotic factors

Major Insect-Pest of Rice crop		Abiotic factor				
		Temprature (ºC)		Relative humidity (%)	Rainfall (mm)	Sun Shine (hrs)
		Min (ºC)	Max. (ºC)			
Yellow stem borer	DH%	NS(0.325)	NS(0.120)	0.560	NS(0.226)	NS(0.204)
	WE%	-0.894	-0.785	-0.799	NS(-0.298)	NS(0.195)
Leaf folder % damage		NS(-0.124)	NS(-0.098)	NS(-0.185)	NS(0.088)	0.720
Green leaf hopper (No./hill)		-0.513	-0.482	NS(-0.094)	NS(-0.205)	0.627
Brown plant hopper (No./hill)		-0.760	-0.696	NS(-0.451)	NS(-0.225)	0.633
Gundhi bug (No./hill)		-0.906	-0.668	-0.608	NS(-0.313)	NS(0.321)

showed that rainfall (r = 0.226), non -significant positive correlation while, minimum temperature (r = 0.325), maximum temperature (r = 0.120) non-significant positive correlation and relative humidity (r = 0.560) had significant positive correlation with stem borer. However, sun shine (r = 0.204) showed non-significantly positive correlation with stem borer at 5 % significant level.

The correlation co-efficient analysis data (Table no.2) of stem borer (white ear) incidence showed that rainfall (r = -0.298), non -significant Negative correlation while, minimum temperature (r =-0.894), maximum temperature (r = -0.785) significant negative correlation and relative humidity (r = -0.799) had significant negative correlation with stem borer. However, sun shine (r = 0.195) showed non-significantly positive correlation with stem borer at 5 % significant level. The result of this study is in agreement with Pandey et al. [26]; Patel and Singh [9]; Sulagatti et al. [10]; Pallavi et al. [27]; Sharma et al. [28]; Shyamrao & Raghuraman (2019), Samrit et al. [11,12].

3.2.2 Correlation of leaf folder with weather parameters

The correlation co-efficient analysis data (Table no.2) indicated that rainfall (r = 0.888) non-significant positive correlation relative humidity (r = -0.185) non-significant negative correlation and with leaf folder incidence. and maximum temperature (r = -0.098) had non- significant negative correlation and minimum temperature (r = -0.124) had non-significant negative correlation However sun shine (0.720) showed significant positive correlation with leaf folder incidence at 5 % significant level. The present study is in accordance with Subhash et al. [14]; Kharat [7]; Sankpal [15]; Boopathi [16]; Jasrotia et al. [29].

3.2.3 Correlation of green leaf hopper with weather parameters

The correlation co-efficient analysis data revealed that relative humidity (r = -0.094) non-significant negative correlation population of green leaf hopper and rainfall (r = -0.205) non-significant negative correlation and minimum temperature (r = -0.513) had significant negative correlation and maximum temperature (r = -0.482) had significant negative correlation with population of green leaf hopper. However sun shine (0.627) had significant positive correlation with population of green leaf hopper. The result of the present study is in agreement with Shamim et al. [20]; Satheesha et al. [30].

3.2.4 Correlation of brown plant hopper with weather parameters

“The correlation co-efficient analysis data revealed that, the relative humidity (r = -0.451) had non-significant negative correlation with population of brown plant hopper. and rainfall (r = -0.225) non-significant negative correlation and maximum temperature (r= -0.696) had significant negative correlation with population of brown plant hopper minimum temperature (r = -0.760) showed significant negative correlation However sun shine (0.633) significant positive correlation with population of brown plant hopper at 5% significant level”. Choudhary et al. [22].

3.2.5 Correlation of Gundhi bug with weather parameters

The correlation co-efficient analysis data revealed that, the relative humidity (r = -0.608)

had significant negative correlation with population of Gundhi bug and minimum temperature (r = -0.906) had significant negative correlation while maximum temperature (r = -0.668) significant negative correlation and rain fall (r = -0.313) had non-significant negative correlation However sun shine (0.321) had significant positive correlation with population of Gundhi bug. The present study is in accordance with Sulagitti et al. [10]; Singh et al. [31].

4. CONCLUSIONS

The maximum Stem borer damage (DH) 12.97 per cent were recorded during 36th SW. Minimum dead hearts 0.67 per cent were recorded during 32th SW with minimum temperature. The maximum Stem borer damage (WE) 7.41 per cent were recorded during 44th SW. During the 46th SMW, a minimum of 3.66 percent of White ears were seen. Leaf folder incidence started in the second week of August (32nd SMW), with 0.10 percent of the leaves injured, and peaked in the third week of September, or 37th SMW, with 3.80 percent of the leaves damaged. Green leaf hopper populations began in the 32nd SMW and persisted until harvesting in the 45th SMW. The population of green leaf hopper was very low (0.02 nos./hill) at initiation in second week of August (32nd SMW) and then it gradually increases to attained peak during last week of October (43th SMW) with population of 3.25 nos./hill. The brown plant hopper population was initiated from 34th SMW and remains continued till harvesting 45th SMW. The population of brown plant hopper was very low (0.15 nos./hill) at initiation in the last week of August (34th SMW) and then it gradually increases and attained peak during first week of November (44th SMW) with population of 9.84 nos./hill. The incidence of gundhi bug was initiated from first week of October (40th SMW) with population of 0.20nos./hill. Then it gradually increases and attained peak during first week of November (44th SMW) with population of 0.75 nos./hill.

The stem borer (dead heart) incidence showed that rainfall (r = 0.226), non -significant positive correlation while, minimum temperature (r = 0.325), maximum temperature (r = 0.120) non-significant positive correlation and relative humidity (r = 0.560) had significant positive correlation with stem borer. The correlation of stem borer (white ear) incidence showed that rainfall (r = -0.298), non-significant Negative correlation while, minimum temperature (r =-0.894), maximum temperature (r = -0.785) significant negative correlation and relative humidity (r = -0.799) had significant negative correlation with stem borer and positive correlation with sun shine. The correlation co-efficient analysis indicated that rainfall (r = 0.888) non-significant positive correlation, relative humidity (r = -0.185) non-significant negative correlation with leaf folder incidence. The maximum temperature (r =-0.098) and minimum temperature (r = -0.124) was non-significant negative correlation however, sun shine (0.720) showed significant positive correlation. The correlation co-efficient analysis revealed that relative humidity (r = -0.094) non-significant negative correlation population of green leaf hopper and rainfall (r = -0.205) non-significant negative correlation and minimum temperature (r = -0.513) and maximum temperature (r = -0.482) was showed significant negative correlation, however sun shine (0.627) significant positive correlation with population of green leaf hopper. The correlation co-efficient analysis revealed that, the relative humidity (r = -0.451) and rainfall (r = -0.225) was showed non-significant negative correlation with population of brown plant hopper. The maximum temperature (r = -0.696) and minimum temperature (r = -0.760) showed significant negative correlation, however sun shine (0.633) significant positive correlation with population of brown plant hopper at 5% significant level. The correlation co-efficient analysis revealed that, the relative humidity (r = -0.608), minimum temperature (r =-0.906) and maximum temperature (r = -0.668) was significant negative correlation while, rain fall (r = -0.313) non-significant negative correlation, however sun shine (0.321) significant positive correlation with population of Gundhi bug.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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