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Research Article

Effect of weather variables on the incidence of yellow stem borer (*Scirpophaga incertulas* W.) and leaf folder (*Cnaphalocrocis medinalis* G.) in rice

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Abstract

A study was conducted on rice variety CSR 30 to analyse the impact of abiotic factors on yellow stem borer, *Scirpophaga incertulas* (Walker) and leaf folder, *Cnaphalocrocis medinalis* (Guenee) infestation during *Kharif* season of 2016 and 2017 at Research Farm, Indian Institute of Wheat and Barley Research, Karnal, Haryana. The infestation of yellow stem borer and leaf folder was noticed in the field from 45th SMW during both years of investigation. The maximum damage of 14.9% and14.5% by yellow stem borer was recorded during 38th SMW in 2016 and during 39th SMW in 2017, respectively.The damage by leaf folder attained peak during 3rd week of September (38th SMW) during 2016 and 2017 with 8.4% and 9.7% infestation levels, respectively. Yellow stem borer infestation exhibited significant negative correlation with morning relative humidity (r = -0.506), evening relative humidity (r = -0.620) and rainfall (r = -0.481). The correlation of incidence of leaf folder damage was found to be significantly positive with maximum (r = 0.619) and minimum temperature (r = 0.552). Other weather parameters showed a non-significant positive and negative relationship with the yellow stem borer and leaf folder population. The studies indicated the role of weather parameters on the abundance of yellow stem borer and leaf folder infestation in rice.

Keywords: Correlation, insect-pests, rice, seasonal incidence, weather parameters

1. Introduction

Rice (*Oryza sativa* L.) is the most important staple food crops of the world having huge impact on economical and social stability in many South Asian countries. In India, it constitutes about 52% and 55% of the total food grain and cereal production, respectively. It is grown under diverse ecosystems such as flooded, irrigated, rainfed lowland and upland conditions (Bhumireddy *et al.,* 2018; Dinesh *et al.,* 2018). Amongst the various threats to rice productivity, damage by various types of insect-pests is considered significant as it can cause large scale reduction both in quality and quantity of rice. Worldwide, around 52 per cent of the rice production is lost yearly due to biotic agents, of which 21 per cent is attributed by insect-pests (Yarasi *et al.,* 2008).

More than 100 insect-pest species are exhibited to attack rice crop (Mandal and Mondal, 2018; Sharma *et al.,* 2018). Among them, yellow stem borer (YSB), *Scirpophaga incertulas* (Walk.), plant hoppers [both brown plant hopper; *Nilaparvata lugens* (Stal) and white-backed plant hopper; *Sogatella furcifera* (Horvath)], rice gall midge, *Orseolia oryzae* (Wood-Mason) and leaf folder, *Cnaphalocrocis medinalis* (Guenee) are very important and responsible for huge economic crop losses (Seni and Naik, 2018). The hot and humid environment of rice field is highly conducive for insect-pests' proliferation. In recent times, the insect-pests scenario in rice has changed and the major factors that have contributed towards these changes are extensive cultivation of high yielding varieties, intensified continuous rice cultivation providing constant niches for pest multiplication, imbalanced use of fertilizers and

non-judicious use of insecticides resulting in pest resistance, resurgence and outbreaks of minor pests (Boopathi *et al.,* 2018; Bisen *et al.,* 2019).

Among these, the yellow stem borer (YSB) is considered as one of the most destructive and widely distributed monophagous insect-pest in Indian subcontinent. YSB infests rice plant throughout the cropping period. The extent of yield losses in rice due to YSB has been estimated as 20-70 per cent (Sharma *et al.,* 2018). The presence of this pest in field can be easily identified by "dead heart" or "white ear" in hills at vegetative stage and panicles at reproductive stages, respectively due to larval feeding and subsequent inter-nodal penetration (Dutta and Roy, 2018). Another important lepidopteran pest is leaf folder, which has attained a status of major pest during the last two decades due to indiscriminate use of nitrogenous fertilizers and insecticides (Shyamrao and Raghuraman, 2019). It occurs in all rice growing areas and more abundantly found during the rainy season. The second instar larvae wrap the leaves longitudinally and scrape the greenmatter inside causing leaf scorching and drying symptoms.The leaf folder is reported to exhibit 30 to 80 per cent yield losses in epidemic situation (Boopathi *et al.,* 2018).

In the post-green revolution era, the emphasis has remained on the sustainability and efficiency instead of further amplification of costly inputs such as insecticides because insecticide intensification promotes outbreaks of secondary pests, which were of minor significance in the past such as rice leaf folder (Bilal *et al.,* 2019). Weather plays an important role for determining the geographical distribution and periodic abundance of major insect-pests in rice (Dutta and Roy, 2018). Abiotic factors such as temperature, relative humidity, rainfall etc., have direct or indirect effects on insect-pest population (Hussain *et al.,* 2018). Rainfall is not only crucial for survival, but also for dispersal of insect population. For devising any control method, the knowledge of population dynamics of pest is considered as a pre-requisite (Meena *et al.,* 2018). The management strategies can be easily devised for sound pest management system if the patterns of the infestation are known to the researchers. Therefore, in today's context, the population dynamics based ecological pest management is essential for timely adoption of different IPM strategies and will be helpful in the areas where insect-pests are appearing year after year and causing serious damage to various crops. The attack by these insect-pests is serious in few years and other years it is recorded to be moderate. Keeping this rationale in view, an experiment has been designed to study overall population fluctuation of YSB and leaf folder in rice and its relationship with weather parameters, with ultimate aim to develop best management strategies for the control of these notorious pests.

2. Materials and methods

A field trial was conducted during *kharif* 2016 and 2017 at the Research farm of ICAR-Indian Institute of Wheat and Barley Research (IIWBR), Karnal to study the population dynamics of major insect-pests of rice and to determine the relationship of weather variables with the extent of damage (per cent infestation) caused by these major insect-pests.

To determine the population dynamics of rice insect-pests, rice variety CSR 30 nursery was sown in second week of June and mechanically transplanted during second week of July in main field plots (10 m x 4 m plot size) with row and row spacing of 20 cm and plant to plant spacing of 10 cm with two plants per hill at depth of 3-5 cm. Recommended crop production practices *viz.,* irrigation, fertilizer application and intercultural operations were followed. No insecticide was applied in this field throughout out the growing season. The field was weekly monitored for yellow stem borer and leaf-folder infestation from August to October. Data was collected from ten randomly selected hills per plot. The extent of damage caused by these two major insects was calculated by following equation:-

Percentage of Yellow Stem Borer damage:

$$\frac{\text{Number of deadhearts or white ears in a hill}}{\text{Total number of tillers in a hill}} \times 100$$

Percentage of Leaf folder damage:

$$\frac{\text{Number of Folded leaves in a hill}}{\text{Total number of leaves in a hill}} \times 100$$

The observations taken during each year at weekly intervals starting from 27th to 45th standard week were used to determine the relationship of weather parameters with damage percentage caused by YSB and leaf folder. The weather data was obtained from Meteorological Observatory of ICAR-Central Soil Salinity Research Institute, Karnal. The relationship between weather factors *viz.,* maximum & minimum temperature (°C), morning and evening relative humidity (%), and amount of rainfall (mm) and extent of insect-pest damage was determined by correlation analysis using SAS software (SAS, 2005).

3. Results and discussion

The data on the weekly weather parameters and incidence of yellow stem borer (*S. incertulas*) and leaf folder (*C. medinalis*) recorded during *Kharif* 2016 and 2017 is shown in Figure 1 and Table 1, respectively.

During *Kharif* 2016, the maximum temperature ranged

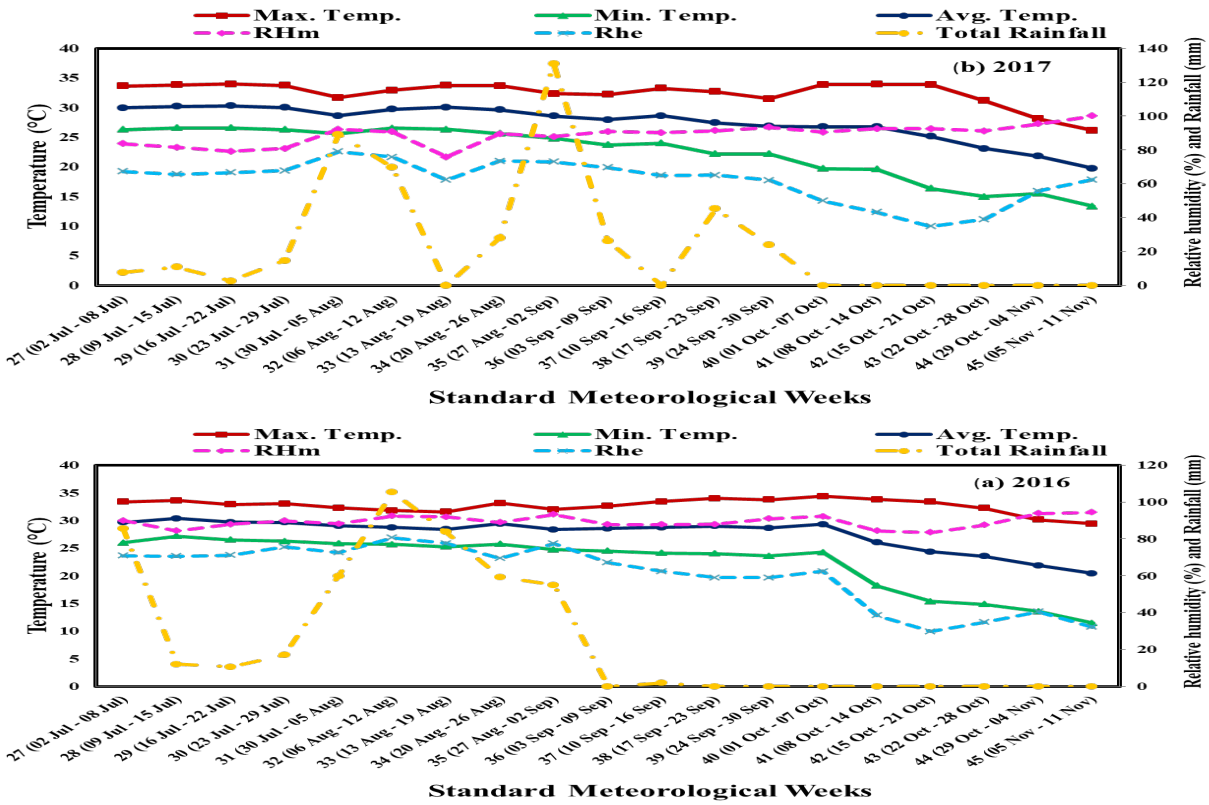

Fig. 1: Weather parameters recorded during Kharif season of (a) 2016 and (b) 2017.

from 31.5 to 34.4°C whereas minimum temperature ranged from 15.4 to 27.2°C. The temperature was almost same during *Kharif* 2017 with maximum temperature from 31.5 to 34.0°C whereas minimum temperature from 16.4 to 26.6°C. Morning humidity ranged between 83.4 to 93.3% during 2016 and 75.6 to 93.4% during 2017 whereas evening humidity ranged between 34.9 to 79.0% during 2016 and 29.7 to 80.6% during 2017. The highest rainfall of 105.4 mm was recorded during 32nd SMW of 2016 and 130.8 mm during 35th SMW of 2017 (Fig. 1).

The yellow stem borer appeared during the third week of July (29th SMW) in *Kharif* 2016 with 0.3% incidence while during *Kharif* 2017 it appeared in first week of July (27th SMW) with 0.2% incidence. It gradually increased during successive standard weeks and reached at the maximum level (14.9%) during 3rd week of September (38th SMW) during *Kharif* 2016 and during 39th SMW in *Kharif* 2017 with 14.5 per cent incidence (Table 1). Earlier studies carried by Sharma *et al.* (2018) have reported that the per cent dead hearts and per cent of white ears caused

Table1: Weekly incidence of yellow stem borer and rice leaf folder during of *Kharif*, 2016 and 2017.

Months and dates	Standard Meteorological Weeks	Yellow stem borer (% Dead hearts 10 hills^{-1})			Leaf folder (% Leaf damage 10 hills^{-1})		
		Kharif 2016	*Kharif* 2017	Pooled	*Kharif* 2016	*Kharif* 2017	Pooled
July 02 - 08 July	27	0.0	0.2	0.1	0.1	0.1	0.1
July 09 -15 July	28	0.0	0.3	0.1	0.1	0.1	0.1
July 16 - 22 July	29	0.3	0.5	0.4	0.4	0.4	0.4
July 23 - 29 July	30	1.0	1.3	1.1	0.4	0.5	0.4
July 30 - 05 Aug.	31	1.5	1.8	1.6	0.5	1.5	1.0
Aug. 06 - 12 Aug.	32	4.3	2.4	3.3	1.3	2.6	2.0
Aug. 13 -19 Aug.	33	5.3	3.3	4.3	2.6	3.7	3.1
Aug. 20 - 26 Aug.	34	5.5	5.3	5.4	2.1	3.2	2.6
Aug. 27 - 02 Sept.	35	7.4	7.3	7.3	4.4	5.3	4.8
Sept. 03 - 09 Sept.	36	9.3	9.5	9.4	5.7	6.5	6.1
Sept. 10 -16 Sept.	37	10.3	10.3	10.3	6.8	7.8	7.3
Sept. 17 - 23 Sept.	38	14.9	13.7	14.3	8.4	9.7	9.0
Sept. 24 - 30 Sept.	39	12.4	14.5	13.4	7.2	8.5	7.9
Oct. 01- 07 Oct.	40	10.9	11.4	11.1	6.2	7.7	7.0
Oct. 08 - 14 Oct.	41	9.4	11.0	10.2	7.2	8.5	7.8
Oct. 15 - 21 Oct.	42	5.2	9.3	7.3	5.9	6.3	6.1
Oct. 22 - 28 Oct.	43	2.2	3.2	2.7	3.2	4.7	4.0
Oct. 29 - 04 Nov.	44	1.1	1.1	1.1	0.9	1.5	1.2
Nov. 05 - 11 Nov.	45	0.1	0.2	0.0	0.1	0.1	0.0

Table 2: Correlation coefficient of yellow stem borer and leaf folder infestation on rice with prevailing weather parameters during *Kharif* 2016 and 2017 (pooled).

Weather parameters	Yellow stem borer infestation (%)	Leaf folder infestation (%)
Maximum Temperature (°C)	0.056	0.619**
Minimum Temperature (°C)	-0.307	0.552**
Rainfall (mm)	-0.481*	0.216
Morning humidity (%)	-0.506*	-0.365
Evening humidity (%)	-0.620**	0.152

*-Significant ($p<0.05$) , **-Significant ($p< 0.01$)

by *S. incertulas* incidence were highest during 41st and 47th standard week, respectively at Varanasi, Uttar Pradesh.

The damage by leaf folder (*C. medinalis*) was first noticed during first week of July (27th SMW) , thereafter it increased gradually during successive standard weeks and reached at the maximum level during 3rd week of September (38th SMW) during 2016 and 2017 with 8.4 per centand 9.7 per cent infestation level, respectively. Bhumireddy *et al.* (2018) and Kakde and Patel (2015) also observed that leaf folder, *C. medinalis* first appeared on 3rd week of August (34th SMW) and the peak activity of the pest was found in 4th week of September (39th SMW) in Allahabad, Uttar Pradesh and Bardoli, Gujarat. As per Sharma *et al.* (2018) the incidence of leaf folder was found to be highest during 39th standard week at Varanasi, Uttar Pradesh.

The correlation of weather components and yellow stem borer and leaf folder damage are shown in Table 2. The correlation analysis of yellow stem borer infestation with weather variables revealed that the incidence of yellow stem borer had non-significant correlation with maximum temperature (r=0.056) and minimum temperature (r=-0.307) while had significant negative correlation with morning (r = -0.506), evening relative humidity (r = -0.620) and rainfall (r = -0.481) (Table 2). The studies indicated that temperature do not have significant impact on the incidence of yellow stem borer while relative humidity and rainfall had negative effect on pest incidence. Previous studies carried by Bisen *et al.* (2019), Seni and Naik (2018) and Singh *et al.* (2012) also reported similar types of correlation of weather parameters with yellow stem borer infestation in rice. As per Hussain *et al.* (2018) the temperature range of 26-32°C has been found ideal range for the activity of yellow stem borer on the basis of insect light trap catches.

The leaf folder infestation was non-significant but positively correlated with rainfall (r = 0.216) and evening relative humidity (r = 0.152), and had negative correlation with morning relative humidity (r = -0.365). The correlation of incidence of leaf folder with maximum (r = 0.619) and minimum temperature (r = 0.552) was found positively significant (Table 2). The findings revealed that rainfall and relative humidity had no significant effect on the incidence of leaf folder while temperature had significant influence on pest incidence. Similar relationship of weather parameters with leaf folder damage was reported by Shyamrao and Raghuraman (2019) where they found that population of leaf folder increased with an increase in temperature. In another study, Khan and Ramamurthy *et al.* (2004) reported that all weather factors *viz.,* maximum and minimum temperature, rainfall and relative humidity had a significantly negative correlation with per cent leaf damage by leaf folder. However, the present results differed from the findings of Ahmed *et al.* (2010) who demonstrated that mean maximum and minimum temperature had no impact on leaf infestation by leaf folder. The possible reason for non-conformity of results could be due to the difference in weather conditions at different locations and their influence on activity of the insect-pest.

The studies indicated that the population build-up of rice pests was highly influenced by the different weather factors in nature. Under changing climatic conditions, the insect-pests are also changing their behaviour and minor pests are becoming serious pests in areas where they were of low importance. Therefore, this information may be helpful in developing population models for the prediction of pest build-up and forewarning the farmers for timely adoption of site specific eco-friendly and cost effective management practices.

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