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Effect of Meteorological Parameters on the population dynamics of Yellow Stem Borer (*Scirpophaga incertulas,* Walker) in Basmati rice ecosystem

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ABSTRACT

The present investigation was conducted to study the effect of weather parameters on the infestation of yellow stem borer, *Scirpophaga incertula* (Walker), in basmati rice. Results revealed that the peak period of pooled maximum dead hearts (8.61%) across both cropping seasons was recorded during the 37th standard week. Thereafter, the infestation declined gradually, but it increased again at the reproductive stage of the crop, with the pooled maximum white ear infestation (5.66%) observed in both seasons during the 39th standard week. Correlation studies on dead hearts with weather parameters showed a positive, though non-significant, correlation with minimum temperature ($r = 0.453^{NS}$), morning relative humidity ($r = 0.290^{NS}$), evening relative humidity ($r = 0.460^{NS}$), and rainfall (r = 0.355NS), while a negative non-significant correlation was recorded with maximum temperature ($r = –0.206^{NS}$). In the case of white ear infestation, a significant negative correlation was observed with minimum temperature (r = –0.568*), morning relative humidity (r = –0.624**), evening relative humidity (r = –0.688**), and rainfall (r = –0.540*), whereas the correlation with maximum temperature ($r = 0.108^{NS}$) was non-significant.

Key words: *Rice yellow stem borer, Dead hearts, White ear head and basmati rice*

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 per cent 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). Basmati rice stands out among other long-grain aromatic varieties due to its elongated slender grains expand to double their original size upon cooking, offering a soft, fluffy texture, distinctive aroma and superior flavour (Adhikari 2014). India is the primary producer of basmati rice, accounting for about 72 per cent of the total world production, followed by Pakistan (Agricultural and Processed Food Products Export Development Authority, 2023-24). The crop thrives in the north-western regions of the Indian subcontinent including states like Haryana, Punjab, Uttarakhand, Western Uttar Pradesh, Jammu & Kashmir and Himachal Pradesh (Rani *et al.,* 2006). 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).

Materials and Methods

Population dynamics of rice yellow stem borer

The field experiments were carried out during June to October 2023 and 2024 at Crop Research Centre, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut Uttar Pradesh. The experiment was conducted in Randomized Block Design (RBD) with rice crop. Pusa Basmati - 1692. The spacing adopted was 20 × 15 cm and all the cultural operations except plant protection were followed as per the recommendations. The observations of *S. incertulas* infestation were recorded at weekly interval, 15 days after transplanting till harvesting. The borer infestation was assessed by counting number of dead hearts (DH) in the initial stage of damage and number of white ear heads (WEH) at later stage from five randomly selected spots consisting of 5 hills each. Both the dead hearts and white ear heads were removed from the infested tillers so that only fresh infestation of the pest can be realized every time. To the study instantaneous effect of major abiotic factors *viz.*, maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, and rainfall on the population of *S. incertulas*, correlation coefficient was worked out. Finally data so obtained were worked out and converted into percentage of dead heart [Per cent dead hearts = Total number of dead hearts / Total number of tillers X 100] and percentage white ear [Per cent white ears = Total number of white ears / Total number of tillers X 100] [8]. The weekly meteorological data recorded at ICAR-Indian Institute of Farming System Research, Modipuram (Meerut) during the *kharif* 2023 and 2024 from July to October period were utilized for this purpose.

Statistical analysis

The influence of weather parameters on damage done by *S. incertulas* (Dead Hearts and White Ears) was analyzed by correlation analysis for a period of two years. The data was analyzed by using statistical software OP Stat.

Results and Discussion

The impact of major abiotic factors on the incidence of per cent dead hearts (DH) at vegetative stage and per cent white ear heads (WEH) at reproductive stage at weekly interval during *kharif* 2023 and 2024 according to standard weeks.

During *Kharif* season 2023

The data are depicted in Table 1 and Fig 1 revealed that the infestation of *S. incertulas* initiated from 32th standard week with 2.47 per cent dead hearts. The peak infestation was observed with 9.54 per cent dead hearts at 37th SW during *Kharif* 2023. Furthermore, the fluctuations in the infestation were recorded, which again reach second peak during third week of October (42nd SW) with 6.23 per cent white ears. The infestation of yellow stem borer was observed till 44th SW (1.41% WEH) Earlier studies carried by Sharma *et al.* (2018) have reported that the per cent dead hearts and per cent of white ears caused by *S. incertulas* incidence were highest during 41 and 47th standard week, respectively at Varanasi, Uttar Pradesh.

The correlation coefficient between stem borer infestation and weather parameters (maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, and rainfall) was found to be non-significant. Results presented in Table 1 revealed that maximum temperature (r = 0.140NS), minimum temperature (r = 0.506NS), morning relative humidity (r = 0.048NS), evening relative humidity (r = 0.406NS), and rainfall (r = 0.301NS) showed non-significant correlations with infestation during the vegetative stage of *Kharif* 2023. similar pattern of seasonal incidence was reported by Sulagitti *et al* (2017) a positive non-significant correlation observed with morning relative humidity and rainfall (r = 0.045 & 0.53). Similarly Patil *et al.* (2020) correlation analysis revealed that the yellow stern borer incidence (le. per cent dead hearts) showed a positive non-significant correlation minimum temperature (r = 0.195)

With respect to the formation of white ears at the reproductive stage, maximum temperature (r = -0.237NS), morning relative humidity (r = -0.327NS),

Table 1. Population dynamics of Yellow stem borer during *kharif*, 2023

SMW	Date	Yellow stem borer		Weather parameters				
				Temperature		Relative Humidity (%)		Rainfall
		%DH	%WEH	Max.	Min.	Morning	Evening	(mm)
30	July,24-30	0.00	0.00	33.9	25.2	88.0	76.3	110.0
31	July,31-Aug.6	0.00	0.00	33.8	26.3	86.0	72.4	64.5
32	Aug,7-13	2.47	0.00	33.9	26.4	77.9	70.7	15.0
33	Aug,14-20	4.31	0.00	35.0	26.2	85.7	71.4	18.3
34	Aug,21-27	4.58	0.00	32.9	25.7	89.6	79.3	90.6
35	Aug,28-Sep.3	5.30	0.00	35.0	25.9	74.7	62.6	0.0
36	Sep,4-10	5.50	0.00	36.1	24.6	76.3	59.0	0.0
37	Sep,11-17	9.54	0.00	31.9	23.9	88.3	77.7	148.2
38	Sep,18-24	8.32	0.00	33.3	24.5	80.0	71.0	0.0
39	Sep,25-Oct.1	0.00	6.10	33.9	22.7	82.7	67.1	2.0
40	Oct,2-8	0.00	5.39	34.3	19.7	74.3	54.9	0.0
41	Oct,9-15	0.00	4.37	34.7	20.0	76.4	55.9	0.0
42	Oct,16-22	0.00	6.23	31.9	17.2	81.9	54.4	24.0
43	Oct,23-29	0.00	4.61	31.0	15.5	79.1	61.0	0.0
44	Oct,30-Nov.5	0.00	1.41	30.9	14.9	89.7	68.7	0.0

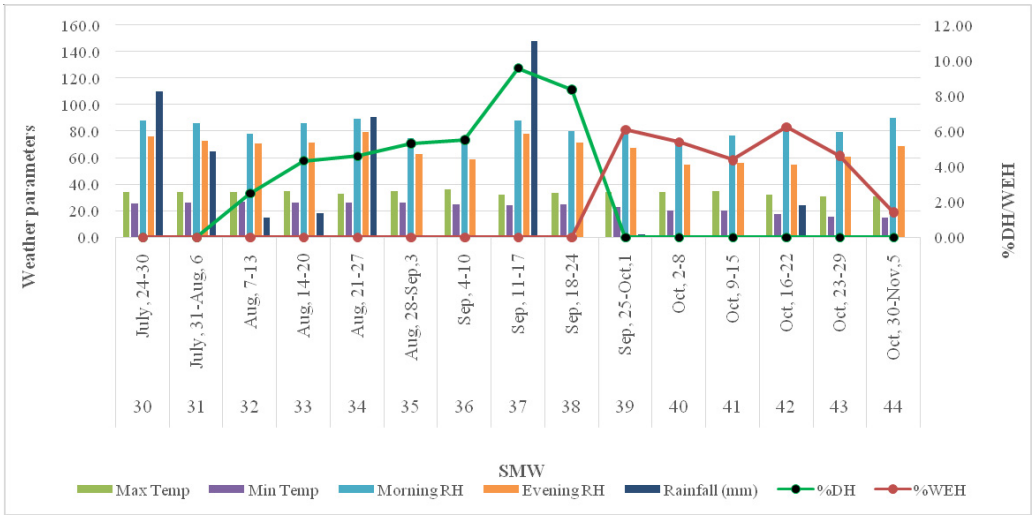

Fig. 1. Population dynamics of Yellow stem borer during *kharif*, 2023

and rainfall (r = -0.411NS) exhibited non-significant negative correlations. However, other weather parameters, namely evening temperature (r = -0.696**) and morning relative humidity (r = -0.696**), showed significant negative correlations with *S. incertulas* infestation for white ear formation during the *Kharif* season of 2023 (Table 4.5). Previous studies carried by Hatwar *et al.* (2020), who reported that non-significant negative correlation with maximum temperature morning relative humidity and rainfall. Devi and Verma (2022) correlation analysis revealed that the yellow stern borer incidence showed a significant negative correlation with preceeding one week minimum (r = -0.82**) and evening relative humidity (r = -0.43*)

During *Kharif* season 2024

The data depicted in Table 2 and Figure 2 revealed that the infestation of *S. incertulas* initiated in the 30th standard week with 0.08% dead hearts. The peak infestation was recorded at 8.79 per cent dead hearts during the 38th standard week (SW) in *Kharif* 2024. Furthermore, fluctuations in infestation were observed, with a second peak recorded in the first week of October (41st SW) at 6.06 per cent white ears. The infestation of yellow stem borer persisted until

Table 2. Population dynamics of Yellow stem borer during *kharif*, 2024

SMW	Date	Yellow stem borer		Weather parameters				
				Temperature		Relative Humidity (%)		Rainfall
		%DH	%WEH	Max.	Min.	Morning	Evening	(mm)
30	July, 22-88	0.08	0.00	34.1	25.8	90.1	78.7	131.0
31	July 29- Aug.4	1.46	0.00	35.6	26.5	85.1	68.4	132.6
32	Aug, 5-11	2.08	0.00	32.8	24.9	83.7	72.3	13.4
33	Aug, 12-18	2.62	0.00	33.7	25.3	86.7	73.3	40.7
34	Aug, 19-25	3.02	0.00	35.0	24.9	87.7	77.3	10.6
35	Aug, 26-Sep 1	5.29	0.00	34.7	23.9	81.3	67.1	45.2
36	Sep, 2-8	7.41	0.00	33.7	24.7	89.1	75.3	59.8
37	Sep, 9-15	7.68	0.00	31.7	24.6	90.6	78.6	165.4
38	Sep, 16-22	8.79	0.00	31.1	23.7	87.6	77.6	42.0
39	Sep, 23-29	0.00	5.22	34.7	25.5	81.4	75.4	0.0
40	Sep, 30-Oct 6	0.00	4.15	35.0	23.8	80.6	67.7	0.0
41	Oct,7-13	0.00	6.06	34.6	21.4	77.4	57.9	0.0
42	Oct, 14-20	0.00	3.11	34.2	18.9	77.3	63.3	0.0
43	Oct,21-27	0.00	1.79	33.5	18.8	82.3	67.9	0.0
44	Oct,28-Nov,3	0.00	1.12	33.0	18.0	83.9	68.7	0.0

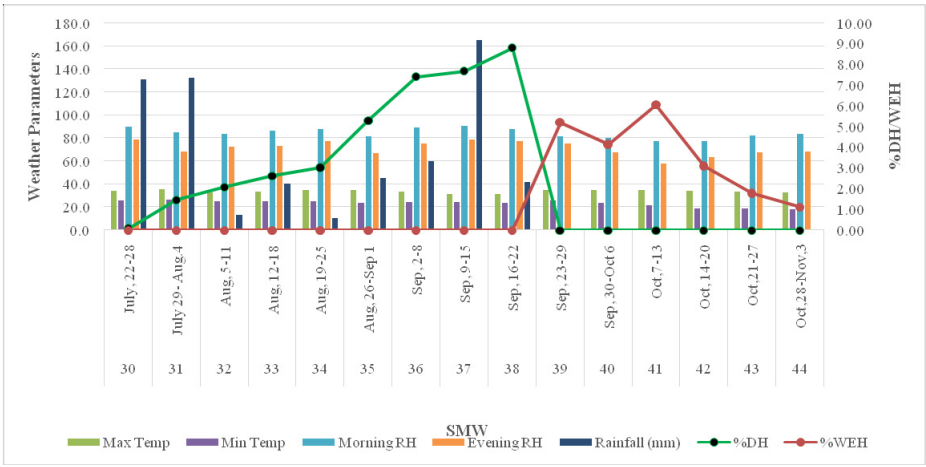

Fig. 2. Population dynamics of Yellow Stem borer during *kharif*, 2024

the 44th SW, with 1.12 per cent white ears. Chavan *et al.* (2013) conducted an experiment and observed that the maximum infestation (15.47 per cent dead hearts) was in first week of September (36th standard week and 45 DAT), whereas least infestation (0.64 per cent) was recorded in second week of October (41th std. week and 84 DAT). The maximum (19.23 per cent) white ear heads damage was seen during third week of October (90 DAT).

The correlation between yellow stem borer infestation and weather parameters is presented in Table 4.1. The correlation matrix indicated a significant negative correlation with maximum temperature (r = –0.586*) and significant positive correlations with morning relative humidity (r = 0.590*) and evening relative humidity (r = 0.514*). Non-significant positive correlations were observed with minimum temperature (r = 0.343NS) and rainfall (r = 0.418NS) at the vegetative stage during *Kharif* 2024. Mondal and Chakraborty (2017) reported that the positively correlated with maximum relative humidity and minimum relative humidity. Similar findings were also reported by Patil *et al.* (2020) positive non-significant correlation with minimum temperature (r = 0.195).

With respect to white ear formation at the reproductive stage, morning relative humidity (r = –0.764**), evening relative humidity (r = –0.591*), and rainfall (r = –0.543*) showed significant negative correlations. All other weather parameters showed

Table 3. Correlation between per cent seasonal incidence of *Scirpophaga incertulas* and weather parameters.

Weather parameters	Correlation coefficient (r)			
	Dead hearts		White ear heads	
	2023	2024	2023	2024
Max. Temperature(°C)	0.140^{NS}	0.586*	0.237^{NS}	0.364^{NS}
Min . Temp (°C)	0.506^{NS}	0.343^{NS}	-0.696^{**}	-0.330^{NS}
Morning RH (%)	0.048^{NS}	0.590*	-0.327^{NS}	-0.764^{**}
Evening RH (%)	0.406^{NS}	0.514*	-0.696^{**}	-0.591^{*}
Rainfall	0.301^{NS}	0.418^{NS}	-0.411^{NS}	-0.543^{*}

*-Significant (p<0.01), **-Significant (p< 0.05), NS -Non significant

non-significant negative correlations: minimum temperature (r = –0.330NS) where as maximum temperature (r = 0.364NS) with a positive non- significant relationship with *S. incertulas* infestation for white ear formation during the *Kharif* season 2024 (Table 3).

Similar findings were also reported by Jasrotia *et al.* (2019) correlation analysis revealed that the yellow stern borer incidence showed a Negative significant correlation morning relative humidity, evening relative humidity (r = 0.195) and rainfall Nirala *et al.* (2015) who had also reported that the non – significant positive correlation maximum temperature (r = + 0.000).

Conclusion

The peak period of *S. incertulas* was recorded in 2nd week of september to 3rd week of sepember (37th standard week) at vegetative stage and at reproductive stage the *S. incertulas* arrived at peak in 4th week of september (39th standard week) during *Kharif*, 2023 and 2024. The seasonal incidence of *S. incertulas* delineated the YSB population build up and interaction with weather parameters, which can be utilized for decision making. The correlation matrix indicated a non-significant negative correlation with maximum temperature (r = –0.206NS), and non-significant positive correlations with minimum temperature (r = 0.453NS), morning relative humidity (r = 0.290NS), evening relative humidity (r = –0.460NS), and rainfall (r = 0.355NS). With respect to the formation of white ears at the reproductive stage, evening temperature (r = –0.568*), morning relative humidity (r = –0.624*), evening relative humidity (r = –0.688**), and rainfall (r = –0.540*) showed significant negative correlations. In contrast, maximum temperature (r = 0.108NS) exhibited a non-significant positive correlation with *S. incertulas* infestation for white ear formation during *Kharif* 2023 and 2024.

Conflict of Interest- None

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