

Original Research Article

SEASONAL OCCURENCE OF MAJOR INSECT PESTS OF RICE GROWN IN
KRISHNA DELTA REGION OF ANDHRA PRADESH

ABSTRACT:

Comment [N1]: Add more background, objective of the research, any conclusion?

~~The~~ An investigation of the seasonal occurrence of major insect pests of rice in Krishna Delta area of Krishna district of Andhra Pradesh, India was conducted during kharif 2023-24 in 30 ~~farmers~~ farmers' fields of 5 mandals (Kankipadu, Penamaluru, Vuyyuru, Thotlavalluru, Gannavaram). Weekly observations on pest population in parallel relation with abiotic factors revealed that initial incidence of yellow stem borer, *Scirpophaga incertulas* (Crambidae: Lepidoptera) as dead hearts (0.30 %) was noticed during SMW meaning? 30 and gradually increased reaching highest per-cent of damage (5.57 % dead hearts) during SMW 38. The incidence of white ears (0.70 %) was first noticed after emergence of panicles during SMW 37 and reached the peak incidence (2.20 %) during SMW 42. The initial incidence (1.10 %) of rice leaf folder, *Cnaphalocrocis medinalis* (Crambidae: Lepidoptera) was noticed during SMW 30 and gradually increased causing highest per-cent leaf damage during SMW 39 with 9.21 % leaf damage, when the crop is at boot leaf stage. The peak population of brown planthopper, *Nilaparvata lugens* and white-backed plant hopper, *Sogatella furcifera* (Delphacidae: Hemiptera) was observed during SMW 39 (9.60 hoppers/hill) and SMW 38 (3.70 hoppers/hill) respectively, when the crop was in panicle initiation stage.

Keywords: Abiotic factors, Brown planthopper, Rice leaf folder, Seasonal occurrence whitebacked plant hopper and Yellow stem borer.

1. INTRODUCTION

Rice, *Oryza sativa* (Poaceae) is one of the most important crops of the world and second largest cultivated cereal crop which occupies foremost status in human food requirements. It is cultivated in almost all tropical, subtropical and temperate countries and is the staple food of over half of the world's population and 90 per-cent of Asians (Kumar *et al.*, 2023). Raw rice is a good source of nutrients, which contains 7-8% protein, 3% fat, 77-84% carbohydrate, 3% fibre and a good source of thiamine (Vitamin B₁) and riboflavin (Vitamin B₂) together with eight essential amino acids (Chaudhari *et al.*, 2018). India is amongst the top most rice producers in the world, second only to China. In Andhra Pradesh (AP), paddy cultivation in Krishna district is highly significant growing in an area of 0.31 Mha out of 2.35 Mha in AP. The significant contributions of Krishna rice farmers in food production are recognized by production and productivity of 1.89 MT and 6006 kg ha⁻¹ respectively (Directorate of Economics and Statistics, 2023).

From seedling to maturity, rice crop is affected by a number of various insect pests which causes the severe quantitative and qualitative loss in yield (Patil *et al.*, 2020). About 100 species of insects have been reported to attack on rice crop in India, out of which, yellow stem borer (YSB) (*Scirpophaga incertulas* Walker), brown planthopper (BPH) (*Nilaparvata lugens* Stal), white backed planthopper (WBPH) (*Sogatella furcifera* Horvath), leaf folder (*Cnaphalocrocis medinalis* Guenee) are very important and can cause 21 to 51 per-cent yield loss in different rice agro ecosystems. (Nikhil *et al.*, 2021).

Weather conditions also play an important role for determining the geographical distribution and periodic abundance of major insect pests in rice (Varsha *et al.*, 2022). The infestation of major insect pests of rice depends on the prevailing weather conditions in an area (Yadav *et al.*, 2023). Hence it is necessary to quantify and verify, by the critical experiments, the theoretical relationships, normally proposed in rice insects between the abiotic factors and the population dynamics (Anil kumar *et al.*, 2020). The knowledge of insect-pests population dynamics is essential for developing

Comment [N2]: Add more background, how climate affects insects.. some researchers about plagues and rice, a short description of the insects under study

Comment [N3]: Maize, wheat and then rice

Comment [N4]: Plus, the susceptibility of the variety

sustainable crop protection strategies. Hence, [in this research the](#) population dynamics of major pests of rice were studied and correlated with the different weather parameters.

2. MATERIALS AND METHODS

Sampling procedure

The study was carried out in Krishna Delta area of Krishna district of Andhra Pradesh during *kharif* 2023-2024. Krishna district is located between 15°-43' and 17°-10' of the Northern Latitude and 80°-0' and 81°-33' of the Eastern Longitude, which occupies first position in the rice growing area across the state (~~2.45~~ [2.45](#) L ha out of 22 L ha in AP). [The data was collected at weekly intervals in 30 farmer fields from five mandals viz., Kankipadu, Penamaluru, Vuyyuru, Thotlavalluru, Gannavaram of the study area. Random sampling was done in fixed plots to record the occurrence of various pests in rice ecosystem for the entire crop growth period i.e., from sowing till harvest. For this, each field was hypothetically assumed and marked with X path for collection of data from ten random sampling spots \(1 square metre each\) using quadrant, and leaving 3 metres distance from the field borders. From each spot all the hills were observed for recording infestation level.](#)

Recording of Observations: In terms of [SMWs](#), the observations were recorded from 30-45 SMWs of 2023 [during the crop season.](#)

Paddy Yellow Stem Borer (YSB): The incidence of YSB was recorded in terms of per cent [of damage](#) by counting the damage done *i.e.*, dead hearts and white ears to total number of tillers and panicles per hill in vegetative and reproductive stages, respectively. The per-centage [of damage](#) was calculated using the below mentioned formula.

$$\text{Per-cent damage (\%)} = \frac{\text{Number of dead hearts or white ears per hill}}{\text{Total number of tillers or panicles per hill}} \times 100$$

Leaf Rice leaf Folder: The leaves that had damage symptoms like folded leaves and scratching of chlorophyll by larva were considered to record per-cent damage infestation. The extent of damage caused by leaf folder was calculated using the formula presented below.

$$\text{Per cent damage (\%)} = \frac{\text{Number of damaged leaves per hill}}{\text{Total number of leaves per hill}} \times 100$$

Comment [N5]: Sorry, what is L?

Comment [N6]: Did you sample each week? All the 30 farms? How many weeks the samples were?

Comment [N7]: Do you have the locations of these farms?

Comment [N8]: Year of sampling?

Comment [N9]: Dates? When they start to sow and when to harvest, probably you could do a table with all the farms locations and the sown and harvest dates

Comment [N10]: So, each week, you sampled 30 farms and in each farm 10 spots? 300 samples per week?

Comment [N11]: Meaning? Standard meteorological weeks?

Comment [N12]: From where to where, which months

Comment [N13]: Reference? For all the methods where you obtain the percentage of damage

Planthoppers (Brown Planthoppers (BPH) and White Backed Planthoppers (WBPH): The number of nymphs and adults per hill were counted to record the abundance of BPH and WBPH in the field and expressed as population per hill.

3. RESULTS AND DISCUSSION

Incidence of Yellow Stem Borer (YSB): Yellow stem borer caused damage to the tillers and panicles in vegetative and reproductive stages of the crop, respectively which were represented as percent dead hearts and percent white ears. The incidence of YSB started in tillering stage and continued untill harvest.

Per cent Dead Hearts during: The dead hearts caused due to YSB incidence presented in (Table 1) revealed that, the initial record of dead hearts (0.30 %) was noticed during SMW 30 (23 Jul - 29 Jul 2023) and gradually increased reaching highest per cent of damage (5.57 %) during SMW 38 (17 Sep - 23 Sep 2023). Studies conducted by Kumar *et al.*, (2013), Patel and Singh (2017), Tandon and Srivastava (2018), Pallavi *et al.*, (2018), Jasrotia *et al.*, (2019), -Patil *et al.*, (2020), Sreelatha *et al.*, (2022), Varsha *et al.*, (2022) also reported the peak infestation of YSB (dead hearts) during SMW 38.

The correlation results of dead hearts caused due to YSB with abiotic factors (Table 2) revealed non-significant positive correlation with minimum temperature (0.264), morning relative humidity (0.227) and evening relative humidity (0.449), while showed non-significant negative correlation maximum temperature (-0.084), and rainfall (-0.100). The incidence of dead hearts and abiotic factors were subjected to multiple linear regression (MLR) analysis and the results revealed coefficient of determination (R^2) value of 0.715, which indicates that the weather parameters could cause 71.5 % variation in occurrence of dead hearts (Table 3). The above discussed results were in agreement with the findings of Rana *et al.*, (2017), Sreelatha *et al.*, (2022) and Kumar *et al.*, (2023) who reported that minimum temperature, morning and evening relative humidity showed non-significant positive correlation. Similar findings were also reported by Nikhil *et al.*, (2021) and Devi and Varma (2022) who stated that maximum temperature and rainfall showed non-significant negative correlation.

Per Cent White Ears: The incidence of white ears (0.70 %) was first noticed after emergence of panicles during SMW 37 (10 Sep - 16 Sep 2023) and reached the peak

Comment [N14]: Where is the data of the SMWs??? How much rain, the maxima and minimum temperature...? Did you have climate data from each one of the 30 sites sampled? From where did u obtain that data?

Comment [N15]: This was mentioned before

Comment [N16]: What happens in the SMW 38 that YSB reaches its peak? Discuss!!!

Comment [N17]: Now, you have to discuss, why? The authors obtained similar results but why, what happens with the rainfall and YSB... and the other climate variables?

incidence (2.20 %) during SMW 42 (15 Oct - 21 Oct 2023) (Table 1). The present results were conferred by Das (2020), Paramasiva *et al.*, (2021), Sreelatha *et al.*, (2022) and Yadav *et al.*, (2023) who also reported the peak infestation of YSB (white ears) during SMW 42.

Comment [N18]: Same than before, there is not discussion

The correlation results of per cent white ears caused by YSB with abiotic factors (Table 2) revealed non-significant negative correlation with minimum temperature (-0.253), evening relative humidity (-0.150) and rainfall (-0.112), while maximum temperature (0.325) and morning relative humidity (0.329) showed positive non-significant correlation. The incidence of white ears and abiotic factors were subjected to MLR analysis and the results revealed coefficient of determination (R^2) value of 0.539, which indicates that the weather parameters could cause 53.9 % variation in occurrence of white ears (Table 3). The findings related to correlation of per cent white ears with abiotic factors were in line with the findings of Appalanaidu *et al.*, (2021) and Morshed *et al.*, (2023) who reported non-significant positive correlation with maximum temperature and non-significant negative correlation with minimum temperature and evening relative humidity. Ashrith *et al.*, (2017), Sulagitti *et al.*, (2017), Varsha *et al.*, (2022) and Amandeep *et al.*, (2022) who reported non-significant positive correlation with morning relative humidity and non-significant negative correlation with rainfall also support the present findings.

Comment [N19]: Again discussion!!

Incidence of Leaf Folder: The data on leaf folder incidence presented in (Table 1) revealed that, the initial incidence (1.10 %) was noticed during SMW 30 (23 Jul - 29 Jul 2023) and gradually increased causing highest per cent leaf damage during SMW 38 (17 Sep - 23 Sep 2023) and SMW 39 (24 Sep - 30 Sep 2023) causing 8.58 % and 9.21 % leaf damage respectively. The present findings are in accordance with the findings of Kakde and Patel (2015), Netam and Gupta (2015), Gajjar *et al.*, (2017), Thokchom *et al.*, (2018), Rautaray *et al.*, (2020), Das (2020), Seni *et al.*, (2022) and Das *et al.*, (2023) who reported peak infestation of leaf folder during SMW 39.

Comment [N20]: No discussion at all

The correlation results of leaf folder damage with abiotic factors (Table 2) revealed non-significant positive correlation with maximum temperature (0.054), morning relative humidity (0.482), evening relative humidity (0.355) and rainfall (0.003) unlike minimum temperature (-0.331), which showed non-significant negative correlation. The incidence of leaf folder and abiotic factors were subjected to MLR analysis and the results revealed coefficient of determination (R^2) value of 0.475, which indicates that the weather parameters could cause 47.5 % variation in leaf folder incidence (Table 3). The above findings with respect to abiotic factors and leaf folder

infestation were in line with the reports of Varsha *et al.*, (2022) who stated that maximum temperature, morning relative humidity, evening relative humidity and rainfall showed non-significant positive correlation. Studies conducted by Ashrith *et al.*, (2017), Bumireddy *et al.*, (2018) and Rautaray *et al.*, (2020) reported that correlation of leaf folder incidence with minimum temperature showed non-significant negative correlation.

Comment [N21]: But why? Where is the discussion?

Incidence of brown planthopper (BPH): The initial incidence of BPH was noticed at early tillering stage of the crop during SMW 31 (30 Jul - 05 Aug 2023) with 0.20 hoppers/hill and gradually increased where the highest number of hoppers/hill were observed during SMW 38 (17 Sep - 23 Sep 2023) and SMW 39 (24 Sep - 30 Sep 2023) and with 9.20 and 9.60 hoppers/hill respectively (Table 1). Tatarwal *et al.*, (2016), Das (2020), Mohanta *et al.*, (2020), Yadav *et al.*, (2023) also reported peak incidence of BPH during SMW 39 which confirms the above findings of the present study.

Comment [N22]: Same, no discussion

The results of correlation between BPH and abiotic factors (Table 2) revealed negative non-significant correlation with maximum temperature (0.422), minimum temperature (0.450) and rainfall (0.123), while showed positive non-significant correlation with morning relative humidity (0.184), evening relative humidity (0.323). The incidence of BPH and abiotic factors were subjected to MLR analysis and the results revealed coefficient of determination (R^2) value of 0.549, which indicates that the weather parameters could cause 60.8 % variation in leaf folder incidence (Table 3). Verma *et al.*, (2021) and Kumar *et al.*, (2023) had also almost similar findings, that morning relative humidity, evening relative humidity showed positive non-significant correlation and rainfall showed positive non-significant correlation. On the other hand, study conducted by Kumar *et al.*, (2020) that showed negative non-significant correlation with maximum temperature and minimum temperature is in agreement with the present study.

Comment [N23]: Lack of discussion

Incidence of white backed planthopper (WBPH): The initial incidence of WBPH started in early tillering stage of the crop during SMW 32 (06 Aug - 12 Aug 2023) with 0.40 hoppers/hill and gradually increased where the highest number of hoppers/hill were observed during SMW 38 (17 Sep - 23 Sep 2023) with 3.70 hoppers/hill (Table 1). The above finding was similar to the findings of Krishnaiah *et al.*, (2007) at Maruteru, Andhra Pradesh, who reported maximum incidence of WBPH at panicle initiation stage. The results of correlation between WBPH and abiotic factors (Table 2) revealed non-significant positive correlation with maximum temperature

(0.089) and evening relative humidity (0.455), while showed non-significant negative correlation minimum temperature (-0.358), rainfall (-0.009) and significant positive correlation with morning relative humidity (0.507*).

Comment [N24]: Write a discussion

4. CONCLUSION

The research revealed that, the initial occurrence of YSB (0.30 %) was observed during SMW 30 and gradually increased reaching highest per cent of damage (5.57 %) during SMW 38 and during reproductive stage of the crop white ear head was maximum during SMW 42. The initial occurrence of leaf folder was observed during SMW 30 and gradually increased causing highest per cent leaf damage during SMW 39 with 9.21 % leaf damage. The initial incidence of brown planthopper (~~*Nilaparvata lugens*~~) was observed at early tillering stage of the crop during SMW 31 with 0.20 hoppers/hill and gradually increased where the highest number of hoppers/hill were observed during SMW 39 with 9.60 hoppers/hill. The results are benefitting to promote Economic Threshold Level (ETL) among farmers as a result of which unnecessary and irrational usage of pesticides can be reduced.

6. REFERENCES

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Table 1. Incidence of insect pests of rice during *kharif* 2022-2023

Standard meteorological week (SMW)	Duration	Yellow stem borer		Leaf folder (% leaf damage)	Brown planthopper (hoppers/hill)	White backed planthopper (hoppers/hill)
		% Dead hearts	% White Ears			
SMW30	23 Jul - 29 Jul 2023	0.30	0.00	1.10	0.00	0.00
SMW31	30 Jul - 05 Aug 2023	0.70	0.00	1.31	0.20	0.00
SMW32	06 Aug - 12 Aug 2023	1.00	0.00	2.50	0.70	0.40
SMW33	13 Aug - 19 Aug 2023	2.15	0.00	2.20	2.45	0.90
SMW34	20 Aug - 26 Aug 2023	3.20	0.00	3.15	3.80	1.20
SMW35	27 Aug - 02 Sep 2023	3.93	0.00	3.94	5.40	1.50
SMW36	03 Sep - 09 Sep 2023	4.70	0.00	7.16	8.95	1.96
SMW37	10 Sep - 16 Sep 2023	4.30	0.70	8.02	7.45	2.35
SMW38	17 Sep - 23 Sep 2023	5.56	1.10	8.58	9.20	3.70
SMW39	24 Sep - 30 Sep 2023	0.50	1.23	9.21	9.60	3.15
SMW40	01 Oct - 07 Oct 2023	0.35	0.90	7.02	4.50	1.33
SMW41	08 Oct - 14 Oct 2023	0.00	1.80	4.60	1.80	0.96
SMW42	15 Oct - 21 Oct 2023	0.00	2.20	2.26	1.33	0.80
SMW43	22 Oct - 28 Oct 2023	0.00	0.50	1.24	0.00	0.00
SMW44	29 Oct - 04 Nov 2023	0.00	0.33	1.00	0.00	0.00
SMW45	05 Nov - 11 Nov 2023	0.00	0.00	0.36	0.00	0.00

Table 2. Correlation between incidence of insect pests of rice and weather parameters during *kharif* 2023-24 in Krishna Delata area of Krishna district of Andhra Pradesh

Insect pest	Correlation coefficient (r)				
	Temperature (⁰ C)		Relative humidity (%)		Rainfall (mm)
	Maximum	Minimum	Morning	Evening	
Yellow stem borer (Dead hearts)	-0.084	0.264	0.227	0.449	-0.100
Yellow stem borer (White ears)	0.325	-0.253	0.329	-0.150	-0.122
Leaf folder	0.054	-0.331	0.482	0.355	0.003
Brown planthopper	-0.020	-0.179	0.490	0.484	-0.018
White backed planthopper	0.089	-0.358	0.507*	0.455	-0.009

** Correlation is significant at 0.01 level (2-tailed)

* Correlation is significant at 0.05 level (2-tailed)

Table 3. Regression equations for insect pest complex of rice with weather parameters during *kharif* 2023-24 in Krishna Delata area of Krishna district of Andhra Pradesh

Insect pests	Regression equation	R ²
Yellow stem borer (Dead hearts)	$Y = -17.265 - 0.271 X_1 + 0.460 X_2 - 0.004 X_3 + 0.285 X_4 - 0.036 X_5$	0.715
Yellow stem borer (White ears)	$Y = -16.040 + 0.282 X_1 - 0.092 X_2 + 0.148 X_3 - 0.055 X_4 + 0.033 X_5$	0.539
Leaf folder	$Y = -50.593 + 0.747 X_1 - 0.643 X_2 + 0.369 X_3 + 0.244 X_4 - 0.031 X_5$	0.475
Brown planthopper	$Y = -53.209 + 0.332 X_1 - 0.219 X_2 + 0.301 X_3 + 0.430 - 0.054 X_5$	0.608
White backed planthopper	$Y = -19.630 + 0.348 X_1 - 0.244 X_2 + 0.089 X_3 - 0.127 X_4 - 0.012 X_5$	0.678

Note: X₁ = Maximum temperature (Mean), X₂ = Minimum temperature (Mean), X₃ = Morning relative humidity (Mean), X₄ = Evening relative humidity (Mean), X₅ = Rainfall (Mean).