



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
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NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; SP-9(1): 30-32
Received: 07-11-2025
Accepted: 13-12-2025

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Effect of weather parameters on outbreak of yellow stem borer in rice crop at Raipur

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DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i1Sa.4597>

Abstract

The research study was carried out on Development of weather-based forewarning model for yellow stem borer (YSB) of rice crop in Raipur district of Chhattisgarh to examine the influence of weather parameters on YSB population, pest dynamics and to develop a forewarning model for its prediction. Long-term light trap data (1998-2023) were obtained from AICRP on Rice and the Department of Entomology, IGKV, Raipur, while corresponding weather data were collected from the Department of Agricultural Meteorology. The study of correlation and regression analysis revealed that the YSB population had significant positive correlation with sunshine hours ($r = 0.671^{**}$) and negative correlation with rainfall ($r = -0.625^{**}$) and RH-II ($r = -0.436^{*}$). Maximum and minimum temperatures ($^{\circ}\text{C}$) and RH-I(%) observed non-significant effects. Stepwise linear regression was used to developed weather-based forewarning models, which were validated by using data for the years 2022 and 2023. The model showed higher accuracy in 2023. This study establishes the role of weather parameters in pest dynamics and provides a reliable model for early prediction and management of YSB in rice crop.

Keywords: Yellow stem borer, weather parameters, regression analysis, forewarning model, population dynamics

Introduction

Rice (*Oryza sativa*) is the most important crop in India. It also contributes significantly in the gross domestic product (GDP). India is the second largest country of rice producing after China. Rice contributes more than 40% of the country's total food grain production (Anonymous, 2019)^[1]. According to the data released by the Government of India, the annual production of rice in India is 138 million metric ton in 2024 (Anonymous, 2024)^[2]. Rice yield is affected by many factors like climate conditions, insect and pest epidemics. Weather plays an important role for determining the geographical distribution and periodic abundance of major insect pests in rice (Singh *et al* 2012)^[5]. Rice stem borer is an important insect pest causing severe damage to rice crop in India (Saini *et al.*, 2015)^[3]. Formation of dead heart and white ear head is responsible for yield loss (Sherawat 2007)^[6]. This leads to yield loss of 3 to 95% in different areas of India. A feasible solution to these problem is through proper understanding of inter-relationship of pest incidence and meteorological parameters which trigger their outbreak under favourable conditions. Some researchers also correlated the incidence of insect pest with weather derived indices (Shekhar *et al.*, 2018)^[7]. Samui *et al.* 2007^[4] also developed weather based forewarning models for major insect pest of rice in Kerala and quantified the favourable weather conditions for various pests. With this in view, an attempt has been made to explore the feasibility to study the effect of weather parameters on occurrence of yellow stem borer in rice crop at Raipur by finding the various weather parameters. These relationships would be useful in evolving a pest management/ forewarning system.

Materials and Methods

The study was conducted using long-term data during the kharif season from 1998-2023 (25 years data) at Raipur, Chhattisgarh (21°16' N latitude and 81°36' E longitude). The long term meteorological data for the study period were obtained from AICRPAM project of the

Department of Agricultural Meteorology (IGKV) Raipur. Simultaneously, long term population data of yellow stem borer (*Scirpophaga incertulas* Walker) were collected through light traps from AICRP on rice and the Department of Entomology, College of Agriculture, Raipur. The pest population data were systematically synchronized with corresponding weather parameters to analyze their influence on pest incidence and seasonal variability.

To quantify the relationship between yellow stem borer population and meteorological variables, stepwise multiple linear regression analysis was carried out. Significant weather parameters were used to develop a predictive model in the form of a multiple regression equation. The predictive efficiency of the model were validated using independent datasets from 2022 and 2023 by comparing observed and predicted pest populations, thereby assessing its suitability for weather-based forewarning and management.

Results and Discussion

Different weather parameters such as maximum temperature (°C), minimum temperature (°C), rainfall (mm), relative humidity-I (%), relative humidity-II (%) and sunshine hours

(hrs) affected population dynamics of yellow stem borer of rice crop, hence simple correlation study was carried out. The correlation study revealed that incidence of YSB had a significant positive correlation with Sunshine hours (hrs), maximum sunshine hours favours the occurrence of YSB population by increasing ambient temperature and develop favourable microclimatic conditions for egg hatching, larval survival and fast development of YSB in early vegetative stages. The YSB population is always less as the rainfall is very scanty during early crop growth period, particularly from transplanting to early tillering stage, negatively affects YSB population by dislodging egg masses from leaf surfaces and washing away newly hatched larvae. The Relative humidity-II was found significantly negatively correlated. The result revealed that adverse impact of relative humidity-II is more pronounced during transplanting to tillering stage, it develop unfavourable microclimatic conditions that interfere with adult moth activity. The maximum temperature (°C), and Relative humidity-I (%) were non significant positively correlated with Yellow stem borer, whereas minimum temperature (°C) was non significant negatively correlated with YSB.

Table 1: Correlation between weekly population of rice yellow stem borer (YSB) and weather parameters from years of 1998-2023.

Weather variables	Yellow stem borer population
Maximum temperature (°C)	0.228
Minimum Temperature (°C)	-0.299
Rainfall (mm)	-0.625**
Relative humidity-I (%)	0.031
Relative humidity-II (%)	-0.436*
Sunshine hours (hrs)	0.670**

* Correlation is significant at 5% level ** Correlation is significant at 1% level

For the development of forewarning model, we first attempted week-wise correlation between the population and weather data for the corresponding and two lag weeks. We collected 25 years YSB and weather data for SMW 27 to SMW 48. The significant relationship observed between YSB population and weather parameters subjected to regression analysis and the regression equation along with R^2 values is presented in table 2. The incidence is generally observed from SMW 27 (i.e. first week of July). For equation of this week sunshine hours, minimum temperature and maximum temperature were significantly correlated at 1% level of significance. From week 28 (i.e. second week of July) population start gradually increasing. For developing equation for SMW 28, minimum temperature of two-week lag, sunshine hours of corresponding and two-week lag were used. Significant at 5% level of significance. For SMW 31 (i.e. first week of august), minimum temperature of corresponding week and RH-II of two-week lag were significantly correlated with YSB were used for development of regression equation. Significant at 1% level of significance. For

the equation of SMW 31, minimum temperature and RH-II should be validated for developing forewarning model. For SMW 33 (i.e. second week of august), two weather parameters contributed to the equation as they were found to be significantly correlated with YSB at 1% level of significance in this week. For SMW 35 (i.e. fourth week of august), only maximum temperature at corresponding week, which was significantly correlated with YSB and used for the development of regression equation were significant at 5% level. For SMW 37 (i.e. second week of September), maximum temperature of corresponding week and maximum temperature of one week lag were used. Significant at 5% level of significance. The equation was developed for SMW 38 (i.e. third week of September). For this week only maximum temperature of corresponding week was identified as the significant correlating factor with YSB in step-wise regression. For SMW 40 (i.e. first week of October), only one weather parameter relative humidity-I at 1 week lag was found significant enough for contributing to the prediction equation. Significant at 5% level of significance.

Table 2: Weather based forewarning model for rice yellow stem borer derived from YSB population and correlated weather parameters.

Regression Equation	R^2
$Y_{27} = 98.67369 - 2.25162 \times T_{\max} (1 \text{ week lag}) - 1.37846 \times T_{\min} (2\text{-week lag}) + 5.29006 \times \text{SSH} (\text{corresponding week}) + 2.601617 \times \text{SSH} (1 \text{ week lag}) + 0.48561 \times \text{SSH} (2\text{-week lag})$	0.255**
$Y_{28} = -10.9929 + 0.359058 \times T_{\min} (2\text{-week lag}) + 4.656154 \times \text{SSH} (\text{corresponding week}) + 0.276336 \times \text{SSH} (2 \text{ week})$	0.221*
$Y_{31} = 102.5459 - 376473 \times T_{\min} (\text{corresponding week}) + 0.024378 \times \text{RH-II} (2\text{-week lag})$	0.316**
$Y_{33} = -87.265 + 3.178423 \times T_{\max} (\text{corresponding Week}) + 3.679416 \times \text{SSH} (\text{corresponding week})$	0.318**
$Y_{35} = -439.608 + 15.51698 \times T_{\max} (\text{corresponding week})$	0.193*
$Y_{37} = -458.6 + 50.51097 \times T_{\max} (\text{corresponding week}) - 1.04052 \times T_{\max} (1 \text{ week lag})$	0.156*
$Y_{38} = -5744.44 + 191.4067 \times T_{\max} (\text{corresponding week})$	0.152*

$$Y_{40}=590.8227-3.43132\times RHI \text{ (1 week lag)}$$

0.200*

** significant at 1% level*significant at 5% level

Fig. 1(A) illustrates the relationship between observed and predicted population during SMW 27-47 of the year 2022. The observed YSB population remained relatively low during SMW 27-31, with minor fluctuations and a similar pattern was followed by predicted population. A gradual increase in population was recorded from SMW 33 onwards followed by SMW 37, indicating the onset of peak pest activity. The highest population was observed during SMW 38-40, during which the predicted population slightly overestimated the observed values. Both observed and predicted YSB population exhibited a declining pattern from SMW 46-47. Overall the predicted values closely followed the observed population pattern throughout the season, indicating the reliability and effectiveness of the prediction model. Fig.1(B) illustrates the relationship between observed and predicted population during SMW 27-47 of the year 2023. During the SMW 27-31, YSB population remained low in both observed and predicted values. Slow increase in population was recorded from SMW 33 onwards followed by SMW 35. The predicted value of our model significantly varied with the actual population during peak weeks (i.e. 38th -40th SMW) but the curve remained similar. This indicates that the model was effective for forewarning purpose.

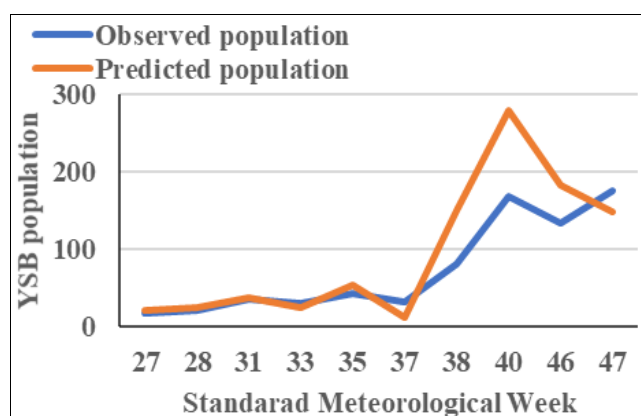


Fig 1 (A): Relation between observed and predicted light trap catches of YSB during 27-47 SMW in 2022.

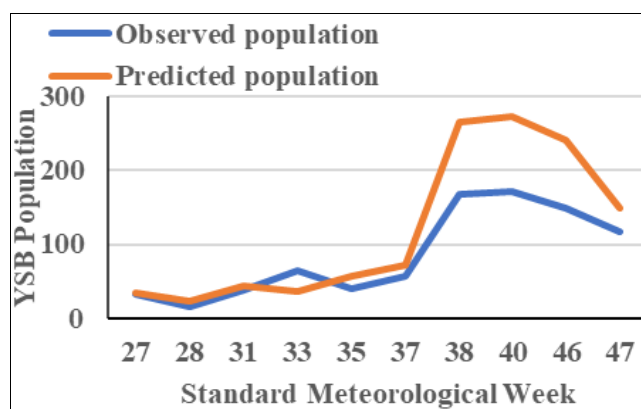


Fig 1 (B): Relation between observed and predicted light trap catches of YSB during 27-47 SMW in 2023.

Conclusion

It is therefore concluded from the above discussion that abiotic factors like temperature, humidity and rainfall have very significant effect on the population fluctuations of rice yellow stem borer. This information is very much helpful in the forecast of these insect pests which is ultimately very important in their

effective management. Based on the result, it can be interpreted that insect attacks depending upon the favourable weather conditions and their distribution influences the pest incidence to a great extent. The sunshine hours and rainfall are major conducive factors which along- with relative humidity influences the severity of pests on rice crop. With proper monitoring of such weather factors, it may be possible to predict the probable pest situation on rice crop so that suitable pest management strategies can be undertaken to protect the rice crop for increased grain yield.

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