



## POPULATION DYNAMICS OF RICE YELLOW STEM BORER AND SHEATH BLIGHT

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### ABSTRACT

Field experiments were conducted on the seasonal incidence of yellow stem borer (*Scirpophaga incertulas*) and sheath blight (*Rhizoctonia solani*). These revealed that maximum deadheart incidence (5.32 and 5.64%) was observed in the 33<sup>rd</sup> and 34<sup>th</sup> standard meteorological week (SMW) in 2018 and 2019, respectively. The incidence of white earhead was maximum (4.96 and 5.28%) during 40<sup>th</sup> SMW. Maximum incidence of sheath blight (50 and 46.67%) was noticed during 36<sup>th</sup> SMW. A significant positive correlation of minimum temperature and evening relative humidity was found with deadheart incidence. Conversely, maximum temperature and morning relative humidity had significant positive correlation with incidence of sheath blight. The model developed for ascertaining effect of weather factors on incidence of pest and disease showed a good relationship between predicted and observed data of % deadheart ( $R^2=0.996$ ), white earhead ( $R^2=0.992$ ) and diseased plants ( $R^2=0.986$ ).

**Key words:** Rice, *Scirpophaga incertulas*, *Rhizoctonia* blight, correlation, deadheart, white earhead, regression models, temperature, relative humidity

Rice (*Oryza sativa* L.) is cultivated in tropical and subtropical countries including India and Punjab occupies an area of 31.42 lakh ha with total production of 189.18 lakh mt and productivity of 60.21 q/ha (Anonymous, 2021). Occurrence of insect pests and diseases is the major limiting factor in rice productivity in India. Among the 23 species of insects attacking rice (Atwal and Dhaliwal, 2005; Pasalu and Katti, 2006), yellow stem borer (*Scirpophaga incertulas*) causes deadheart and white earheads (Sulagitti et al., 2018) causing direct yield losses (Rahman et al., 2004). In addition to this, sheath blight incited by *Rhizoctonia solani* Kuhn has also emerged an important threat in all rice growing areas with 25 to 50% yield losses (Roy, 1993; Prasanna Kumar and Veerabhadraswamy, 2014; Shinde and Prashanthi, 2014). Precise agroecosystem information on incidence and distribution of pest and disease in relation to weather parameters is prerequisite to develop any management programme (Patel and Shekh, 2006; Singh et al., 2012). Many studies have been conducted to study the effect of various weather parameters on seasonal abundance of yellow stem borer, their population buildup and progression of sheath blight (Rana et al., 2017; Nag et al., 2018; Seni and Naik, 2018; Shilpa et al., 2018; Bisen et al., 2019; Jasrotia et al., 2019). During last decade there has been an increase in area under rice cultivation in lower Shiwaliks of Punjab and there are frequent queries by

the farmers regarding incidence of *S. incertulas*) and *R. solani*. The present study was conducted to find out the peak period congenial for the incidence and progression of aforesaid pest and disease on rice in different locations in lower Shiwalik area of Punjab, India and its relation with various weather factors.

### MATERIALS AND METHODS

A survey of paddy fields (Variety PR 126) in the vicinity of village Saunkhri of Balachaur block of Punjab, India was undertaken from July to October, 2018 and 2019 during kharif season to record weekly data on incidence of *S. incertulas* and *R. solani* from three randomly selected plots (1 m<sup>2</sup> area) of three farmer's fields following standard procedure. The incidence of *S. incertulas* was assessed by counting number of deadhearts (DH) and white earheads (WEH) in vegetative and reproductive stage, respectively. Incidence of *R. solani* was recorded by counting number infected plants in random sample. The weather parameters, viz., maximum temperature, minimum temperature, average relative humidity and rainfall (data obtained from meteorology observatory at Dr Dev Raj Bhumbra Regional Research Station, Ballawal Saunkhri) were correlated with the incidence and correlation coefficients were worked out. Regression models for predicting the incidence were worked out

for temperature ( $T_{max}$  and  $T_{min}$ ), relative humidity ( $RH_{mor}$  and  $RH_{eve}$ ) and rainfall (RF), in XLSTAT software using regression technique. The two years (2018 and 2019) recorded data was divided in a ratio of 70:30 for model development (70 and 30% for model development and validation, respectively). The performance analysis of developed regression models included computation of different statistical parameters viz. mean absolute % error (MAE), root mean square error (RMSE) (Ramanathan, 1995), standard deviation (SD) and Willmott index of agreement (d) (Willmott et al., 2012).

### RESULTS AND DISCUSSION

During kharif 2018 and 2019, the incidence level of *S. incertulas* was medium to low; deadhearts start appeared during 3<sup>rd</sup> week of July reaching maximum level of 5.32 % during 2<sup>nd</sup> week of August 2018 (33<sup>rd</sup> SMW) and 5.64% during 3<sup>rd</sup> week of August 2019 (34<sup>th</sup> SMW) (Fig. 1). Similarly white earhead incidence started to appear during 1<sup>st</sup> week (0.42%) and 2<sup>nd</sup> week of September (0.42%) during 2018 and 2019, respectively; maximum level of 4.96 and 5.28% were during 1<sup>st</sup> week of October (40<sup>th</sup> SMW) which start decreasing thereafter. These observations corroborate with those of Murali et al. (2017) that deadheart incidence started during 1<sup>st</sup> week of August 31<sup>st</sup> SMW which reached at peak during 3<sup>rd</sup> week and 4<sup>th</sup> week of August. The present findings are also similar to those of Kalita et al. (2020). Correlation coefficients revealed a positive and significant values with minimum temperature ( $r=+0.57$  &  $+0.48$ ) and evening RH ( $r=+0.49$  &  $+0.46$ ), respectively; maximum ( $r=-0.01$  &  $-0.14$ ) and minimum temperature ( $r=-0.28$

&  $-0.34$ ), morning ( $r=-0.34$  &  $-0.16$ ) and evening RH ( $r=-0.31$  &  $-0.29$ ), rainfall ( $r=-0.41$  &  $-0.29$ ) were negatively but non-significantly correlated with white earhead during 2018 and 2019, respectively; while a significant negative correlation was observed with number of rainy days ( $r= -0.45^*$  &  $-0.59^*$ ). Minimum temperature and evening relative humidity enhanced the deadheart incidence. Murali et al. (2017) observed that relative humidity had positive correlation with deadhearts while it was negative for white earhead incidence with temperature, RH and rainfall. These results corroborate with those of Pallavi et al. (2018) and Sawai and Kothikar (2019), Kumar et al. (2020). Patel and Singh (2017) reported that weather parameters are the major ones with incidence of *S. incertulas*. Weekly observations from 27<sup>th</sup> to 46<sup>nd</sup> SMW, on incidence of *R. solani* revealed a continuous increase from 34<sup>th</sup> to 36<sup>th</sup> SMW reaching 50 and 46.67% during 36<sup>th</sup> SMW of 2018 and 2019, respectively (Fig. 1). Correlation coefficients revealed that a maximum temperature around 32-34 °C and >90% RH conducive. These results are accordance with those of earlier findings (Pasalu et al., 2005; Bhukal et al., 2015; Nandi, 1980; Tiwari and Chaur, 1997; Biswas et al., 2011; Bhukal et al., 2015). A significant positive correlation of maximum temperature and morning RH with incidence was evident (Fig. 1). Lenka et al. (2008) observed a significant positive correlation with incidence.

The statistical comparison indicated that the developed models were sufficiently accurate to predict the deadheart, white earhead and diseased plants in relation to the recorded  $T_{max}$ ,  $T_{min}$ ,  $RH_{mor}$ ,  $RH_{eve}$ ,

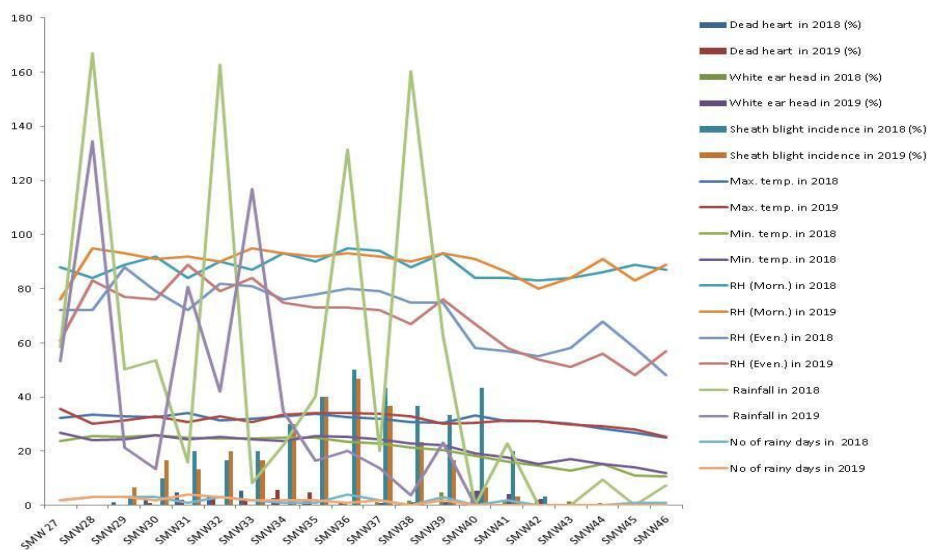


Fig. 1. Population dynamics of *S. incertulas* and *R. solani* of rice (kharif 2018, 2019)

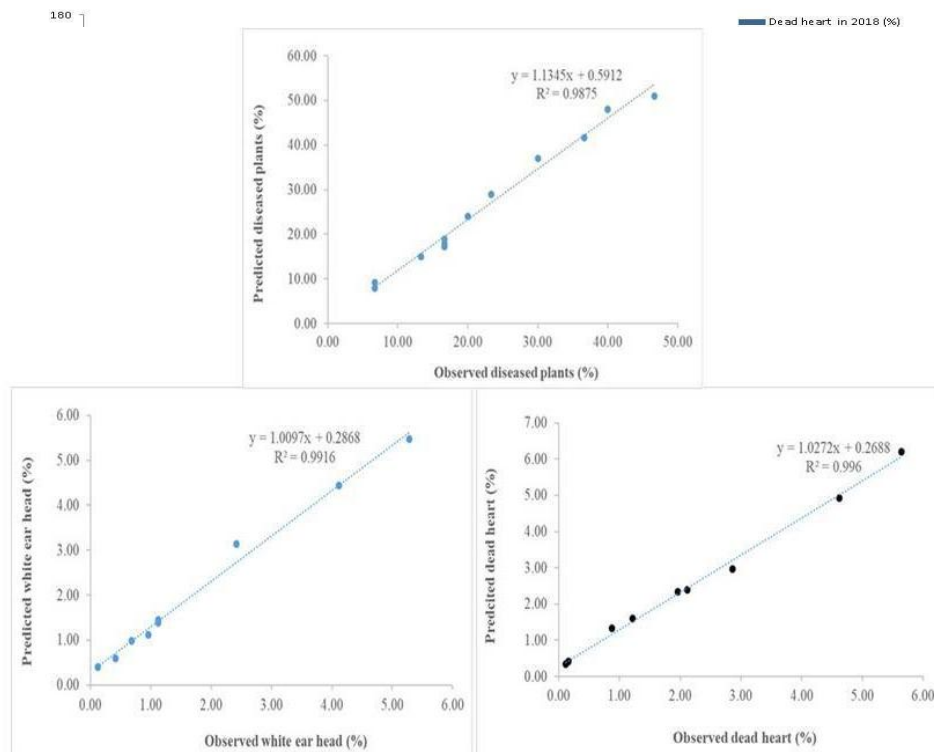


Fig. 2. Model (observed and predicted % deadheart, white earheads and diseased plants)

and RF. The predicted % deadheart formed a good relationship with the observed values for year 2019 as indicated in Fig. 2 ( $R^2=0.996$ ). Similarly, good relation was recorded between predicted and observed data of white earhead and % diseased plants. The statistical parameters viz. MAE, RMSE, SD and d values were computed to be in the range of 0.33-3.66, 0.35-4.32, 0.13-2.30 and 0.98-1.00, respectively. Both predicted and observed data indicated a high degree of agreement. The present results are in accordance with Chander and Palta (2010), who analyzed location- specific relations between pest and weather using empirical models and Manibhushanrao and Krishnan (1991) who also formulated a simulation model (EPIBLA) for leaf Blast disease of rice using multiple regression equations based on maximum temperature and maximum RH.

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#### AUTHOR CONTRIBUTION STATEMENT

RKS and KKS conceived and designed research experiments. RKS and KKS conducted experiments. RKS and KKS analyzed data. RKS and KKS wrote the manuscript. Both authors read and approved the manuscript.

#### CONFLICT OF INTEREST

There are no conflicts of interest or competing interests.

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