RESEARCH PAPER:

Influence of weather factors on the infestation of yellow stem borer, *Scirpophaga incertulas* Walker in aerobic rice

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SUMMARY

Field experiment was conducted to study the influence of weather factors on the infestation of yellow stem borer, *Scirpophaga incertulas* Walker in aerobic rice at College of Agriculture, Shimoga University of Agricultural Sciences, Bangalore. It was revealed that during *Kharif* 2005, borer infestation attained its peak activity when the crop was 60 days old, while in *Rabi* 2006, the peak activity was noticed at 75 days after sowing. Regression equations between the infestation of stem borer and weather parameters showed a significant negative correlation with minimum temperature and afternoon relative humidity but showed non-significant and negative correlation with maximum temperature, morning relative humidity and rainfall and had significant positive correlation with sunshine hours in *Kharif*. While in *Rabi* season, per cent dead heart or white earhead showed significant positive correlation with morning and afternoon relative humidity and non-significant positive correlation with the mean sunshine hours per day.

Key words : Aerobic rice, Correlation, Weather factors

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Among the cereals, rice is a staple food of India. Among the different insects associated with rice, the yellow stem borer, *Scirpophaga incertulas* Walker is one of the most destructive and widely distributed from tropics to temperate regions (Torii, 1967) infesting from seedling to maturity stages. The damage in the early stage of the crops results in dead hearts and at a later stage in white ears. It is rather difficult to find a direct cause and effect relationship between any single factor and pest activity because the impact of weather factors on pest is usually compounded. For developing weather-based pest forecasting models, the information on the relationship between the incidence of insect pests and weather factors is needed. Kisimoto and Dyck (1976) stated that climatic factors are responsible for causing certain biological events. Thus, the present study was undertaken to identify the weather factors, if any that influences the infestation of YSB on aerobic paddy.

MATERIALS AND METHODS

The field experiment was conducted at College of Agriculture, Navile Shimoga, University of Agricultural Sciences, Bangalore. during *Kharif* and *Rabi* seasons of 2005-06 with rice variety Rasi to assess the impact of weather factors on infestation by *Scirpophaga incertulas* in aerobic paddy. In each plot of 20 sq.m, five quadrants of one m^2 were randomly selected in 'W' design. From each quadrant, four hills were selected for counting dead hearts or white earheads at fortnightly intervals from 15 days following sowing. To the study instantaneous effect of major abiotic factors *viz.*, maximum temperature, minimum temperature, morning and afternoon relative humidity, rainfall and sunshine hours on pest infestation, a correlation coefficient and multiple linear regression was worked out taking fortnightly per cent dead hearts or white earheads as dependent variable with the fortnightly mean meteorological data as independent variables. Meteorological data were recorded from the observatory situated at College of Agriculture, Navile, Shimoga.

RESULTS AND DISCUSSION

The results obtained from the present investigation are summarized below :

Kharif season:

The impact of major abiotic factors on the incidence of per cent dead heart (DH) or white ears (WH) as affected by *Scirpophaga incertulas* at fortnightly interval during *Kharif* season are given in Table 1 and 2.

Table 1 : Influence of major abiotic factors on the infestation caused by *Scirpophaga incertulas* to aerobic paddy (var.-Rasi) during *Kharif* season of 2005-06

Days after sowing	DH or WH (%) (Y)	Major abiotic factors					
		Temperature (^{0}C)		Relative humidity (%)		Sunshine (hours/day)	Total rainfall (mm)
		Minimum (X_1)	Maximum (X_2)	Morning (X_3)	Afternoon (X_4)	(X_5)	(X_6)
15	2.80	21.80	29.04	88.80	68.67	3.08	44.0
30	3.50	20.80	29.67	89.80	67.00	4.68	144.4
45	4.45	19.68	28.64	82.80	65.81	3.13	160.2
60	7.91	19.80	28.54	84.66	57.53	4.99	12.4
75	7.42	19.05	28.92	85.67	64.20	4.69	36.0
90	7.73	17.45	28.20	80.19	57.75	6.63	3.4
105	7.61*	19.65	29.20	85.60	58.53	6.54	5.4

* Indicates white ears

Table 2 : Correlation coefficient and regression equation values for average dead heart or white ear heads (Y) with respect to weather parameters (X1 to X6) during *Kharif* season of 2005-06

Particulars	DH or WH (%) (Y)	Major abiotic factors					
		Temperature (^{0}C)		Relative humidity (%)		Sunshine (hours/ day)	Total rainfall (mm)
		Minimum (X_1)	Maximum (X_2)	Morning (X_3)	Afternoon (X_4)	(X_5)	(X_6)
Correlation coefficient	1.00	-0.77*	0.52	0.62	-0.91**	0.76*	0.70
Regression coefficient	-41.49	-2.12	4.69	0.038	-0.606	-2.10	-0.02
R^2	0.66						
$\hat{Y}$ =	-41.49	-2.19 (X_1)	+4.69 (X_2)	+0.04 (X_3)	-0.61 (X_4)	-2.10 (X_5)	-0.02 (X_6)

* and ** indicate significant of values at P=0.05 and 0.01, respectively

It is evident from Table 1 that the per cent dead hearts (DH) or white ear head (WH) had significant negative correlation with minimum temperature (r= -0.77*) and afternoon relative humidity (r= -0.91**). The highest per cent DH of 7.91 was observed during the second fortnight of September when the minimum temperature was 19.8 ^{o}C and afternoon relative humidity was 57.53 per cent and lowest per cent DH of 2.80 was observed during the first fortnight of August when the minimum temperature and afternoon relative humidity were 21.8 ^{o}C and 68.67 per cent, respectively. These results agree with the findings of Bhatnagar and Saxena (1999) and Kumar and Sudhakar (2001).

The per cent DH or WH had the non-significant but negative correlation with maximum temperature (r =-0.52*) and morning relative humidity (r=-0.62*) (Table 2). The pest incidence of 7.91 per cent DH was recorded when the maximum temperature was 28.54^{o}C and morning relative humidity was 84.66 per cent. It was also evident from lower incidence of 2.80 per cent DH which occurred during first fortnight of August when the maximum temperature was 29.04^{0}C and morning relative humidity was 88.80 per cent, which agree with the findings of Kumar and Sudhakar (2001). It may be because of the sunshine is the limiting factor during *Kharif*.

However, sunshine hours showed significant positive correlation with pest infestation (r= 0.76*), which was evident from lower incidence of 2.80 per cent DH which occurred during first fortnight of August when the sunshine hours was only 3.08 hours, while with increase in sunshine hours (6.63 hours) the pest infestation was higher (7.73 per cent DH) during second fortnight of October and it was in agreement with Kumar *et al*. (1995).

Impact of rainfall on incidence of DH or WH was non-significant (r= -0.70) but showed negative effect as the per cent dead heart (4.45 %) was low when highest amount of rainfall was 160.2 mm and the outbreak of *S. incertulas* (7.73 % DH) had the lowest amount of rainfall of 3.4 mm and the per cent WH was 7.61 when the rainfall was 5.4 mm, which correlate with the findings of Sushil Kumar *et. al*. (1995). Similarly, Rao and Padhi (1981) reported that outbreak of *S. incertulas* had the lowest amount of rainfall, number of rainy days and highest sunshine hours. Further, they concluded that the rainy

days adversely affected the mating, flight, oviposition, egg hatchability, larval survival and tiller penetration.

Multiple regression equation fitted to the data, taking dead hearts and white ear heads together as a dependent variable and weather factors as independent variables could explain 66 per cent of total variation in the incidence of stem borer. The equation is as follows;

Y (stem borer incidence) = -41.49 - 2.12 (X_1) + 4.69 (X_2) + 0.04 (X_3) -0.61 (X_4) -2.10 (X_5) -0.02 (X_6) with (R^2=0.66) where, X_1 = minimum temperature (ºC), X_2 = maximum temperature (ºC), X_3 = morning relative humidity (%), X_4= afternoon relative humidity (%), X_5= sunshine hours (hours per day) and X_6= total rainfall (mm).

Rabi season:

The impact of major abiotic factors on the incidence of per cent dead heart (DH) or white ears (WH) as affected by *Scirpophaga incertulas* at fortnightly interval during *Rabi* season are given in Table 3 and 4.

The per cent dead hearts (DH) or white ear heads (WH) had significant positive correlation with minimum temperature (r=0.79*) and maximum temperature (r=0.91**), which was evident from higher incidence of pest infestation (6.5 % DH) which occurred during first fortnight of February when the minimum temperature (20.46^{0}C) and maximum temperature (35.45^{0}C) was higher while with decrease in minimum temperature (13.50^{0}C) and maximum temperature (29.61^{0}C) the pest infestation was low (0.25 % DH) which occurred during first fortnight of December (Table 3). These results were in agreement with Kumar and Sudhakar (2001). Tian (1981) also reported that high temperature had favoured the development of stem borers.

However, the per cent dead hearts (DH) or white ear heads (WH) had significant negative correlation with morning relative humidity (r=-0.82*) and afternoon relative humidity (r=-0.86*) (Table 4). The per cent DH was highest (6.5 % DH) during first fortnight of February when morning relative humidity (81.73 %) and afternoon relative humidity (38.06 %) were lower while with increase in morning relative humidity (88 %) and afternoon relative humidity (44 %) the pest infestation was low (0.25 % DH) during first fortnight of December. These results are in agreement with the findings of Bhatnagar and Saxena (1999) and Kumar and Sudhakar (2001).

However, sunshine hours showed non-significant but

Table 3 : Influence of major abiotic factors on the infestation caused by *Scirpophaga incertulas* Walker to aerobic paddy(var.-Rasi) during *Rabi* season of 2005-06

Days after sowing	DH or WH (%) (Y)	Major abiotic factors					
		Temperature (^{0}C)		Relative humidity (%)		Sunshine (hours/day)	Total rainfall (mm)
		Minimum (X_1)	Maximum (X_2)	Morning (X_3)	Afternoon (X_4)	(X_5)	(X_6)
15	0.25	13.50	29.61	88.00	44.00	5.20	0.0
30	0.36	15.56	30.31	86.81	43.38	5.40	8.4
45	0.81	17.13	31.89	84.23	43.81	3.80	0.8
60	5.5	18.32	34.54	83.93	40.13	5.74	0.0
75	6.5	20.46	35.45	81.73	38.06	6.14	0.0
90	4.3	22.02	31.86	81.56	43.06	3.50	0.0
105	4.5*	18.46	34.28	81.33	42.15	4.80	0.0

* Indicate white ears

Table 4 : Correlation coefficient and regression equation values for average dead heart or white ear heads (Y) with respect to weather parameters (X1 to X6) during *Rabi* season of 2005-06

Particulars	DH or WH (%) (Y)	Major abiotic factors					
		Temperature (^{0}C)		Relative humidity (%)		Sunshine (hours/ day)	Total rainfall (mm)
		Minimum (X_1)	Maximum (X_2)	Morning (X_3)	Afternoon (X_4)	(X_5)	(X_6)
Correlation coefficient	1.00	0.79*	0.91**	-0.82*	-0.86*	0.30	-0.52
Regression coefficient	-148.75	1.26	0.79	0.33	1.43	3.19	-0.34
R^2	0.65						
$\hat{Y}$ =	-148.75	+1.26 (X_1)	+0.79 (X_2)	+0.33 (X_3)	+1.43 (X_4)	+3.19 (X_5)	-0.34 (X_6)

* and ** indicate significant of values at P=0.05 and 0.01, respectively

positive correlation with pest infestation (r= 0.30). The positive correlation with sunshine hours was evident from higher incidence of 6.5 per cent DH which occurred during second fortnight of February when the sunshine hours was 6.14 hr., while with decrease in sunshine hours (5.2 hours) the pest infestation was lower (0.25 per cent DH) during first fortnight of December. However, Rao and Padhi (1988) reported that the mean sunshine hours per day during September to October were positively correlated with borer infestation at heading stage in different years and Kumar and Sudhakar (2001) summarized that during *Rabi* season sunshine hours played a key role in enhancing borer incidence.

Impact of rainfall on incidence of DH or WH was non-significant (r= -0.52) but showed negative effect as the per cent dead heart (0.36 %) was low when highest amount of rainfall was 8.4 mm. The outbreak of *S. incertulas* (6.5 % DH) was noticed when there was no rainfall. Similar results are also supported by Kumar and Sudhakar (2001).

When all the abiotic factors were analysed to find out multiple regression equation, taking dead hearts and white ear heads together as a dependent variable and weather factors as independent variables it could explain that 65 per cent of total variation in the incidence of stem borer. The equation is as follows:

Y(stem borer incidence)=-148.75 +1.26 (X_1)+ 0.79 (X_2) + 0.33 (X_3) + 1.43 (X_4)+3.19 (X_5) -0.34 (X_6) with (R^2=0.65)

where, X_1 = minimum temperature (^{0}C), X_2 = maximum temperature (^{0}C), X_3 = morning relative humidity (%), X_4= afternoon relative humidity (%), X_5= sunshine hours (hours per day) and X_6= total rainfall (mm).

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