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Forewarning Model for Borers of Sugarcane Under Bihar Agro Ecosystem

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ABSTRACT

The model for forewarning about the incidence of root-shoot borer and top borer in sugarcane was studied through dead hearts and bunchy top in the sugarcane crop over ten years (2006-07 to 2015-16). The observations were recorded of root/shoot borer and top borer from March to July and from March to February, respectively. The maximum incidence of shoot/root borer (16.8) per cent in the month of May and 22.88 per cent with top borer in the month of July during course of investigation. Using the original data on the response variable i.e. incidence of root-shoot borer and top borer, the simple linear regression model was fitted with fortnightly as explanatory variable and describe the dynamics of the infestation of the root-shoot borer and top borer during the fortnight. The value of multiple correlations for root-shoot borer and top borer were 0.7179 and 0.9674, respectively. We also include meteorological factor i.e. maximum temperature, minimum temperature, relative humidity and rainfall in the model. This model provides the dynamics of the incidence of the above mentioned root-shoot borer and top borer forewarning. Meteorological factors played an important role in seasonal abundance, distribution and population buildup of root-shoot borer and top borer in sugarcane. For management purpose this model will be useful to predict the incidence of root/shoot and top borer.

Multiple Regression Model for –

Shoot/Root borer (Y1) = $-53.2974+3.3005X_1-2.163X_2-0.4048X_3+0.6426X_4+0.255X_5$

Top borer (Y2) = $-4.2309-0.3641X_1+0.7294X_2+0.2115X_3-0.1813X_4+0.0595X_5$

Key Words- *Incidence, Forewarning, Sugarcane, Ecosystem. Root/Shoot borer and Top borer.*

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INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is most important cash crop of Bihar. In terms of area and production of Bihar is 4th and 5th position respectively in India. Its ground area is 5284 thousands ha with production of 336900m tone during 2015-16 [1]. In Bihar Root-Shoot borer and Top borer played a major roll of reduction in yield and sugarcane recovery of sugarcane. Root-Shoot borer and Top borer are of the major insect pests of sugarcane. It occurs in most of the sugarcane growing areas. If information about time and severity of outbreak of Root-shoot borer and Top borer is available in advance, timely control measures can be taken up to reduce the losses. Weather plays an important role in Root-shoot borer and Top borer development. Therefore, weather based models can be an effective scientific tool for forewarning incidence of Root-shoot borer and Top borer at an appropriate time. In India sugarcane in cultivated all over the country from latitude 8^0N to 33^0N, except cold hilly areas Kashmir Valley, Himanchal Pradesh and Arunachal Pradesh. There are two distinct sugarcane growing belts (tropical and subtropical) in the country which are characterized by marked difference in climatic and agricultural conditions. India by contributing 18.59% area and 17.16% production ranks second among sugarcane growing countries of the world for both area and production of sugarcane (2009). In this country, sugarcane is an important cash crop in agriculture sector which shares 5.23% to the total value of agricultural output and occupies only 2.25% gross cropped area (2009). Information of weather and Root-shoot and top borer status is expected to be below or above the threshold level is used for models building. Root-shoot borer and Top borer severity at most damaging stage was larva, Insect/pest population affect severity at different stages of crop growth or at various standard fortnight. Time of

maximum population/severity of progress., Occurrence/non-occurrence of Root-shoot borer and Top borer and extent of damage. Prakasa Rao [2] reported that maximum moth emergence was high when temperature ranges from 14-27^{0}C to 28-30^{0}C with humid nights. Adults were abundant in April-May, July-August development of borers [4, 6]. Prajneshu [3] developed a nonlinear statistical model for describing the dynamics population growth. The present study was under taken to develop suitable models to know the dynamics of insect pests in relation to fortnightly as well as with meteorological variables so that active period may be ascertained for forewarning to avoid the loss to the sugarcane caused by the infestation of the insect pests.

MATERIALS AND METHODS

In order to determine fluctuation in the seasonal incidence of shoot/root and top borer in sugarcane, a roving survey was conducted at Pusa Farm, SRI, Dr. Rajendra Prasad Central Agricultural University, Pusa (Samastipur) during cropping season of 2006-07 to 2015-16. The crop was completely free from insecticidal contamination. The observation was recorded on per cent incidence of shoot/root and top borer based on dead hearts and bunchy top, respectively, throughout cropping season at fortnightly interval. The per cent incidence of shoot/root borer and top borer were worked out by using formulae.

Percent incidence of shoot/root borer = $\frac{\text{No.of dead hearts}}{\text{Total no.of tillers}} \text{X } 100$

Percent incidence of top borer = $\frac{\text{No.of bunchy top}}{\text{Total no.of tillers}} \text{X } 100$

The calculated fortnightly average of 10 years observations for insect pests including meteorological variables are given in table 1.

STATISTICAL ANALYSIS

The regression equation involving meteorological variables as independent variables and pest incidence as depended variables was developed. For forecasting purpose it will be useful to know the effects of meteorological variables on the incidence.

The following statistical model was used to know the pest incidence.

$$\mathbf{Y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5}$$

Where, Y = Dependent variable (Pest incidence)

a= Pure constant

b_1= Regression coefficient for maximum temperature (X_1)

b_2= Regression coefficient for minimum temperature (X_2)

b_3=Regression coefficient for RH at 7 hrs. (X_3)

b_4= Regression coefficient for RH at 14 hrs. (X_4)

b_5= Regression coefficient for rainfall (X_5)

For each insect pest, the one model described above, was fitted using regression technique and the values for regression coefficient, multiple correlation (R^2) and adjusted multiple correlation (R^2) were calculated. The results for each insect pests is given in model (1) in which the asterisks** and *denote the significance of term in the models at 1 and 5 per cent levels, respectively.

RESULTS AND DISCUSSION

The model for forecasting the incidence of shoot/root borer and top borer in sugarcane cropping season was studied by taking observations on incidence percent over ten years (2006-07 to 2015-16). Maximum incidence percentage of shoot/root borer and top borer were recorded in the months of May and July, respectively, all the years during courses of study. Simple correlation was worked out between weather factors and pests incidence(Table 2). It was observed that maximum temperature showed significant positive correlation (0.6822*) with shoot/root borer incidence, while relative humidity at 7 hrs. showed significant but negative relationship (-0.7826**) and rainfall showed negative role with incidence of the pest. In case of top borer, correlation with maximum temperature, minimum temperature, relative humidity and rainfall were found as 0.6158*, 0.8894**, 0.7213** and 0.9696**, respectively, and were statistically significant except relative humidity at 7 hrs. (-0.112) with showed negative relationship. The multiple linear regression was worked out by taking shoot/root borer incidence as dependent variable and weather factors as independent variables (Table 3).

The value of R^2 (0.8461) and adjusted R^2(0.7179) with shoot/root borer and R^2 (0.9822) value and adjusted R^2 (0.9674) with top borer incidence indicated that the above model fits well for the monthly observed pests incidence in sugarcane and we may predict the incidence of pests in sugarcane. The value of R^2 and adjusted R^2 obtained using above model are of different values. The regression equation suggested that the effects of metrological variables are significant on the pest incidence in sugarcane. For management purpose it will be useful to use above model to predict the incidence of pests in sugarcane.

The present findings are more or less similar to the report of Sharma *et. al.* [5] they prepared the models for forewarning about the infestation of rice pests.

CONCLUSION

The forewarning models described in the present communication may be used to predict the dynamics of pests considered in the paper. These considerations may help to reduce certain degree of loss caused by these sugarcane crop pests.

Table -1: Means of observations on incidence (%) and weather factors for 10 years in sugarcane

Months	Per cent incidence		Weather factors				
	Root/Shoot borer	Top borer	Temperature (^{0}C)		Relative humidity (%)		Rainfall (mm)
			Maximum	Minimum	at 7 hrs.	at 14 hrs.	
March	3.8	2.0	30.75	15.6	83.0	42.00	7.5
April	12.4	6.05	36.18	21.12	74.1	36.1	13.6
May	16.8	10.61	35.71	24.2	68.7	47.4	97.0
June	9.0	14.20	35.77	26.0	83.9	60.0	150.8
July	5.3	22.88	32.53	26.4	89.6	73.0	284.0
August	0.0	21.47	32.71	26.2	79.2	71.3	225.3
September	0.0	20.06	32.36	25.3	89.2	69.4	234.5
October	0.0	9.11	31.58	22.0	89.5	58.0	72.1
November	0.0	6.44	28.52	15.4	89.2	47.8	2.5
December	0.0	0.73	22.40	10.5	90.2	57.0	1.0
January	0.0	0.70	20.88	8.2	90.1	59.6	8.8
February	0.0	0.65	25.19	11.7	88.1	49.4	7.0

Table -2: Correlation matrix: Effect of weather factors on shoot root and top borer incidence

Percent incidence	No. of observations	Weather factors				
		Temperature (^{0}C)		Relative humidity (%)		Rainfall (mm) (X_5)
		Maximum (X_1)	Minimum (X_2)	at 7 hrs. (X_3)	at 14 hrs. (X_4)	
Shoot/root borer (Y_1)	12	0.6822*	0.3987	-0.7826*	-0.4846	-0.0420
Top borer (Y_2)	12	0.6158*	0.8894**	-0.1102	0.7213**	0.9696**

* - Significant at 5% probability, **-Significant at 1% probability

Table -3: Multiple linear regression models for weather factors on shoot/root and top borer incidence in sugarcane

Percent incidence	No. of observations	Pure constant	Weather factors					R^2	R^2 adjusted
			Temperature (^{0}C)		Relative humidity (%)		Rainfall (mm)		
			Maximum	Minimum	at 7 hrs.	at 14 hrs.			
Y_1	12	-53.2974	3.3005	-2.163	-0.4048	0.6426	0.0255	0.8461	0.7179
Y_2	12	-7.2309	-0.3641	0.7294	0.2115	-0.1813	0.0595	0.9822	0.9674

Multiple Regression Models –

Shoot/Root borer (Y_1) = $-53.2974+3.3005X_1-2.163X_2-0.4048X_3+0.6426X_4+0.255X_5$

Top borer (Y_2) = $-7.2309-0.3641X_1+0.7294X_2+0.2115X_3-0.1813X_4+0.0595X_5$

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