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Prediction of okra shoot and fruit borer (*Earias vittella* Fab.) incidence using weather variables at Pusa, Bihar

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ABSTRACT
Weather based forewarning of the incidence of insect pest and generating the information about critical weather sensitive phases in the life cycle of insect can guide operational and tactical strategy in insect pest management. Keeping this in view, a field experiment was conducted at Rajendra Agricultural University, Pusa, Bihar to study the impact of weather variables on population dynamics of shoot and fruit borer, *Earias vittella* Fab. in okra *(Abelmoschus esculentus* L. Moench) crop during summer seasons of year 2000 and 2001. With delay in sowing the borer pest attack increased manifold. In late sown crop (7th April), nearly 31 per cent reduction in the yield of okra was observed. The prediction function using step-wise regression analysis explained 93.1 per cent variability due to weather variables in the percentage damage of fruits and 94.9 per cent variability for the larval population per hundred fruits.

Key words : Shoot and fruit borer, Prediction and Weather.

INTRODUCTION

Vegetable is an important constituent of human diet. Among different vegetables, okra is an important dietary vegetable crop in the country. In India, okra is mostly grown in different regions and are adopted to various agro-climatic conditions. There are about 13 major insect and non-insect pests species, which attack this crop at various stages of growth (Dhamdhere *et al.*, 1984). Unfortunately, okra is the worst sufferer of shoot and fruit borer (*Earias vittella* Fab.), which is main bottleneck for cultivation of this crop. Under different agro-climatic conditions, the losses may vary from 10.1 to 50.0 per cent (Kashyap and Verma, 1983). Sometimes the late sown crop may fail completely if the crop is not protected from the shoot and fruit borer attack. The incidence and spread of okra shoot and fruit borer is largely controlled by various meteorological parameters *viz.*, temperature, relative humidity and rainfall. Information on interaction of weather parameters and insect development can provide vital support in insect management strategies for achieving optimum use of insecticides and also reducing chemical load on environment. Very little information is available for prediction of shoot and fruit borer incidence using the sowing dates and weather conditions. Keeping this in view, the present study was undertaken to study the effect of date of sowing on the pest attack and to develop simple shoot and fruit borer prediction models using various weather parameters.

MATERIALS AND METHODS

The field experiments were conducted at the University Apiary of Rajendra Agricultural University, Bihar, Pusa (Samastipur) during the summer seasons of 2000 and 2001. It is situated at 23º39¢ N latitudes and 85º 4¢ E longitudes at a mean sea level height of 52 m. This area is characterised by sub-humid, sub-tropical climate with very hot summer from April to June and cold winters from December to January. The okra cv. "Pusa Sawani" was sown on six dates at 10 days intervals on 16 February, 26 February, 8 March, 18 March, 28 March and 7 April in Randomised Blocks replicated four times. Each plot size consisted of 3m x 2m with 30cm x 30cm plant spacing. The crop was raised as per the package and practices of Rajendra Agricultural University, Bihar, Pusa (Samastipur).

Meteorological Observations

The weekly meteorological data during the period of experiment were collected from the Agrometeorological Observatory, Pusa (Samastipur). Weekly mean maximum temperature, minimum temperature, relative humidity for 700 hrs. & 1400 hrs. and total weekly rainfall were used to work out the association of weather parameters on infestation of the pest on okra.

Correlation coefficients between the pest incidence and individual weather parameters for the corresponding sowing dates have been worked out. The most predominant sowing dates *viz.*, D_2 (26th February), D_4 (18th March) and D_6 (7th April) were chosen for correlation coefficients studies and development of multiple regressions. The correlation and step-wise regression analysis was done using computer software.

Insect Parameters

Per cent shoot infestation

Ten plants from each plot were randomly selected and tagged. The shoot damage was worked out by counting the withered terminal shoots out of all the shoots of total tagged plants in each replications at weekly observations on each sowing dates of crops. The per cent shoot damage was calculated as :

$$\text{Percent shoot damage} = \frac{\text{Number of damaged shoots}}{\text{Total number of (healthy + damaged) shoots}} \times 100$$

Per cent fruit infestation

Fruit infestation was observed in the first batch of harvested fruits and continued throughout the fruiting stage of crops on each sowing dates of crops. The fruit damage on weight basis was worked out by sorting out the infested and healthy fruits and weight of infested as well as total harvested fruits were recorded. Per cent fruit damage was calculated as :

$$\text{Percent fruit damage} = \frac{\text{Weight of damaged fruits}}{\text{Total weight of (healthy + damaged) fruits}} \times 100$$

Larval population

The larval population per hundred fruits was taken at each pickings from first batch of harvested fruits and continued throughout the crop seasons on each sowing dates of crops. Larva were either crawling on the infested fruits or were present inside the infested okra fruits. The larva in infested fruits were counted by cutting them longitudinally.

RESULTS AND DISCUSSION

Occurrence of the Pests

The activity of shoot and fruit borer (*E. vittella*) on summer okra

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was observed from 35 days age of the crop. The pest succession followed a similar trend in both the crop seasons of 2000 and 2001. The infestation on shoots ranged between 0.3 to 3.46 per cent in 2000 and 1.45 to 4.86 per cent in 2001 on different sowing dates of the crops. These infestations were almost negligible and no infestation on shoots was observed after fruit setting.

Effect of Sowing Dates on the Pest Incidence and Crop Yield

The results were found to be statistically significant (Table 1). The minimum percentage of fruit damage (27.33) was recorded in the first date of sowing (16th February) while with a delay in sowing of the crop, the percentage of fruit infestation gradually increased upto 7th April. The larval population per hundred fruits was observed to be maximum (59.74) in the crops sown on 7th April. The maximum yield (112.60 q/ha) was recorded in the first date of sowing (16th February), which declined later on, giving minimum yield (77.4 q/ha) in the last date of sowing (7th April).

Looking to the pooled results of incidence of the pests and yield levels, probably delayed sowing played an effective role towards yield loss. The key factor related here could be of meteorological parameters creating congenial condition for pest multiplication. From the production and protection point of view 16th February can be a suitable date for the sowing of okra so that the fruit damage due to *Earias vittella* can be reduced to some extent on early sown okra. These results are similar to those of Gupta *et al.* (1981) who found the earliest sowing generally gave the highest okra yield, which decreased with each later sowing date since the crop escaped the pest infestation.

Table 1 : Effect of sowing dates on shoot and fruit borer attack and yield (Pooled mean, 2000 and 2001).

Sl. No.	Sowing dates	Fruit damage (%)	Larval Population per 100 fruits	Yield q/ha
1.	D_1 – 16th February	27.33 (31.80)	42.28 (40.55)	112.60
2.	D_2 – 26th February	31.55 (34.16)	46.35 (42.93)	107.75
3.	D_3 – 8th March	33.20 (35.18)	48.40 (44.08)	103.87
4.	D_4 – 18th March	37.65 (37.84)	52.85 (46.64)	99.68
5.	D_5 – 28th March	40.13 (39.30)	56.27 (48.46)	86.83
6.	D_6 – 7th April	42.93 (40.92)	59.74 (50.62)	77.40
	Seem (±)	0.778	0.775	1.459
	CD (P=0.05)	2.346	2.335	4.2396

Figures in parentheses indicate Arc sine transformed values.

Correlation Coefficient of E. vittella Pest Infestation with Weather Variables

Correlations between okra shoot and fruit borer in terms of fruit damage percentage on weight basis and the larval population per hundred fruits as well as prevailing weather parameters (Table 2) revealed that the maximum temperature had negative effect, whereas, the minimum temperature, relative humidity (morning and evening) and rainfall had positive effect on the fruit infestation and the larval population of *E. vittella* at D_2, D_4 and D_6 sowing dates (Table 2).

Regressions between Weather Parameters and Fruit Infestation and the Larval Population

The multiple regression equations developed between fruit infestation as well as the larval population and weather parameters for D_2, D_4 and D_6 sowing dates are presented in Table 3 and 4. The maximum value of coefficient of determination (R^2) was observed at D_4 sowing date. With delay in sowing, the value of R^2 decreased. Similarly, the multiple regressions between the larval population per hundred fruits and weather parameters revealed that the highest value of R^2 was observed for D_4 sowing date and it decreased with delay in sowing of the crop (Table 4).

CONCLUSIONS

The early date of sowing (16th February) proved to be the best date of sowing for higher okra yield and low shoot and fruit borer infestation. By adjusting the sowing date, the pest incidence can be reduced to a great extent. None of the weather variables was alone responsible for *Earias vittella* incidence on the okra crop and consequently its growth and multiplication.

Table 2 : Correlation coefficients between shoot and fruit borer incidence and weather variables at different sowing dates (Pooled mean, 2000 and 2001).

Weather parameters	Fruit damage (%)			Larval population/100 fruits		
	D_2	D_4	D_6	D_2	D_4	D_6
Maximum Temperature (°C)	-0.525	-0.496	-0.738	-0.531	-0.452	-0.686**
Minimum Temperature (°C)	0.867**	0.756**	0.037	0.860**	0.770**	0.100
Relative humidity at 700 hrs.	0.926**	0.790**	0.756**	0.914**	0.810**	0.749**
Relative humidity at 1400 hrs.	0.942**	0.882**	0.860**	0.951**	0.887**	0.902**
Rainfall (mm)	0.644*	0.226	0.383	0.669*	0.312	0.360

* - Significant at 5% level.
** - Significant at 1% level.

Where, D_2 - Sowing date (26th February)
D_4 - Sowing data (18th March)
D_6 - Sowing date (7th April)

Table 3 : Regression equations between weather parameters and fruit damage (F.D.) of okra [Pooled data, 2000 and 2001].

Sowing date		F.D. vs T max. and T min.	
D_2	$Y_1 =$	$27.386 – 2.213 X_1 + 3.150 X_2$	(R^2 = 84.78%)
D_4	$Y_1 =$	$18.553 – 2.089 X_1 + 3.383 X_2$	(R^2 = 75.09%)
D_6	$Y_1 =$	$111.475 – 2.955 X_1 + 1.079 X_2$	(R^2 = 56.67%)
		F.D. vs T max., T min., $RH_{700\ hrs.}$ and $RH_{1400\ hrs.}$	
D_2	$Y_1 =$	$-70.370 + 0.491 X_1 + 0.478 X_2 + 0.593 X_3 + 0.374 X_4$	(R^2 = 91.64%)
D_4	$Y_1 =$	$-54.019 – 0.215 X_1 + 2.105 X_2 + 0.043 X_3 + 0.575 X_4$	(R^2 = 92.53%)
D_6	$Y_1 =$	$-45.072 – 0.824 X_1 + 1.413 X_2 + 0.396 X_3 + 0.577 X_4$	(R^2 = 81.18%)
		F.D. vs T max., T min, $RH_{700\ hrs.}$, $RH_{1400\ hrs.}$ and R.F.	
D_2	$Y_1 =$	$-79.535 + 0.611 X_1 + 0.178 X_2 + 0.723 X_3 + 0.412 X_4 – 0.012 X_5$	(R^2 = 91.81%)
D_4	$Y_1 =$	$-55.165 – 0.351 X_1 + 2.050 X_2 + 0.143 X_3 + 0.563 X_4 – 0.011 X_5$	(R^2 = 93.14%)
D_6	$Y_1 =$	$-36.315 – 1.055 X_1 + 1.272 X_2 + 0.429 X_3 + 0.588 X_4 – 0.015 X_5$	(R^2 = 83.40%)

Where,
- Y_1 - Fruit damage (%)
- D_2 - Sowing date (26th February)
- D_4 - Sowing data (18th March)
- D_6 - Sowing date (7th April)
- $T_{max.}$ - Maximum temperature (^oC)
- $T_{min.}$ - Minimum temperature (^oC)
- $RH_{700\ hrs.}$ - Relative humidity (%) at 700 hrs.
- $RH_{1400\ hrs.}$ - Relative humidity (%) at 1400 hrs.
- RF - Rainfall (mm)

Table 4 : Regression equations between weather parameters and the larval population(LP) of *Earias vittella* [Pooled Data 2000 and 2001].

Sowing date		L.P. vs T max. and T min.	
D_2	$Y_2 =$	$45.281 – 2.374 X_1 + 3.255 X_2$	(R^2 = 83.99%)
D_4	$Y_2 =$	$23.255 – 1.873 X_1 + 3.488 X_2$	(R^2 = 73.51%)
D_6	$Y_2 =$	$86.899 – 2.066 X_1 + 1.453 X_2$	(R^2 = 54.53%)
		L.P. vs T max., T min., $RH_{700\ hrs.}$ and $RH_{1400\ hrs.}$	
D_2	$Y_2 =$	$-45.819 + 0.631 X_1 + 0.257 X_2 + 0.369 X_3 + 0.538 X_4$	(R^2 = 91.93%)
D_4	$Y_2 =$	$-75.906 + 0.303 X_1 + 2.017 X_2 + 0.293 X_3 + 0.571 X_4$	(R^2 = 94.76%)
D_6	$Y_2 =$	$-53.186 – 0.160 X_1 + 1.751 X_2 + 0.355 X_3 + 0.516 X_4$	(R^2 = 93.01%)
		L.P. vs T max., T min, $RH_{700\ hrs.}$, $RH_{1400\ hrs.}$ and R.F.	
D_2	$Y_2 =$	$-44.589 + 0.615 X_1 + 0.298 X_2 + 0.352 X_3 + 0.533 X_4 + 0.001 X_5$	(R^2 = 91.93%)
D_4	$Y_2 =$	$-75.384 + 0.365 X_1 + 2.042 X_2 + 0.248 X_3 + 0.576 X_4 + 0.005 X_5$	(R^2 = 94.88%)
D_6	$Y_2 =$	$-48.066 – 0.295 X_1 + 1.669 X_2 + 0.374 X_3 + 0.522 X_4 – 0.009 X_5$	(R^2 = 93.82%)

Where,
- Y_2 - Larval population per hundred fruits
- D_2 - Sowing date (26th February)
- D_4 - Sowing data (18th March)
- D_6 - Sowing date (7th April)
- $T_{max.}$ - Maximum temperature (^oC)
- $T_{min.}$ - Minimum temperature (^oC)
- $RH_{700\ hrs.}$ - Relative humidity (%) at 700 hrs.
- $RH_{1400\ hrs.}$ - Relative humidity (%) at 1400 hrs.
- RF - Rainfall (mm)

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