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Studies on Population Dynamics of Spotted Pod Borer *Maruca vitrata* in Dolichos Bean, *Lablab purpureus* L. and their Relation with Abiotic Factors

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ABSTRACT

The present study was carried out to find the correlation between population dynamics of spotted pod borer, Maruca vitrata Geyer with weather variables during kharif 2015-16 and kharif 2016-17 respectively. The results on the seasonal incidence of M. vitrata during kharif 2015-16 revealed that the highest Maruca larval population was recorded during 47th and 49th standard weeks with 3.2 and 3.6 larvae per plant, respectively. During kharif 2016-17 the incidence of M. vitrata on field bean was commenced from 45th standard week and continued upto 4th standard week. The peak incidence of M. vitrata population was recorded at 50th standard week with 4.3 larvae per plant. The study on relationship between the M. vitrata larval population with preceding one week (one week lag) weather parameters during kharif 2015-16 revealed that there was a significant negative correlation was observed with maximum temperature (-0.351) at 5 % level of significance whereas significant positive correlation with evening relative humidity (0.129*) at 5 % level of significance. During kharif 2016-17 maximum temperature (-0.553*), minimum temperature (-0.575*) and evaporation (-0.581*) were negatively significant with M. vitrata larval population at 5% level while, mean temperature (-0.639**) was negatively significant with spotted pod borer larval population at 1% level.*

Key words: *Population dynamics, Spotted pod borer, M. vitrata, correlation, Multiple regression.*

INTRODUCTION

The Indian bean *Lablab purpureus* (L.) Sweet. popularly known as field bean, hyacinth bean, dolichos bean, country bean and butter bean which is an important pulse cum vegetable crop in India and is cultivated extensively in recent past for its fresh tender pods, leaves and seeds and as cattle feed. The field bean fresh pods are acceptable and liked by all, especially during winter season under South Indian conditions and it is rich in nutritive value as it is a rich source of carbohydrates, minerals, vitamins, such as vitamin A, vitamin C, fat and fiber. The protein content of field bean is quite high varying from 20.0 to 28.0 per cent[1].

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The primary cause attributed for lower yields of field bean can be due to the heavy infestation of an array of pest complex. As many as 55 species of insects and a species of mite feeding on the crop from seedling stage to the harvest of the crop in Karnataka[2]. Among them, the pod borers were considered to be most important and they appeared regularly causing crop loss to the tune of 80-100 per cent [3]. Pod borers were the key impediments for the low productivity in India which sometimes incur the loss to a tune of nearly 54 per cent in field beans[4]. The major yield loss was inflicted by the pod feeders which include both the pod borers and pod bugs.

The pod borer complex includes Maruca vitrata Geyer, *Maruca testulalis* (Geyer), *Helicoverpa armigera* (Hubner), *Adisura atkinsoni* (Moore), *Etiella zinckenella* (Treitschke), *Cydiaptychora* (Meyrick), *Exelastis atomosa* (Walshinghan) and *Lampides boeticus* (Linnaeus). The spotted pod borer, *Maruca testulalis* and is an important insect pest of grain legumes appear on the crop from vegetative to reproductive stage and cause substantial damage to flowers, by webbing and also boring into the pods. The damage inflicted by *H. armigera* is generally confined to flower heads, seeds and pods. Plume moth attacks the crop at thestage of flowering and continues up to pod maturity. The young larvae of *L. boeticus* damage flowers and pods [5]. Hence to know the insect pest scenario and population dynamics on the crop, the present studies have planned.

MATERIAL AND METHODS

To study the population dynamics spotted pod borer, *Maruca vitrata* Geyer on the field bean crop was grown by raising 100 m^2 crop with a spacing of 90 x 20cm. The study was carried out during *Kharif* 2015 and 2016 at open filed located at horticulture garden, College of Agriculture, Rajendranagar, Hyderabad, PJTS Agricultural University. All the recommended routine agronomic practices except plant protection measures were followed for raising the crop. From the date of germination onwards, observations were made in the bulk plots in ten selected plants for infestation of the insects at weekly interval. To assess the incidence of *M. vitrata* the observations were made at weekly interval commencing from randomly selected ten plants by counting the number larvae per plant .The data obtained in the population dynamics studies of *M. vitrata* on filed bean during *kharif* 2015-16 and *kharif* 2016-17 were subjected to correlation and multiple regression with various weather parameters *viz*., maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, rainfall, sunshine hours, evaporation etc.

RESULTS AND DISCUSSION

The data pertaining to population dynamics spotted pod borer, *M. vitrata* (Plate 1a and 1b) was collected from randomly tagged ten field bean plants at weekly intervals from an unprotected crop raised during *kharif* 2015-16 and 2016-17. The standard week wise data pertains to the mean spotted pod borer population per plant data from germination to harvest during *kharif* 2015-16 and 2016-17 were presented in tables 3.1 and 3.2 respectively (Figure 3.1).

***Kharif* 2015-16**

The data pertaining to the incidence of *M. vitrata* was presented in table 4.1. The data indicated that the pest incidence commenced from first week November (45^{th} standard week) of *kharif* 2015-16 with 0.1 larvae per plant and the spotted pod borer population ranged between 0.1 to 3.6 larvae per plant during the crop growth period (Figure 3.1). The population gradually reached peak during 3^{rd} week of November (47^{th} standard week) and once again during first week of December (49^{th} standard week) by 3.2 and 3.6 larvae per plant, respectively. Later the *M. vitrata* population decreased gradually by the end of the *kharif* season reaching 0.2 larvae/plant at

first week of January (1st standard week) and it was zero at 2nd, 3rd and 4th week of January (2nd, 3rd and 4th standard weeks). The highest number of 3.6 larvae per plant was recorded during the 1st week of December 2015 (49th standard week).

***Kharif* 2016-17**

The data pertaining to incidence of *M. vitrata* presented in table 4.2. The data indicated that the pest incidence commenced from 44th standard week of *kharif* 2016-17 was recorded with 0.3 larvae per plant and the population ranged between 0.2 to 4.3 larvae per plant (Figure 3.1).

The population gradually reached peak during 2nd week of December (50th standard week) 4.3 larvae/plant, respectively. Later the *M. vitrata* population decreased gradually by the end of the *kharif* season reaching 0.2 larvae/plant at last week of January

(4th standard week). The highest number of 4.3 larvae per plant was recorded during the 2nd week of December 2016 (50th standard week).

The two population peaks has been observed in moth catches from light traps at ICRISAT, Hyderabad *i.e* first peak during September and second peak in early November to first fortnight of December [6]. These results are similarly comparable with the present findings.

The incidence of *M. testulalis* commenced from last week of October and continued up to harvest (third week of January) and the population peaked during first week of December [7]. The population dynamics of major pod borers in redgram and revealed that spotted pod borer, *M. vitrata* incidence was initiated during last week of October and reached peak during second week of December [8].

In contrary to the present findings the peak incidence of *Maruca* during July, August and October in cowpea at Bangalore[9]. The incidence of spotted pod borer commenced from the second week of August and remained active up to first week of October in blackgram at Junagadh[10]. These variations might be due to change in season, crop and biotic/ abiotic factors. The seasonal incidence of spotted pod borer differed from crop to crop and season to season. However, the peak incidence of larvae was observed at flowering and pod development stage in different pulse crops[11].

Effect of abiotic factors between larval population of *M. vitrata* and weather parameters during *kharif* 2015-16 & 2016-17

The correlation studies conducted between the *M. vitrata* population and weather parameters of one week lag during *kharif* 2015-16 and 2016-17 was presented in table 3.3. Multiple Regression model developed for the population of *M. vitrata* with preceding one week weather parameters (one week lag) during *kharif* 2015-16 and 2016-17 was presented in table 3.4.

***Kharif* 2015-16**

The correlation coefficients data of *M. vitrata* and preceding one week weather factors during *kharif* 2015-16 (one week lag) was presented in table 3.3. The correlation studies between the seasonal incidence of *M. vitrata* population with the preceding one week weather parameters (one week lag) during *kharif* 2015-16 crop revealed that, maximum temperature (-0.351*) had significant negative correlation (p=0.05) with *M. vitrata* larval population. However, evening relative humidity (0.129*) had significantly positive correlation (p=0.05) with *M. vitrata* larval population. Minimum temperature (0.048) and morning relative humidity (0.132) were showing positive correlation with *M. vitrata* larval population. Whereas, rainfall, rainy days, sunshine hours, wind speed, evaporation and mean temperature were negatively correlated (-0.097, -0.165, -0.396, -0.296, -0.443 and -0.102, respectively) with larval

population *of M. vitrata* in field bean during *kharif* 2015-16

Regression analysis revealed that, all weather parameters collectively influenced the *M. vitrata* larval population to the extent of 88.96 per cent (R^2 =0.89%) on field bean (Table 3.4). Multiple regression equation was developed for *M. vitrata* larval population with preceding one week weather parameters (one week lag) was presented in table 4.10 which indicated that increase in one unit of evening relative humidity, rainfall, mean sunshine hours and mean temperature resulted in the increase of *M. vitrata* larval population by 0.80, 8.32, 0.83 and 1.59 units, respectively. Further, with one unit increase in maximum temperature, minimum temperature, morning relative humidity, rainy days, wind speed and mean evaporation the larval population was decreased by 0.29, 0.57, 0.35, 9.04, 0.15 and 1.17 units, respectively in field bean.

***Kharif* 2016-17**

The correlation studies between the population dynamics of *M. vitrata* population with the preceding one week weather parameters (one week lag) during *kharif* 2016-17 in field bean crop revealed that, maximum temperature (-0.553*), minimum temperature (-0.575*) and evaporation (-0.581*) had significant negative correlation (p=0.05) with *M. vitrata* larval population. Whereas, the mean temperature (-0639**) had significant negative correlation (p=0.01) with the larval population of spotted pod borer. However, sunshine hours (0.108) alone shown positive non significant correlation with *M. vitrata* larval population, whereas, morning relative humidity (-0.058) and evening relative humidity (-0.109) rainfall (-0.227), rainy days (-0.311) and wind speed (-0.354) were shown non significant negative correlation with *M. vitrata* larval population (Table 3.3).

Regression analysis revealed that, all weather parameters collectively influenced the spotted pod borer, *M. vitrata* larval population to the extent of 83.83 per cent (R^2 =0.84%) on field bean (Table 3.4).

Multiple regression equation was developed for *M. vitrata* larval population with preceding one week weather parameters (one week lag) was presented in table 3.4. Which indicated that increase in one unit of morning relative humidity, rainfall, mean sunshine hours, wind speed and mean temperature resulted in the increase of *M. vitrata* larval population by 0.10, 4.58, 0.54, 0.35 and 20.93 units, respectively. Further, with one unit increase in maximum temperature, minimum temperature, evening relative humidity, rainy days and mean evaporation the larval population was decreased by 4.52, 18.99, 0.10, 4.79 and 1.10 units, respectively.

The conformity results showing that the *Maruca testulalis* showed significant negative correlation with maximum temperature (r = -0.54) and significant positive correlation with morning relative humidity (r = 0.54) and evening relative humidity (r = 0.53) [7]. The pod borer population in field bean exhibited significant negative correlation with maximum temperature and relative humidity and showed non significant positive correlation with total rainfall[12]. Studies on population dynamics of spotted pod borer in black gram indicated that larval population and per cent pod damage by the pest exhibited a significant negative correlation (r = -0.5540 and r = -0.5555 respectively) with minimum temperature. There was no effect of other abiotic factors on the pest population and pod damage[10].

The present results contrary such that the correlation between the weather factors and *M. vitrata* larval population on greengram revealed that maximum temperature, minimum temperature and morning relative humidity showed positive influence where as rainfall and evening relative humidity showed negative influence[13]. However, none of them were significant except maximum temperature. This variation of the present finding may be due to change in crop.

Table 1: Population dynamics of *Maruca vitrata* Gayer larval population in field bean during *kharif* 2015-16

SMW	Date of observation	*M. vitrata* Larval population	Temperature (^{0}C)		Mean Relative Humidity (%)		Rainfall (mm)	Rainy Days	Mean Sunshine (hrs day^{-1})	Wind speed (km hr^{-1})	Mean evaporation (mm day^{-1})	Mean Temp (^{0}C)
			Max.	Min.	I	II						
41	11/10/2015	0.0	33.4	19.6	88.4	37.4	0.0	0	7.9	0.1	4.5	26.5
42	18/10/2015	0.0	32.8	19.1	91.7	42.0	0.0	0	8.4	0.6	4.5	26.0
43	25/10/2015	0.0	32.4	18.1	89.3	43.6	0.0	0	8.9	1.8	4.7	25.3
44	01/11/2015	0.0	31.3	20.7	91.7	50.9	18.3	1	7.3	1.3	3.6	26.0
45	08/11/2015	0.1	31.3	17.4	90.6	73.6	0.0	0	7.3	2.3	4.4	24.3
46	15/11/2015	0.5	30.0	15.8	85.1	52.9	0.0	0	6.7	2.4	4.0	22.9
47	22/11/2015	3.2	29.4	19.1	83.0	53.9	0.8	0	6.6	1.4	3.9	24.2
48	29/11/2015	2.9	30.4	17.8	87.4	47.0	0.0	0	7.7	0.6	3.8	24.1
49	06/12/2015	3.6	29.4	14.4	91.7	36.7	1.4	0	7.0	0.4	3.5	21.9
50	13/12/2015	0.9	32.2	17.0	90.0	37.0	0.0	0	7.6	0.7	3.9	24.6
51	20/12/2015	0.4	32.4	15.7	92.9	35.3	0.0	0	8.9	0.9	4.2	24.1
52	27/12/2015	0.6	30.0	11.1	73.3	24.6	0.0	0	8.8	0.8	3.9	20.6
1	03/01/2016	0.2	30.4	11.8	84.1	26.0	0.0	0	9.6	0.9	3.9	21.1
2	10/01/2016	0.0	29.2	11.0	78.4	25.6	0.0	0	9.1	1.2	3.9	20.1
3	17/01/2016	0.0	29.1	16.6	76.6	36.4	0.0	0	6.8	1.6	3.7	22.9
4	24/01/2016	0.0	29.1	15.6	79.4	37.3	0.0	0	7.2	1.6	3.8	22.4

* SMW- Standard Meteorological Week

*Mean no. of insects from 10 plants per plot

Table 2: Population dynamics of *Maruca vitrata* Gayer larval population in field bean during *kharif* 2016-17

SMW	Date of observation	*M. vitrata* Larval population	Temperature (^{0}C)		Mean Relative Humidity (%)		Rainfall (mm)	Rainy Days	Mean Sunshine (hrs day^{-1})	Wind speed (km hr^{-1})	Mean evaporation (mm day^{-1})	Mean Temp (^{0}C)
			Max.	Min.	I	II						
41	11/10/2015	0.0	29.9	20.8	94.4	50.9	27.8	3	5.3	0.0	3.1	25.3
42	18/10/2015	0.1	30.6	14.6	92.7	34.1	0.0	0	9.2	0.0	4.0	22.6
43	25/10/2015	0.4	30.2	15.1	91.9	38.3	0.0	0	8.8	0.0	4.1	22.7
44	01/11/2015	0.9	30.9	19.9	84.0	47.1	0.0	0	7.0	0.0	3.6	25.4
45	08/11/2015	1.1	30.1	12.3	88.0	28.7	0.0	0	8.5	0.0	3.8	21.2
46	15/11/2015	1.8	29.8	15.7	88.7	44.9	0.0	0	6.5	0.0	3.3	22.8
47	22/11/2015	3.0	29.7	9.8	89.7	28.1	0.0	0	8.7	0.0	3.6	19.8
48	29/11/2015	2.4	30.8	10.0	90.9	31.4	0.0	0	8.3	0.0	3.3	20.4
49	06/12/2015	3.3	29.1	14.0	92.6	42.3	0.0	0	7.4	0.0	3.1	21.5
50	13/12/2015	1.5	27.9	13.1	86.3	51.3	2.0	0	6.7	0.0	3.1	20.5
51	20/12/2015	1.4	29.4	9.5	88.3	24.0	0.0	0	9.1	0.0	3.6	19.5
52	27/12/2015	1.9	29.4	8.9	91.4	31.0	0.0	0	9.0	0.0	3.5	19.2
1	03/01/2016	1.7	29.1	9.7	89.6	29.7	0.0	0	8.8	0.0	3.4	19.4
2	10/01/2016	0.9	29.3	13.2	84.0	38.0	0.0	0	7.6	0.8	3.4	21.25
3	17/01/2016	0.4	28.2	11.4	89.1	31.7	0.0	0	7.7	1.2	3.6	19.8
4	24/01/2016	0.1	29.9	14.7	85.9	38.4	0.0	0	7.6	3.0	4.3	22.3

SMW- Standard Meteorological Week

*Mean no. of insects from 10 plants per plot

Table 3: Correlation coefficients between Spotted pod borer *Maruca vitrata* larval population and weather parameters (one week lag in field bean during *Kharif*, 2015-16 and *kharif* 2016-17

Weather parameters	Correlation coefficients (r)	
	***Kharif* 2015-16**	***Kharif* 2016-17**
Maximum temperature	-0.351*	-0.553*
Minimum temperature	0.048	-0.575*
Morning relative humidity (RH I %)	0.132	-0.058
Evening relative humidity (RH II %)	0.129*	-0.109
Rainfall (mm)	-0.097	-0.277
Rainy days (R.D)	-0.165	-0.311
Sunshine hours (S.S.H)	-0.396	0.108
Wind speed (W.S) Km/h	-0.296	-0.354
Evaporation (E. pan) (mm)	-0.443	-0.581*
Mean temperature	-0.102	-0.639**

* Significant at 5 % level
* * Significant at 1 % level

Table 4: Multiple regression between larval population of *M. vitrata* with weather parameters at one week lag in field bean during *kharif* 2015-16 & 2016-17

Season	Multiple regression equation	Coefficient of determination (R^2)
Kharif 2015-16	$Y = 5.18 - 0.29\ X_1 - 0.57\ X_2 - 0.35\ X_3 + 0.80\ X_4 + 8.32\ X_5 - 9.03\ X_6 + 0.83\ X_7 - 0.15\ X_8 - 1.17\ X_9 + 1.59\ X_{10}$	0.89
Kharif 2016-17	$Y = 8.07 - 4.52\ X_1 - 18.99\ X_2 + 0.10\ X_3 - 0.004\ X_4 + 4.58\ X_5 - 4.79\ X_6 + 0.54\ X_7 + 0.35\ X_8 - 1.10\ X_9 + 20.93\ X_{10}$	0.84

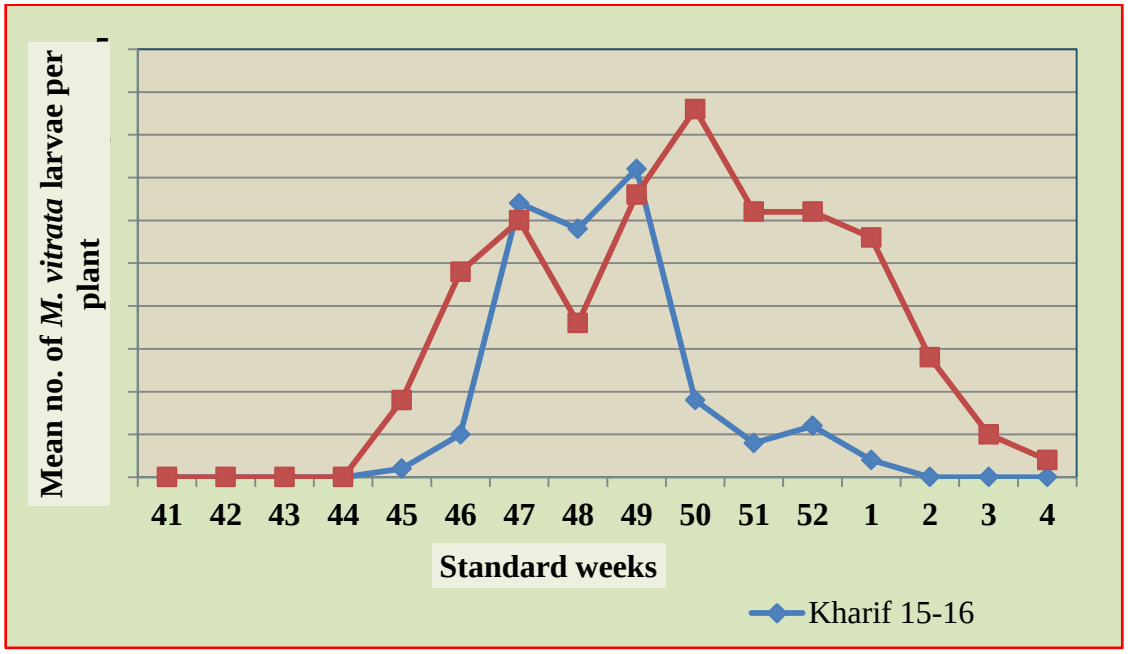

Fig. 1: Population dynamics of *Maruca vitrata* on field bean during *kharif* 2015-16 and 2016-17

Plate 1a. *Maruca vitrata* damage on inflorescence and pods of field bean

Plate 1b. Webbing of leaves with excreta of *Maruca vitrata* larvae

Plate 1 *Maruca vitrata* damage on field bean

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