



POPULATION DYNAMICS OF FALL ARMYWORM, *SPODOPTERA FRUGIPERDA* (J. E. SMITH) ON MAIZE

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ABSTRACT

A field experiment to study the population dynamics of *Spodoptera frugiperda* (J. E. Smith) on maize was carried out during *Kharif*, 2019 at the Instructional Farm, Rajasthan College of Agriculture, Udaipur (Rajasthan). The fall armyworm larvae began infesting the crop from the 29th SMW and their numerical abundance peaked during the 33rd SMW with a mean population of 26.50 larvae/10 plants; while, the incidence of its associated larval parasitoids started during the 31st SMW and the population reached to its peak in the 33rd SMW with a mean population of 3.75 larvae/10 plants. The population of fall armyworm and its parasitoids evinced a significant and positive correlation ($r = 0.68$), ($r = 0.64$) with total rainfall, respectively. During the study, total six hymenopteran larval parasitoids (3 species of Braconidae, 2 species of Ichneumonidae and 1 species of Bethyridae) were recorded.

Key words: Fall armyworm, population dynamics, maize, incidence

INTRODUCTION

Maize (*Zea mays* L.) is an important cereal crop in the world's agricultural economy. Worldwide, it is popularly known as the “Queen of cereals” because of its high genetic yield potential and wider adaptability (Tali *et al.*, 2018a). In addition to being a staple food for human beings and quality feed for animals, it is also used as a basic raw material in several industries (Tali *et al.*, 2018b). In India, the area under maize is 9.30 million hectares with a production of 28.50 million tonnes and productivity of 3060 kg ha⁻¹ (Anonymous, 2020a). In Rajasthan, maize is cultivated in an area of 8.87 lakh hectares, with the production and productivity of 1.22 million tonnes and 1378 kg ha⁻¹, respectively (Anonymous, 2020b).

About 141 species of insect pests have been reported causing varying degree of damage to maize plant in India (Reddy and Trivedi, 2008; Kumar *et al.*, 2015). Among these, some of the important ones are the stem borer, *Chilo partellus* (Swinhoe); pink stem borer, *Sesamia inferens*

(Walker); armyworm, *Mythimna separata* (Walker) and maize aphid, *Rhopalosiphum maidis* (Fitch) (Jeengar *et al.*, 2010; Saini *et al.*, 2011; Patel and Patel, 2012). In this regard, an invasive pest, the fall armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) has been reported from many states of India causing serious damage to maize crop (Samal and Sahu, 2020). In Rajasthan, it was first time reported in the year 2019 from Banswara and Dungarpur districts (Babu *et al.*, 2019). The pest has remarkable dispersal ability, wide host range and high reproductive capacity, which make it one of the more severe economic pests.

MATERIALS AND METHODS

The experiment to study the population dynamics of *S. frugiperda* infesting maize was laid out in plot size measuring 7 m × 4.5 m replicated four times. Maize variety Pratap Makka-3 was sown during the first week of July, 2019 with row to row and plant to plant spacing of 75 cm × 25 cm, respectively. The observations for the population of

fall armyworm larvae were taken at weekly intervals during morning hours between 6.30 am to 9.00 am on ten randomly selected plants in each plot by visual count; while, for the observations for the associated natural enemies, with a view to estimate the parasitization by various larval parasitoids, the larvae collected from the field were brought to the laboratory and reared in glass jars on maize leaves until the emergence of *S. frugiperda* adult or any parasitoid.

Statistical Analysis:

(a) The population data of *S. frugiperda* and its larval parasitoids thus obtained was subjected to statistical analysis to find out the co-efficient of correlation with the prevailing abiotic conditions of the atmosphere using the following formula:

$$r_{xy} = \frac{\Sigma XY - \frac{\Sigma X \Sigma Y}{n}}{\sqrt{\left[\Sigma X^2 - \frac{(\Sigma X)^2}{n} \right] \left[\Sigma Y^2 - \frac{(\Sigma Y)^2}{n} \right]}}$$

Where,

r_{xy} = Simple correlation coefficient

x = Variable *i.e.* abiotic component

y = Variable *i.e.* mean number of insects

n = Number of observations

The correlation coefficient (r) values were subjected to the test of significance using t- test:

$$t = \frac{r}{\sqrt{1-r^2}} \times \sqrt{n-2} \sim t_{n-2} \text{ d.f}$$

The calculated t-value obtained was compared with the tabulated t-value at 5 per cent level of significance.

(b) The parasitization per cent (Murua *et al.*, 2006) and effective parasitization per cent (Tian *et al.*, 2008) were calculated using following formulas:

Parasitization (%) =

$$\frac{\text{No. of parasitized individuals}}{\text{No. of total individuals observed}} \times 100$$

Effective Parasitization (%) =

$$\frac{\text{No. of parasitized larvae}}{\text{No. of parasitized + healthy larvae}} \times 100$$

RESULTS AND DISCUSSION

The fall armyworm infestation initiated in the 3rd week of July (29th SMW) with a mean population of 1.75 larvae/10 plants. The population increased gradually and reached to its peak in the 3rd week of August (33rd SMW) with a mean population of 26.50 larvae/10 plants. Visalakshi *et al.* (2019) recorded the maximum infestation in the 2nd week of August. The fall armyworm population exhibited a non significant negative correlation with mean atmospheric temperature ($r = -0.34$) and a non significant positive correlation with mean relative humidity ($r = 0.35$). The mean rainfall during the crop season was congenial for the larval development on account of which there existed a significant positive correlation ($r = 0.68$) with the larval population (Table 1). The findings of the present investigation corroborate with the results of Murua *et al.* (2006) who reported that the fall armyworm population had a significant and positive correlation with rainfall. Fonseca-Medrano *et al.* (2019) reported that the pest exhibited a significant and positive correlation with minimum temperature and relative humidity, but negative correlation with maximum temperature; whereas, non significant and positive correlation with rainfall.

The parasitoid infestation initiated in the 1st week of August (31st SMW). The population reached its peak in the 3rd week of August with a mean population of 3.75 larvae/10 plants. In the present study, as a density-dependent activity, the population of larval parasitoids happened to increase with an increase in the availability of fall armyworm larvae. As for the influence of the abiotic factors of the environment, the parasitoids evinced a non significant negative correlation with mean atmospheric temperature ($r = -0.47$); non significant positive correlation with mean relative humidity ($r = 0.29$) and significant positive correlation with rainfall ($r = 0.64$) (Table 1). Castro *et al.* (1988) reported that the parasitization in fall armyworm larvae increased with an increase in rainfall. Murua *et al.* (2006) reported that the parasitoid population was positively and significantly affected by temperature.

Six hymenopteran parasitoids belonging to

Table 1. Influence of key environmental factors on *S. frugiperda*, infesting maize, and its larval parasitoids during *Kharif*, 2019

SMW	Mean Atm. Temperature (°C)	Mean RH (%)	Total Rainfall (mm)	Mean larvae /10 plants	Mean larval parasitoids /10 plants
28	27.90	64.50	0.00	0.00	0.00
29	28.85	66.50	4.94	1.75	0.00
30	28.05	74.50	1.80	5.00	0.00
31	26.95	83.50	2.14	9.00	0.25
32	25.45	83.00	26.02	12.75	1.00
33	24.65	85.00	21.85	26.50	3.75
34	26.65	73.50	9.94	23.00	1.25
35	25.85	86.00	20.14	15.00	0.50
36	27.10	88.50	12.21	8.30	0.25
37	26.80	83.00	5.15	1.30	0.00
38	26.40	75.00	6.02	0.30	0.00
39	25.60	82.50	2.02	0.00	0.00
40	24.40	78.50	9.54	0.00	0.00
Coefficient of correlation (r) for population and mean atmospheric temperature				-0.34	-0.47
Coefficient of correlation (r) for population and mean relative humidity				0.35	0.29
Coefficient of correlation (r) for population and total rainfall				0.68*	0.64*
Coefficient of correlation (r) between FAW and parasitoids				0.85*	

*Significant at 5% level, SMW = Standard Meteorological Week

Table 2. Activity of natural larval parasitoids of *S. frugiperda* infesting maize during *Kharif*, 2019

SMW	Mean larvae/ 10 plants	Mean larval parasitoids/10 plants	Parasitization (%)	Effective parasitization (%)
28	0.00	0.00	0.00	0.00
29	1.75	0.00	0.00	0.00
30	5.00	0.00	0.00	0.00
31	9.00	0.25	2.77	2.70
32	12.75	1.00	7.84	7.27
33	26.50	3.75	14.15	12.40
34	23.00	1.25	5.43	5.15
35	15.00	0.50	3.33	3.23
36	8.30	0.25	3.01	2.92
37	1.30	0.00	0.00	0.00

SMW = Standard Meteorological Week

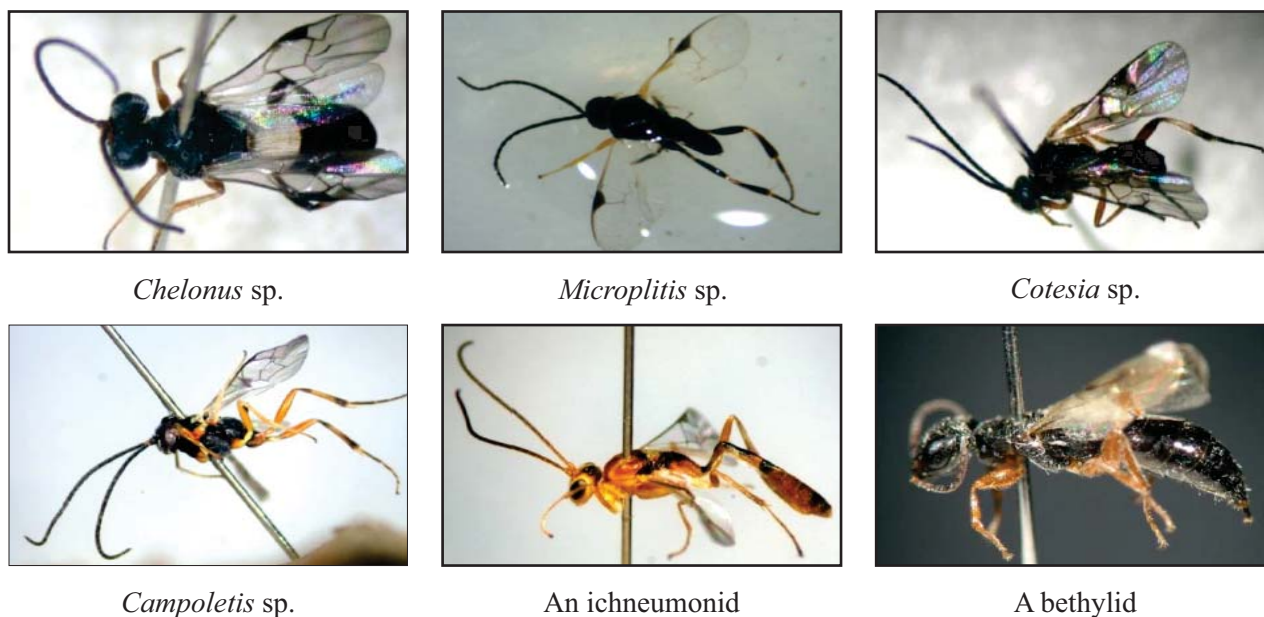


Fig 1: Parasitoids of fall armyworm recorded during the study

three families were recorded during the study period: Braconidae (*Chelonus* sp., *Microplitis* sp. and *Cotesia* sp.), Ichneumonidae (*Campoletis* sp. and other indeterminate) and one species of Bethyidae (Fig. 1). The parasitization (%) and Effective parasitization (%) were also computed which have been presented in Table (2). It can be observed that the maximum parasitization (14.15 %) was recorded during the 33rd SMW. The results show a significant abundance and diversity of the fall armyworm parasitoids, which indicate that these can be exploited to implement conservation biological control for managing this pest in near future.

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