POPULATION DYNAMICS OF FALL ARMYWORM, SPODOPTERA FRUGIPERDA IN MAIZE

Abstract

Fall armyworm (*Spodoptera frugiperda*) is one of the polyphagous invasive insect to India, initially reported from Karnataka. A roving survey was conducted during two cropping seasons at fortnightly interval at *kharif* and *rabi* of 2019-~~20~~ 2020 to know the status of the pest in Haveri district. The results revealed that the mean larval population and per cent infestation of fall armyworm was ranged from 0.30 to 0.44 larvae per plant and 23.10 to 33.77 per cent, respectively. In the study period, parasitisation by two larval parasitoids viz., *Campoletis chlorideae* (Hymenoptera: Ichneumonidae) and *Exorista xanthaspis* (Diptera: Tachinidae) and infection by an entomopathogenic fungi, *Metarhizium rileyi* were also observed.

Key words: Karnataka, larval population, per cent infestation, seasonal incidence, natural enemies, parasitoids, entomopathogenic fungi, *kharif*, *rabi*, correlation

Introduction

Maize (*Zea mays*) is one of the utmost significant cereal crops in the global agriculture economy equally as food for man and fodder for animals and referred as "Queen of cereals" because of greater yield potential. It is being cultivated both in the tropical and subtropical climatic conditions. At present, the average yields of cereal grains are lower in India due to variety of factors, among which, the insect pests have been considered as one of the most important constraints. It is estimated that as many as 141 insect pests cause different degrees of damage to maize crop from sowing to harvesting (Reddy and Trivedi, 2008). Among these, stem borer (*Chilo partellus*), cob borer (*Stenachroia elongella*) and shoot fly

(*Atherigona soccata*) were found to be as major pests. Stem borers are the major insect pests followed by defoliators but now, the fall armyworm (FAW), *Spodoptera frugiperda* (J.E. Smith) (Noctuidae: Lepidoptera), a polyphagous and extreme pest of many important crops, including maize in India. The pest has been very recently reported on maize from Karnataka for the first time in India (Sharanabasappa et al., 2018). There is every chance that this pest may migrate to neighboring states in India as well as other Asian countries. The main explanation for its rapid spread may be its efficient ability to travel and migrate long distances in short time. Despite strict quarantine standards, the invasion of this pest may contribute to easy global trade and transport and human activities. In this context, an attempt was made to document the status of fall armyworm at major maize growing areas of Haveri district in which maize is being cultivated under rain fed condition.

Methodology

Roving surveys were conducted in four villages each in different talukas of Haveri district. From each village five randomly selected fields were observed at fortnightly interval to record infestation of fall armyworm in maize. In each field, twenty plants were randomly selected and observations on the number of plants damaged due to fall armyworm out of twenty plants as well as number of larvae per plant were recorded. Further, this data was used for calculation of mean larval population per plant as well as percent pest infestation by using the following formulae,

$$\text{Incidence of larvae per plant (nos.)} = \frac{\text{No. of larvae}}{\text{Total no. of plants observed}}$$

$$\text{Per cent infestation} = \frac{\text{No. of plants damaged}}{\text{Total no. of plants observed}} \text{x} 100$$

The data collected from fortnightly survey was subjected for correlation coefficient and regression analysis against meteorological data of study period.

Twenty number of fall armyworm larvae were collected randomly from each field for the observation of larval parasitisation. The collected larvae were reared under laboratory conditions and observed for the emergence of any parasitoids. Further, these parasitoids were preserved in 70 per cent ethyl alcohol and get identified. The data obtained were used for calculation of per cent parasitisation.

$$\text{Per cent parasitisation} = \frac{\text{No. of parasitoids observed}}{\text{Total no. of larvae collected}} x100$$

During the survey, the cadaver of fall armyworm larvae were collected in butter paper covers separately and preserved under cold storage. Further, these larval cadavers were diluted in distilled water and smeared over suitable growth media for pathological studies of fungi. Later, these fungus involved in infection was identified by seeking help from expertise.

Results and Discussion

The survey was conducted on two cropping seasons at fortnightly interval in seven talukas of Haveri district during *kharif* and *rabi* of 2019-~~20~~2020. The larval load and per cent infestation of fall armyworm and its natural enemies were recorded during the roving survey. During the course of survey, the larval load and per cent infestation in different talukas ranged between 0.30 to 0.44 larvae per plant and 23.10 to 33.77 per cent, respectively whereas, the highest mean larval load and per cent infestation was noticed in Savanur taluka with 0.44 larvae per plant and 33.77 per cent infestation, respectively, followed by Ranebennur taluka (0.41 larvae per plant and 32.00 per cent infestation). Meanwhile, the lowest mean larval load and per cent infestation was noticed in Hirekerur taluka (0.30 and 23.10, respectively) (Table 1). This variation in the level of fall armyworm incidence might be due to difference in sowing date of maize in all the seven talukas surveyed, disparity among cultivars used, cultural practices, distribution of weather elements (temperature, rainfall and relative humidity) coupled with geographical variation and edaphic factors which

may have the direct impact on the level of fall armyworm infestation. The effect of climatic factors on fall armyworm incidence was documented by Waddill et al. (1981) reported that heavy rainfall was found lethal to the pest as rain drops accumulates in whorls which creates suffocation to larvae. Kumar et al. (2020) also reported that rainfall was having a significant negative correlation with the incidence of fall armyworm during *kharif* season in Perambalur district. Irrespective of the talukas, the late sown maize crop (last week of July) suffered more as compared to the early sown (last week of May) or timely sown crop (first week of June). Mallapur et al. (2018a) who stated that the infestation of fall armyworm in northern Karnataka was ranged between 6.00 to 100 per cent. Painkra et al. (2019) reported that infestation of fall armyworm was ranged between 35 to 70 per cent.

Two species of parasitoids *viz., Campoletis chlorideae* and *Exorista xanthaspis* were recorded on the fall armyworm during the study period. The highest mean per cent parasitization of both *C. chlorideae* and *E. xanthaspis* were observed in Savanur taluka (1.21 and 0.29 per cent, respectively), followed by Ranebennur taluka (1.05 and 0.28 per cent, respectively). Whereas, the lowest mean parasitization of both parasitoids were noticed in Hirekerur taluka (0.83 and 0.22 per cent, respectively) (Table 1). However, the peak per cent parasitization of both parasitoids were coincidence with peak fall armyworm infestation. This might be due to the predator-prey relationship *i.e* increased density of pest also led to increased parasitization of these parasitoids. Shylesha et al. (2018) observed *Telenomus* sp. (Hymenoptera: Platygastridae), *Trichogramma* sp. (Hymenoptera: Trichogrammatidae) egg parasitoids and solitary larval parasitoid, *C. chlorideae* (Hymenoptera: Ichneumonidae) were known to parasitize the FAW effectively. Sharanabasappa et al. (2018) recorded five species of larval parasitoids *viz., Coccygidium melleum, C. chlorideae, Eriborus* sp., *E. sorbillans* and *Odontepyris* sp. Which were found attacking larvae of *S. frugiperda*. Navik et al. (2020) reported for the first time the *E. xanthaspis* as a parasitoid of fall armyworm in India.

Along with parasitoids, one entomopathogenic fungi, *Metarhizium rileyi* was known to infect the FAW which was collected during the survey period. *M. rileyi* was observed on the fall armyworm throughout the *kharif* season. However, the fungus was not observed in *rabi* season, due to prevalence of lower relative humidity which was not favourable for the pathogen to survive. *M. rileyi* was recorded its highest incidence in Hirekerur taluka (3.56 per cent), followed by Hangal taluka (3.34 per cent) whereas, the lowest incidence was observed at Savanur taluka (2.41 per cent) (Table 1). Mallapur *et al*. (2018b) reported that infection of *M. rileyi* on *S. frugiperda* ranging from 1.87 to 18.30 per cent in northern karnataka. Sharanabasappa et al. (2019) recorded the infestation of *M. rileyi* on larvae of fall armyworm to the tune of 10 to 15 per cent in August month.

The incidence of the fall armyworm population showed positive correlation with the maximum and minimum temperature in all the seven talukas during *kharif* season. Where, relative humidity and rainfall were negatively correlated with the pest incidence. The rainfall (r = -0.889) was only parameter having significantly negative influence on pest incidence (Table 2). This may be due to rainy water filling up in the plant whorl and increased soil moisture, which affect the food, shelter and respiration of the pest population, hence the rainfall is having direct control over pest incidence. While, in *rabi* season all the weather parameters correlated negatively except maximum temperature which was positively correlated to the occurrence of *S. frugiperda* (Table 3). The present findings are in line with Waddill et al. (1981) who reported that heavy rainfall was found lethal to the pest as rain drops accumulates in whorls which creates suffocation to larvae and having a significantly negative impact on the incidence of fall armyworm during *kharif* season in Perambalur district (Kumar et al., 2020).

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Table 1. Status of fall armyworm and its natural enemies in Haveri district

Sl. No.	Talukas	Seasonal mean of larvae/plant	Seasonal mean of infested plants (%)	Seasonal mean of natural enemies		
				Parasitisation (%)		*Metarhizium rileyi* (% infection)
				Campoletis chlorideae	*Exorista xanthaspis*	
1	Hirekerur	0.30	23.10	0.83	0.22	3.56
2	Ranebennur	0.41	32.00	1.05	0.28	2.60
3	Byadagi	0.40	31.22	1.02	0.27	3.08
4	Haveri	0.37	29.78	0.99	0.26	2.92
5	Shiggaon	0.35	27.03	0.93	0.25	2.81
6	Savanur	0.44	33.77	1.21	0.29	2.41
7	Hangal	0.33	26.08	0.92	0.24	3.34
Range		0.30±0.44	23.10±33.77	0.83±1.21	0.22±0.29	2.41±3.56
Mean±SD		0.37±0.04	28.99±3.75	1.00±0.12	0.26±0.02	2.96±0.40

Table 2. Correlation and regression analysis between fall armyworm population and abiotic factors in Haveri district in *kharif*

Sl. No.	Taluka	Correlation coefficient				Regression equation	R^2 value
		Rainfall	RH	Temperature			
				Max.	Min.		
1	Hirekerur	- 0.889**	- 0.528	0.390	0.095	Y= 66.483 - 0.812X1 + 0.436X2 + 0. 507X3 - 0.394X4	0.75
2	Byadagi	- 0.740*	- 0.502	0.631	0.276	Y= - 19.243 - 0.767X1 + 0.226X2 + 0.204X3 - 0.141X4	0.61
3	Shiggaon	- 0.773*	- 0.512	0.602	0.196	Y= - 44.288 - 0.743X1 + 0.001X2 + 0.191X3 - 0.254X4	0.66
4	Savanur	- 0.671*	- 0.354	0.686	0.565	Y= 37.505 - 0.669X1 + 0.745X2 + 0. 285X3 - 0.229X4	0.60
5	Ranebennur	- 0.676*	- 0.442	0.641	0.379	Y= - 25.837 - 0.613X1 + 0.214X2 + 0.198X3 - 0.108X4	0.60
6	Haveri	- 0.764*	- 0.507	0.628	0.225	Y= - 75.657 - 0.716X1 + 0.396X2 + 0.236X3 - 0.236X4	0.64
7	Hangal	- 0.868**	- 0.528	0.543	0.044	Y= - 32.431 - 0.708X1 + 0.012X2 + 0. 102X3 - 0.129X4	0.70

******Significant at 0.01 level, * Significant at 0.05 level, RH – Relative humidity, X_1 - Rainfall (mm), X_2 -Temp. (Max), X_3 - Temp. (Min), X_4 – Relative humidity

Table 3. Correlation and regression analysis between fall armyworm population and abiotic factors in Haveri district in *rabi*

Sl. No.	Taluka	Correlation coefficient				Regression equation	R^2 value
		Rainfall	RH	Temperature			
				Max.	Min.		
1	Shiggaon	- 0.552	- 0.487	0.367	- 0.076	Y= 51.001 - 0.586X1 + 0.264X2 - 0. 122X3 - 0.196X4	0.40
2	Hangal	- 0.565	- 0.504	0.353	- 0.068	Y= 38.392 - 0.441X1 + 0.875X2 - 0.136X3 - 0.113X4	0.42
3	Byadagi	- 0.508	- 0.388	0.457	- 0.130	Y= 54.791 - 0.318X1 + 0.352X2 - 0.123X3 - 0.216X4	0.32
4	Savanur	- 0.476	- 0.342	0.501	- 0.213	Y= 58.908 - 0.424X1 + 0.454X2 - 0. 101X3 - 0.227X4	0.27
5	Hirekerur	- 0.568	- 0.507	0.343	- 0.029	Y= 53.730 - 0.334X1 + 0.381X2 - 0.237X3 - 0.217X4	0.44
6	Ranebennur	- 0.483	- 0.373	0.481	- 0.136	Y= 46.076 - 0.446X1 + 0.190X2 - 0.194X3 - 0.177X4	0.30
7	Haveri	- 0.532	- 0.399	0.393	- 0.099	Y= 38.996 - 0.470X1 + 0.054X2 - 0. 267X3 - 0.150X4	0.39

RH – Relative humidity, X_1 - Rainfall (mm), X_2 -Temp. (Max), X_3 - Temp. (Min), X_4 - Relative humidity

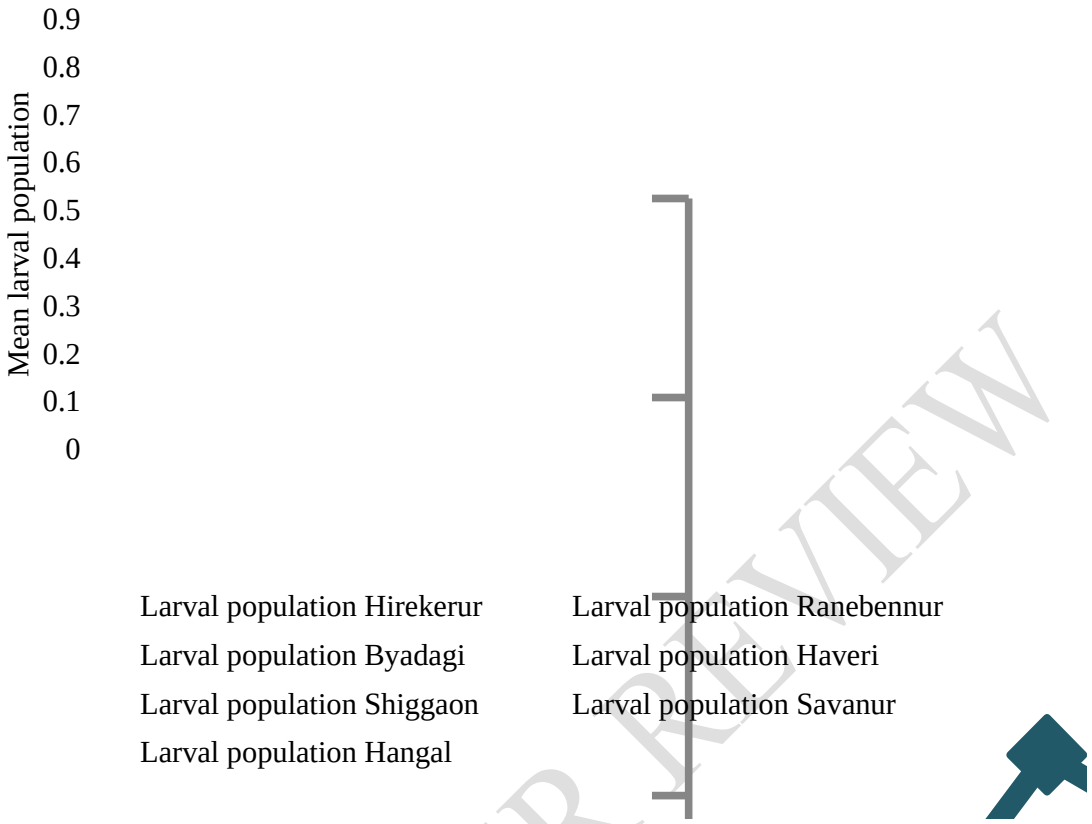

Figure 1. Population dynamics of fall armyworm in different talukas of Haveri district