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# Seasonal incidence of maize fall armyworm *Spodoptera frugiperda* (J.E. Smith) (Noctuidae; Lepidoptera) in Perambalur district of Tamil Nadu, India

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**Abstract**
Maize, *Zea mays* L (Family: Poaceae), is the most adaptable crop, grown in varied agro-climatic regions globally, next to wheat and rice, except Antarctica. The Fall Armyworm (FAW), *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae), an invasive pest which is highly migratory and economically destructive, is native of tropical and subtropical regions of the Americas. Being polyphagous, it feeds on maize, rice, sorghum, millet, sugarcane, vegetable crops and cotton but can feed on more than 80 additional species of crops. A study on seasonal incidence of fall armyworm in both *Kharif* and *Rabi* season in farmers field at four blocks *viz.*, Perambalur, Veppanthattai, Alathur and Veppur block of Perambalur district was taken during July 2019 to January 2020 at fortnight intervals. *S. frugiperda* incidence was minimum during second fortnight of October, 2019 (10%) and maximum incidence was recorded in first fortnight of November, 2019 (72%). During *Kharif* and *Rabi*, occurrence of *S. frugiperda* in terms of larval population showed significant positive correlation with the maximum temperatures (r=0.7205) and negative correlation and significant relationship with relative humidity (r= -0.6739) and rainfall (r= -0.8293) in Perambalur district.

**Keywords:** Maize fall armyworm, weather parameters, correlation, seasonal incidence

## Introduction
Maize, *Zea mays* L. (Poaceae) is one of the most adaptable crop having wider acceptability under varied agro-climatic conditions, in every parts of globe except Antarctica. Universally, maize is known as "Queen of cereals" because of its high genetic yield potential among the cereals and third important cereal crops next to wheat and rice in the world. Seventy countries, including 53 developing countries, plant maize more than 100,000 ha [4]. In India, maize is cultivated to serve various purposes like human consumption, cattle and poultry feed, food processing and in the extraction of starch, dextrose, corn syrup, corn oil [6]. Maize contains approximately 72% starch, 10% protein, and 4% fat, supplying an energy density of 365 Kcal/100 g [13]. The crop is attacked by several pests *viz.*, insects, nematodes, mites, birds, rodents. As many as 141 insect pests cause varying degree of damage to maize from the time of sowing till harvest [14].
The Fall Armyworm (FAW), *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae), an invasive pest which is highly migratory and economically destructive, is native of tropical and subtropical regions of the Americas [7]. Being polyphagous, feeds on maize, rice, sorghum, millet, sugarcane, vegetable crops and cotton but can feed more than 80 additional species of crops [2]. The first infestation of FAW was reported formally in Africa during January 2016 and spread to several parts of African continent. Maize losses have been estimated at 2.5 to 6 million US $ in Africa in 2017 [3]. FAW has the potential of causing losses from 8 to 20 million tons of maize every year in the absence of effective control methods in 12 maize producing countries of Africa and has invaded the 44 African nations already [15]. The FAW in the last two years caused damage to more than 1.5 million ha of maize crop in Africa alone affecting the food security and livelihoods of several million smallholder farmers. The pest has been reported for the first time in India in Karnataka in July 2018 and subsequently in few other states, such as Andhra Pradesh, Telangana, Tamil Nadu, Maharashtra and Odisha [9].
The production of maize in 2017-18 was 20,118 MT in *Kharif* and 8,634 MT in *Rabi* with a total production of 28,753 MT in India. After the entry of Fall Armyworm, the production is

reduced to 19,410 MT in *Kharif* and 8300 MT in *Rabi* with a total of 27,720 MT in 2018-19 [5].

## Materials and Methods

Perambalur district, the dry tract of Tamil Nadu with black cotton soil has cotton and maize as its major crop. This district is having a maximum area of maize production (*Kharif* 55,692 ha and *Rabi* 5,950 ha) in the State. A roving survey was carried out in four maize growing blocks of Perambalur district *viz.*, Perambalur, Veppanthattai, Alathur and Veppur during *Kharif* and *Rabi* season of 2019-20. Three farmers field from each block were selected for the study and observations on larval count of *S. frugiperda* incidence were recorded at fortnight intervals from July, 2019 to January, 2020. Survey was done in a semi-systematic manner, in which the samples are taken in a zig-zag positions, in the form of "W" pattern in the field [11]. Their population was expressed per plant from the mean of three replications and each replication data is a mean of data obtained from 10 plants

The data on abiotic factors such as maximum temperature, minimum temperature, relative humidity and rainfall were collected using NASA POWER website [8] for the different blocks of Perambalur District. Correlation and regression with weather parameters such as maximum temperature, minimum temperature, relative humidity and rainfall were worked out to know the relationship of pest with these weather parameters.

## Results and Discussion

In *Kharif* season, the incidence of *S. frugiperda* was maximum during the second fortnight of July, 2019 as 49, 56, 40 and 38 percent while the minimum recorded during second fortnight of October, 2019 as 10, 22, 25 and 23 percent in Perambalur, Veppanthattai, Alathur and Veppur blocks of Perambalur District respectively (Table 1)

**Table 1:** Seasonal incidence of *S. frugiperda* in Maize during *Kharif*, 2019-2020

| Date of Observation | No. of larva / plant* | | | |
|---|---|---|---|---|
| | Perambalur | Veppanthattai | Alathur | Veppur |
| 15-Jul | 0.35 | 0.32 | 0.30 | 0.29 |
| 30-Jul | 0.49 | 0.56 | 0.40 | 0.38 |
| 15-Aug | 0.33 | 0.51 | 0.37 | 0.34 |
| 30-Aug | 0.41 | 0.36 | 0.34 | 0.31 |
| 15-Sep | 0.26 | 0.45 | 0.33 | 0.30 |
| 30-Sep | 0.21 | 0.33 | 0.28 | 0.25 |
| 15-Oct | 0.47 | 0.42 | 0.44 | 0.40 |
| 30-Oct | 0.10 | 0.22 | 0.25 | 0.23 |

*Mean of three replications

The incidence of *S. frugiperda*, during the *Rabi* season was maximum during the first fortnight of November, 2019 with 59, 61, 72 and 70 percent damage while the minimum was seen at second fortnight of November, 2019 with 31, 21, 34 and 31 percent at Perambalur, Veppanthattai, Alathur and Veppur blocks of Perambalur district (Table 2).

**Table 2:** Seasonal incidence of *S. frugiperda* in Maize during *Rabi*, 2019-2020

| Date of observation | No. of larva / plant* | | | |
|---|---|---|---|---|
| | Perambalur | Veppanthattai | Alathur | Veppur |
| 15-Nov | 0.59 | 0.61 | 0.72 | 0.70 |
| 30-Nov | 0.31 | 0.21 | 0.34 | 0.31 |
| 15-Dec | 0.38 | 0.34 | 0.40 | 0.38 |
| 30-Dec | 0.4 | 0.41 | 0.44 | 0.42 |
| 15-Jan | 0.45 | 0.47 | 0.52 | 0.51 |
| 30-Jan | 0.57 | 0.53 | 0.64 | 0.60 |

*Mean of three replications

Correlation of weather parameters of *Kharif* season with fall armyworm incidence indicated a positive correlation with the maximum and minimum temperature in all the blocks. Two other parameters such as relative humidity and rainfall parameters were negatively correlated with the pest incidence (Table 3). The maximum temperature (r=0.7205) was the only parameter found to have positive and significant relationship with pest incidence while the relative humidity (r= -0.6739) and rainfall (r= -0.8293) showed negative relationship on the pest incidence.

**Table 3:** Relationship between *S. frugiperda* incidence with weather parameters, during *Kharif* season

| Weather parameters | r values | | | |
|---|---|---|---|---|
| | Perambalur | Veppanthattai | Alathur | Veppur |
| Max. Temperature | 0.5868 | 0.7205* | 0.3989 | 0.4732 |
| Min. Temperature | 0.3339 | 0.3022 | 0.2341 | 0.3436 |
| Relative humidity | -0.5555 | -0.6739* | -0.3305 | -0.4087 |
| Rainfall | -0.8293** | -0.7444* | -0.6612* | -0.6867* |

** Significant at 0.01 level, * Significant at 0.05% level or ($P$<0.05)

In *Rabi* season, the occurrence of *S. frugiperda* was positively correlated only with maximum temperature while it was negatively correlated with other weather parameters such as minimum temperature, relative humidity and rainfall in all the blocks surveyed in Perambalur (Table 4). Therefore, the *S. frugiperda* had significantly positive correlation with the maximum temperature alone (r=0.7761).

**Table 4:** Relationship between *S. frugiperda* incidence with weather parameters, during *Rabi* season

| Weather parameters | r values | | | |
|---|---|---|---|---|
| | Perambalur | Veppanthattai | Alathur | Veppur |
| Max. temp | 0.7761* | 0.6523 | 0.6985 | 0.6619 |
| Min. temp | -0.0642 | -0.1928 | -0.0260 | -0.0533 |
| Relative humidity | -0.5473 | -0.5280 | -0.4728 | -0.4622 |
| Rainfall | -0.5874 | -0.7172 | -0.5268 | -0.5505 |

* Significant at 0.05% level or ($P$<0.05)

**Table 5:** Regression of larval population with weather parameters, during *Kharif* season

| Block | Regression equation | $R^2$ value |
|---|---|---|
| Perambalur | Y= -0.2758 + (-0.0126) $X_1$+ 0.0437 $X_2$ + 0.0015 $X_3$ + (-0.0204) $X_4$ | 0.76 |
| Veppanthattai | Y= -5.4536 + 0.1381 $X_1$+ (-0.036) $X_2$ + 0.0306 $X_3$ + (-0.0021) $X_4$ | 074 |
| Alathur | Y= -4.0730 + 0.0984 $X_1$+ (-0.0270) $X_2$ + 0.0258 $X_3$ + (-0.0052) $X_4$ | 0.64 |
| Veppur | Y= -2.7481 + 0.0547 $X_1$+ 0.0087 $X_2$ + 0.0153 $X_3$ + (-0.0061) $X_4$ | 0.71 |

$X_1$ – Max. temp, $X_2$ – Min. temp, $X_3$ – Relative humidity, $X_4$ - Rainfall

The coefficient of determination ($R_2$) was 0.76, 0.74, 0.64 and 0.71 showed that as much as 76%, 74%, 64% and 71% variation in the *S. frugiperda* incidence was due to the effect of weather factors in the Perambalur, Veppanthattai, Alathur and Veppur blocks (Table 5).

**Table 6:** Regression of larval population with weather parameters, during *Rabi* season

| Block | Regression equation | $R^2$ value |
|---|---|---|
| Perambalur | Y= -5.9655 + (0.1624) $X_1$+ (-0.08778) $X_2$ + 0.0418 $X_3$ + (-0.003) $X_4$ | 0.76 |
| Veppanthattai | Y= -13.5308 + 0.3518 $X_1$+ (-0.2409) $X_2$ + 0.1036 $X_3$ + (-0.0043) $X_4$ | 0.73 |
| Alathur | Y= -10.4843 + 0.2768 $X_1$+ (-0.1670) $X_2$ + 0.0761 $X_3$ + (-0.0026) $X_4$ | 0.65 |
| Veppur | Y= -10.482 + 0.2759 $X_1$+ (-0.1708) $X_2$ + 0.0771 $X_3$ + (-0.0031) $X_4$ | 0.61 |

$X_1$ – Max. temp, $X_2$ – Min. temp, $X_3$ – Relative humidity, $X_4$ - Rainfall

The coefficient of determination ($R_2$) was 0.76, 0.73, 0.65 and 0.61 showing that as much as 76%, 73%, 65% and 61% variation in the *S. frugiperda* incidence was due to the effect of weather factors in the Perambalur, Veppanthattai, Alathur and Veppur blocks (Table 6).

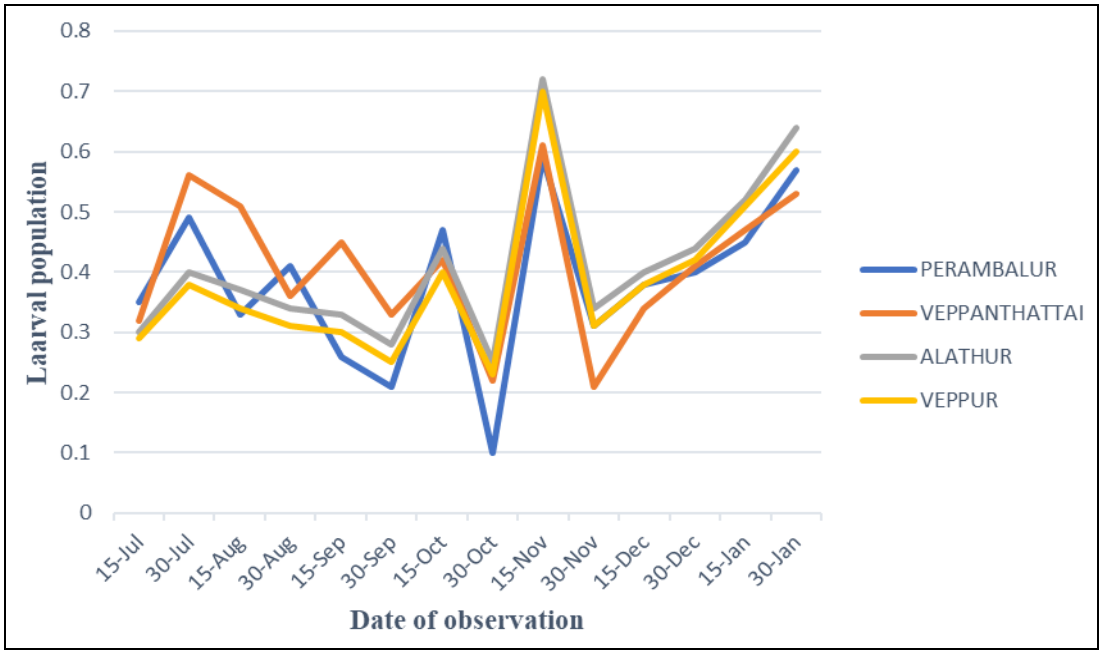


**Fig 1:** *S. frugiperda* incidence during Kharif and Rabi season at Perambalur District

The incidence of *S. frugiperda* was similar to the findings of [17], who reported the minimum incidence of *Spodoptera litura* (Fabricius) in castor during October while the maximum was seen in November. The findings of the present study are in accordance with [10], who reported that the incidence of *S. litura* showed negative correlation with rainfall in *Kharif* season. Our research finding was found to be positively correlated with [1] who reported that the relative humidity and rainfall showed negative relationship with population of *S. litura* infesting groundnut crop in Junagadh area. The incidence of *S. litura* in bhendi was positively correlated with the maximum temperature [16]. Similarly, the result of negative correlation with relative humidity and rainfall and positive correlation with maximum temperature with *S. litura* on potato during *Rabi* season was recorded by [12].

## Conclusion

The population of *S. frugiperda* was seen minimum during the second fortnight of October, 2019 and the maximum population was found at the first fortnight of November, 2019. The correlation with weather parameters had shown that the population of the *S. frugiperda* decreased when there was increase in the rainfall and relative humidity. Therefore, rainfall and relative humidity was found to be negatively correlated with the *S. frugiperda* incidence in maize. When the temperature parameter was considered, the pest increased as the temperature increased, therefore, the maize fall armyworm, *S. frugiperda* had positive correlation with temperature.

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