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Influence of weather parameters on trap catches against fall armyworm *Spodoptera frugiperda* (J. E. Smith) on maize

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Abstract
The field experiments were carried out in the farmer field at Jadamangalam, Trichy during rabi of 2019-2020 and kharif of 2020. The results of trap catches revealed that the peak activity of *S. frugiperda* on maize observed from 42nd MSW (2019) to 3rd MSW (2020) where the population was in the range from 2.63 to 13.2 moths/trap/week and the maximum number of moths 13.2 moths/trap/week were trapped in 43rd MSW during rabi season. During kharif, the peak activity period of *S. frugiperda* was observed from 37 to 42 MSW where the population range of 5.20 to 12.1 moths/ trap/ week, where the maximum of male moths 12.1/trap/week were trapped in 37th MSW. The results of correlation studies showed that trap catches of *S. frugiperda* exhibited positive correlation with maximum temperature, minimum temperature and rainfall, while negatively correlated with relative humidity during rabi 2019. During kharif 2020, trap catches were negatively correlated with maximum temperature, minimum temperature and relative humidity, while positively correlated with rainfall during kharif 2020.

Keywords: fall armyworm, pheromone trap, peak activity, correlation and regression

Introduction

Maize, *Zea mays* Linnaeus, belongs to the family Poaceae and is one among the emerging crop mostly grown widely under varied agro climatic conditions. It is a monoecious and cross pollinated crop with the determinate type of plant habit and cultivated in both Kharif and Rabi season requires a minimum of water compared to other cereals (800 mm). In India, it ranks fourth in area and 7th in maize in the world with production and productivity of 29 MT and 9.50 t/ha respectively in an area of 3.05 mha (USDA, 2020) [18]. Tamil Nadu contributes (3.6%) of the total maize area of the country with major growing districts are Perambalur, Ariyalur, Trichy, Cuddalore, Dindigul and Tirupur, etc., (Rakshit, 2019) [14]. Among the various biotic and abiotic stresses that constrained the successful cultivation of maize crops, the most important factor is the damage caused by the insect pests (Sharanabasappa *et al*., 2018) [17]. More than 141 insect pests cause varying degrees of damage to maize from the time of sowing till harvest in the maize ecosystem were reported. *Chilo partellus* (Swinhoe) and *Sesamia inferens* (Walker), *Spodoptera litura*, *S. exigua* and *Helicoverpa armigera* which are sporadic pests of corn cause yield losses up to 35% (Chouraddi & Mallapur, 2017) [4]. The recently introduced psest in India, Fall armyworm *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae). FAW is a polyphagous invasive pest (Montezano *et al*., 2018) [11] and it was reported on more than 100 plant species under 27 families (Georgen *et al*., 2016) [7]. Neonate larvae mainly feed on leaf tissue whereas the second and third instars feed on the leaf making holes in leaves, a typical damage symptom of FAW (Belay *et al*., 2012) [3]. In addition to the polyphagous and voracious feeding nature, *S. frugiperda* has also developed resistance to popular insecticides (Rojas, 2004) [15]. The number of insecticides have been found effective and recommended to control this but the IPM techniques are highly effective (Prasanna *et al*., 2018) [12]. The aim of this study was to determine the role of meteorological factors on trap catches of *S. frugiperda* on maize. Hence the present study was undertaken to develop a pheromone based monitoring and trapping system for fluctuations of *S. frugiperda* population build-up. This will facilitate to execute proper time of application of insecticides and other control strategies for the *S. frugiperda* on maize.

Materials and Methods

A field trial was carried out at an already established farmer's field, Jadamangalam, Trichy during rabi (Oct-Jan) of 2019-2020 and kharif (July – Oct) of 2020 by raising the variety of Rasi 4558 at spacing 60 X 25cm in the area of 1 acre. The funnel shaped sex pheromone trap along with FAW lure were obtained from Pest Control Private Limited (PCI) Chennai. The traps were installed @ 5/ acre in the maize field at early morning/evening. The height of trap should be adjusted each week matching with the crop canopy, lures were replaced in 21 days intervals and three replications were maintained to minimize the error. The numbers of male moths of *S. frugiperda* trapped in the traps were counted at weekly intervals and the data on moth catches were correlated with weather parameters as per the Gomez and Gomez 1984.

Results and Discussion

Peak activity periods of *S. frugiperda* during rabi season 2019

The result of pheromone trap catches of *S. frugiperda* in maize indicated that the activity of male moth trap catches were observed from 42nd MSW (2019) and it continued up to 3rd MSW (2020) table 1. Peak activities of male moths of *S. frugiperda* trapped were observed from 42nd to 45th MSW where the population was in the range of 5.85 to 13.2 moths/ trap/ week. The maximum numbers of moths were trapped in 43rd MSW (13.2 moths/trap/week). The findings in the study showed similarly with Monobrullah *et al*. (2007) [10] who reported that the first peak of pest population was recorded at 19th MSW and again attained peak at 43rd MSW. Similarly, Basavaraj *et al*. (2013) [2] observed two peaks in pest population level through pheromone trap catch, one in October (69.0/trap) and another in the second week of December (74.0/trap).

Correlation and multiple regressions between weather parameters and pheromone trap catch of *S. frugiperda* on maize during rabi 2019

The results revealed that the trap catches of *S. frugiperda* during rabi 2019-20 shows (table 2) maximum temperature (r= 0.06) though positively correlated with trap catches, but it was non-significant. Minimum temperature (r= 0.634) and rainfall (r= 0.854) shows a significant and highly significant positive correlation respectively with the trap catches. However, relative humidity (r= 0.537) existed significantly negative correlation with trap catches.

The multiple regression equation fitted with weather factors predicted that the trap catches of *S. frugiperda*

Particular regression equation

Rabi 2019 $Y= 38.22 – 0.895\ X_1 – 0.176\ X_2 + 0.576\ X_3 – 0.094\ X_4$;

X_1=Maximum temperature X_2=Minimum temperature

X_3 = Rainfall X_4 = Relative humidity

The coefficient of determination R^2 showed that there was 77.8 per cent variation in the trap catches of *S. frugiperda* and it was due to the effect of weather factors. The regression model revealed that the increase of 1^0 C of maximum temperature or one per cent of minimum temperature or one per cent relative humidity would result in decreases of 0.81, 0.10 and 0.33 trap catches per trap, per week respectively whereas 1mm of rainfall increases trap catches by 2.79 in per trap/ week. These findings were in agreement with Arvind kumar (2014) [1] reported that moth trapping increases with increasing temperature and relative humidity and slight rainfall favours to population build trap *S. litura*. Similarly, increasing rainfall increases the trapping of moth population as compared to cooled months which supports the observation of Geetha Lakshmi *et al*. (2004). Mahalingam *et al*. (2003) found that temperature change was the reason for variation in trap catches of *S. litura* table 3.

Peak activity periods of *S. frugiperda* during kharif 2020

The results of pheromone trap catches of *S. frugiperda* male moths indicated that the activity of male moth trap catches were observed during 37th MSW and continued till the end of the crop season. The maximum of male moths (12.1/trap/week) was trapped in 37th MSW and peak activity period of *S. frugiperda* was observed from 37 to 42 MSW where the population range of 5.20 to 12.1 moths/ trap/ week. The present study was in collaboration with Arvind kumar (2014) [1] maximum number of moth trap catches occur from June to August month in groundnut crop. These variations may be due to different dates of sowing and crop duration which influences the weather parameters to built up the *S. frugiperda* populations table 1.

Correlation between weather parameters and pheromone trap catches of *S. frugiperda* on maize during kharif 2020

The results revealed that the trap catches of *S. frugiperda* during kharif 2020 exhibited a negative correlation existed with maximum temperature (r=0.395), minimum temperature (r=0.526) and relative humidity (r=0.403) whereas positive correlation was recorded with rainfall (r = 0.341) though positively correlated with trap catches, non significant table 2.

Table 1: Weekly observation on pheromone trap catches of *S. frugiperda* on maize

Trap catches of male moth *S. frugiperda*					
Rabi			Kharif		
Month	MSW	Mean of *S. frugiperda* trapped/trap/week	Month	MSW	Mean of *S. frugiperda* trapped/trap/week
Oct	42	5.85	Jul	29	5.4
	43	13.2		30	0.00
	44	9.76		31	0.00
Nov	45	8.50	Aug	32	6.74
	46	0.00		33	10.6
	47	5.4		34	6.35
	48	6.74		35	5.20
Dec	49	5.85	Sep	36	0.00
	50	4.35		37	12.1
	51	0.00		38	5.2
	52	2.50		39	6.78
Jan	1	0.00	Oct	40	7.45
	2	0.0		41	8.65
	3	2.63		42	6.65

Season I - Date of Transplanting: 28.09.2019, Date 0f Pheromone traps installed: 12.10.2019 MSW – Meteorological Standard Week
Season II- Date of Transplanting: 01. 07. 2020, Date 0f Pheromone traps installed: 12.07.2020

Table 2: Simple correlation matrix of trap catches of *S. frugiperda* with weather parameters in maize

Season	Weather parameters			
	Maximum temperature	Minimum temperature	Rainfall	Relative humidity
Rabi	0.106	0.634*	0.854**	-0.537*
Kharif	-0.395	-0.526	0.341	-0.403

*Significant P= 0.05 CD (P= 0.05): 0.532
**Highly significant P= 0.01 CD (P= 0.01): 0.661

The multiple regression equation fitted with weather factors predicted that the trap catches of *S. frugiperda*

Particular regression equation

Kharif 2020 $Y= 104.63 – 0.870 X_1 – 1.822 X_2 + 0.026 X_3 – 0.317 X_4$

The coefficient of determination R^2 showed that there was 47 per cent variation in the trap catches of *S. frugiperda* and it was due to the effect of weather

factors. The regression model revealed that the increase of 1^0 C of maximum temperature or one per cent of minimum temperature or one per cent relative humidity would result in decreases of 0.69, 1.37 and 1.32 trap catches per trap, per week respectively, whereas 1mm of rainfall increases trap catches by 0.07 in per trap/ week.

The present findings were confirmed with Radhika (2013) [13], who reported that minimum

temperature and relative humidity showed negative correlation with the trap catches of *S. litura*. Similarly, Gedia *et al*. (2007) [5] found that the male moths trap catches of *S. litura* showed negatively correlated with R.H and wind speed.

These results were in close agreement with Rudraswamy *et al*. (2006) [16] who observed that there was a positive and highly significant relationship between the number of moths trapped and average weekly rainfall table 3.

Table 3: Multiple regression analysis of pheromone trap catches of *S. frugiperda* (Y) and weather parameters (X) in maize during rabi (2019) and kharif (2020) (n= 14)

Season	Variables	Partial regression coefficient	Standard error	't' value	R^2
Rabi (2019-2020)	X1= Max. Temperature	-0.895	1.104	-0.810	0.778
	X2= Min. Temperature	-0.176	1.650	-0.106	
	X3= Rainfall	0.576	0.205	2.797	
	X4= Relative Humidity	-0.094	0.279	-0.338	
Kharif (2020)	X1= Max. Temperature	-0.870	1.245	-0.699	0.475
	X2= Min. Temperature	-1.822	1.327	-1.372	
	X3= Rainfall	0.026	0.362	0.073	
	X4= Relative Humidity	-0.317	0.238	-1.328	

*Significant at 0.05 probability level
**Highly significant at 0.01 probability level

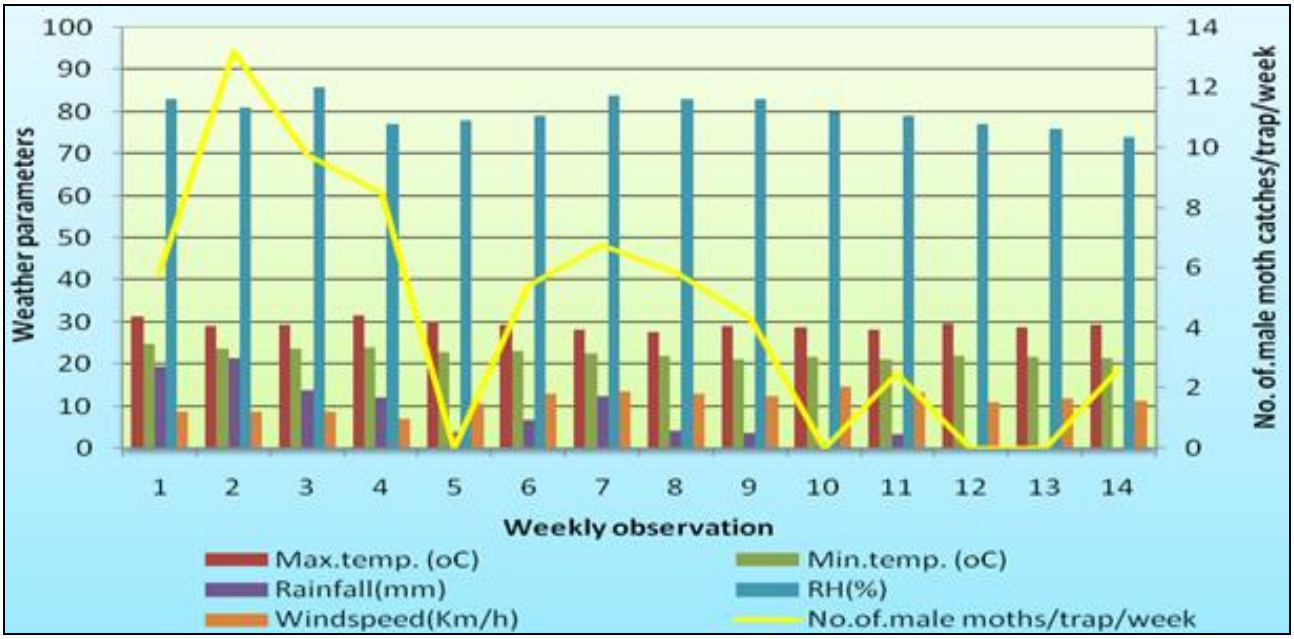

Fig 1: Pheromone trap catches of *S. frugiperda* on maize during rabi

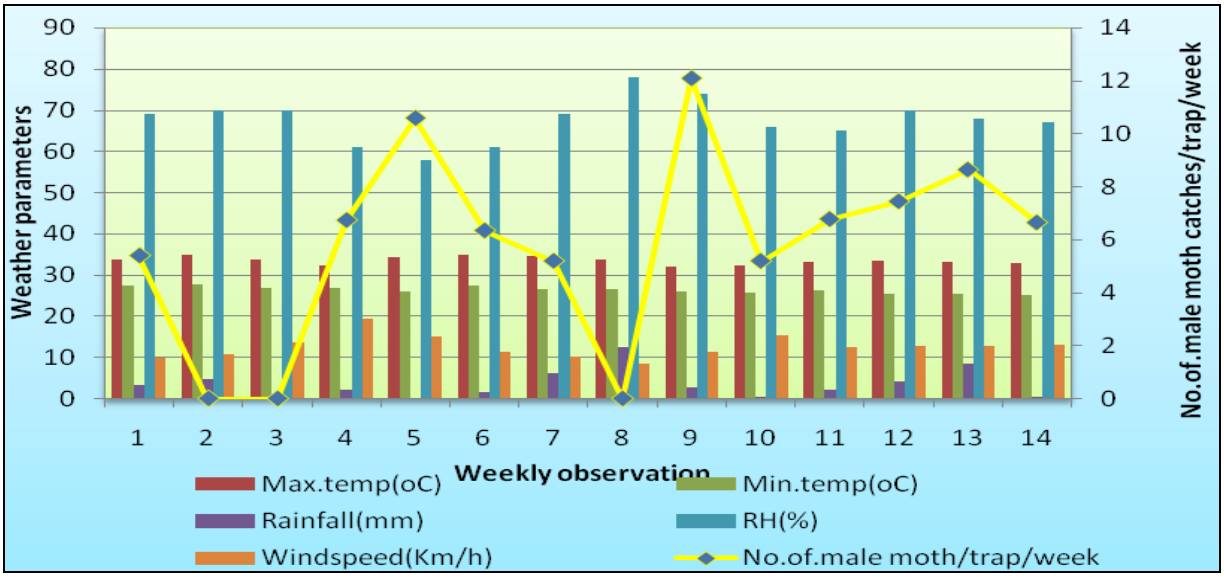

Fig 2: Pheromone trap catches of *S. frugiperda* on maize during kharif

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