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Impact of Weather on the Incidence of the Fall Armyworm, *Spodoptera frugiperda* on Maize under East Coast Agroclimatic Conditions of India

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ABSTRACT

A study on weather's impact on the fall armyworm's incidence on maize under East Coast agroclimatic conditions of Andhra Pradesh, India, was studied in 2018-19 and 2019-20. The experiment consisted of seven dates of sowings: 1st FN of July, 1st FN of August, 1st FN of September, 1st FN of October, 1st FN of November, 1st FN of December and 1st FN of January. The results indicated a positive correlation between the number of fall armyworm larvae/plant and its per cent infestation with T_{min}, relative humidity and rainfall when maize was sown from July to September except for T_{max}. However, a negative correlation was observed when maize was sown from October to January. The data concluded that the rainfall, temperature and humidity significantly influenced the emergence of the fall armyworm and its infestation on maize. The incidence of FAW started in 38th MSW (0.52 larvae/plant), and the population increased gradually and reached the peak in the 44th MSW (1.20 larvae/plant), which coincided with the maximum per cent infestation (53.72%) in *rabi* 2019. The incidence of FAW in the summer of 2020 started from the 8th MSW (0.69 larvae/plant), and reached the peak in the 12th MSW (1.69 larvae/plant), which coincided with the maximum per cent infestation (58.33%). Correlation analysis in the *rabi* season revealed that larval population and infestation showed a significant positive correlation with the evening relative humidity (r=0.727). At the same time, maximum and minimum temperature and rainfall exhibited a negative association with larval incidence and infestation of *S. frugiperda.* During the summer season, the correlation analysis showed a positive correlation with maximum temperature (r=0.675), while minimum temperature, morning and evening humidity and rainfall showed a negative correlation.

Key words: Seasonal incidence, correlation, *rabi,* summer, maize, fall armyworm

INTRODUCTION

Global climate change affects agriculture in many ways. Climate and agriculture have a close connection to each other and cannot be separated. Moreover, these are inter and intra-dependent on one another. An increase in temperature can potentially affect insect survival, development, geographic spread and population size. Temperature and rainfall, in particular, have a powerful influence on the insect-pest population's development, reproduction and survival. As a result, these organisms will likely be affected by any changes in climate. American native pest, *Spodoptera frugiperda* (fall armyworm) recently migrated to the tropics and sub-tropics of the Indian subcontinent. The FAW causes enormous damage to the maize by damaging the crown of the plants resulting in huge crop loss (Plem *et al.,* 2016). The FAW was first recorded in the southern part of India in 2018 (Sharanabasappa *et al.*, 2018) on maize at the institute farm, University of Agricultural Sciences, Shivamogga, Karnataka, India. It was noticed at the same time in maize during the same time in Andhra Pradesh. It caused a considerable loss to the maize crop in different maize growing belts of the Krishnaagro-climatic zone of Andhra Pradesh, resulting in a considerable loss of yield. Hence, the present investigation was initiated to study the effect of different weather factors on the infestation of the fall armyworm on maize in the South Coastal Andhra Pradesh, India.

MATERIALS AND METHODS

A field experiment was conducted in 2018-19 and 2019-20 on the clay soils of the Regional Agricultural Research Station, Lam, Guntur, India, located about 60 kilometers west of the Bay of Bengal, with GPS coordinates of 16°18′51.1524″N and 80°26′6.1008″E. The field experiment was conducted during *kharif* and *rabi*. The experimental field soils were low in available nitrogen, medium in P_2O_5, high

in K_2O, low in organic matter and neutral in pH.

Seven sowings viz., T_1: 1st FN of July, T_2: 1st FN of August, T_3: 1st FN of September, T_4: 1st FN of October, T_5: 1st FN of November, T_6: 1st FN of December and T_7: 1st FN of January were sown randomly. Each sowing was replicated thrice in a randomized block design (RBD) for two years of experimentation. The recommended dose of N, P and K (80 : 24 : 20 kg/ha) was applied; $^1/_3$ N as basal, $^1/_3$ N at 30 DAS, $^1/_3$ N at 50 DAS, and 50% K, and entire P as basal, and the remaining K at flowering. Two years of experimentation were conducted in the same field. The data about the number of larvae/plant, % infestation, yield and standard meteorological week-wise weather data about Tmax, Tmin, RH_1, RH_2 and rainfall were collected and statistically analyzed by following the analysis of variance technique for RBD.

RESULTS AND DISCUSSION

The weekly observations on larval population, per cent infestation and weather parameters; maximum temperature, minimum temperature, morning RH, evening RH and rainfall for all the sowings were statistically analyzed, and the mean values were tabulated and presented in Fig. 1, Tables 1 and 2. The per cent infestation of *S. frugiperda* was noticed in all the sowings from July to January. Per cent infestation started from 34th MSW and gradually increased. The peak was noticed in 41st MSW, and the per cent infestation was 85.4, 82.8 and 85.0% during mid-July, mid-August and mid-September, respectively, with a minimum population of 0.50 larvae/plant, and the population reached its peak during 41st MSW (mid-October) with the maximum population of 1.20 larvae/plant. After the peak, the overall incidence gradually declined and lasted up to nine weeks, with the larval population of 0.41 larvae/plant at 46th MSW (4th week of December) on maize. The per cent infestation during mid-November (42%) and mid-December (47.1%) was minimum on 48th and 51st MSW. It was clearly stated that early-sown crops were infested more compared to latter sowing (Fig. 2). Kumar *et al.* (2020) found that *S. frugiperda* in maize was minimum in the second fortnight of November 2019 with 31, 21, 34 and 31% infestation at Peramblur, Veppanthattai, Alathur and Veppur blocks of Perambalur district, respectively.

The incidence of *S. frugiperda* was observed minimum from 38th to 46th MSW in *rabi* 2019, compared to summer 2020, with maximum incidence from 8th to 16th MSW.

The influence of weather parameters on fall armyworm (*S. frugiperda*) larval incidence in maize from mid-July to mid-January sowing is presented in Table 1. The correlation on larval incidence during *kharif* (mid-July to mid-August) revealed a significant positive association with Tmin °C, morning and evening relative humidity and rainfall except for Tmax °C (r = -0.150). The larval population of FAW was negatively correlated with Tmax, Tmin, morning and evening relative humidity and rainfall during *rabi* (mid-September to mid-December), as r values for each sowings (Table 1).

The fall armyworm infestation significantly influenced the grain yield of maize (Table 2). The yield was not recorded when the crop was sown in mid-October, with 100 and 90.8% crop damage in 2019-20 and 2020-21, respectively. In contrast, the significantly highest yield was observed when maize was sown during mid-July (4074 kg/ha), followed by mid-December and November. It was attributable to the unfavourable weather conditions for the fall armyworm when the crop was sown early (Mid-July) or late in the season (Mid-December), which resulted in less infestation of maize. These findings are similar to those of Nivetha *et al.* (2022) analysis showing a positive correlation with maximum temperature (r=0.675), while minimum temperature, morning humidity, evening humidity and rainfall showed a negative correlation.

CONCLUSION

The study suggested that the FAW larval incidence and per cent infestation recorded during *rabi* 2019 was less compared to summer 2020. During *rabi* 2019, the incidence started from the 38th MSW (4th week of September) and attained peak activity at the 42nd MSW (4th week of October) and retained up to the 46th MSW (4th week of December), which was significantly associated with evening RH, while morning RH and rainfall were positively correlated.

During the summer 2020, the incidence started from the 8th MSW (3rd week of

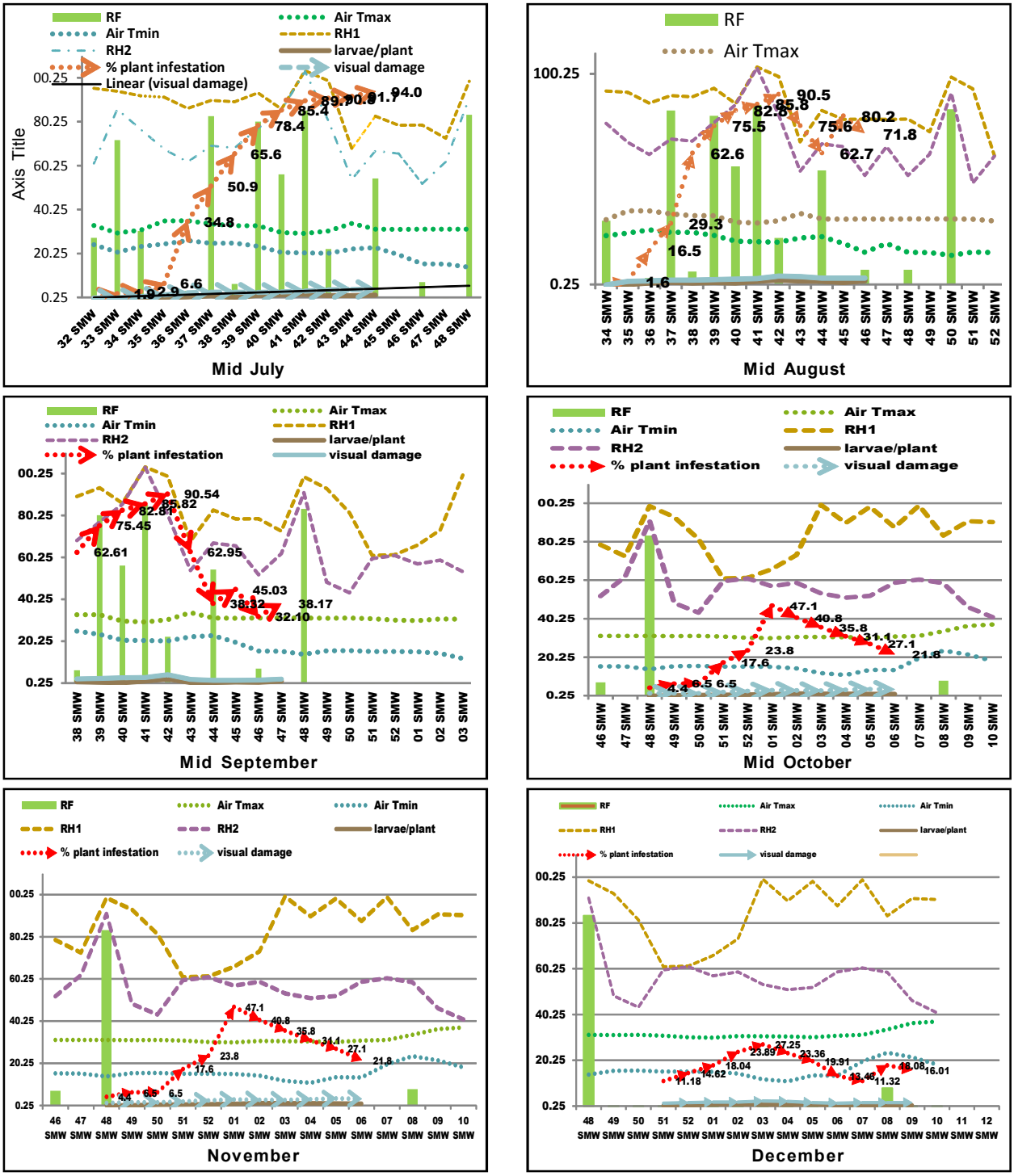

Fig. 1. Per cent plant infestation of fall armyworm on maize vs. weather parameters from July to December sowings.

February) and attained peak activity at the 12th MSW (2nd week of March) and retained up to the 16th MSW (2nd week of April) and had a positive association with maximum and minimum temperature. The minimum temperature and the maximum temperature had a negative association with incidence. In contrast, morning and evening relative humidity and rainfall exhibited a negative association. Therefore, temperature plays a significant role in the biology of *S. frugiperda*.

Table 1. The correlation coefficient between weather parameters vs. per cent infestation of fall armyworm at different sowings

Weather parameters	r values						
	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.
Tmax °C	-0.0675	-0.1726	0.1425	-0.0701	-0.5611	-0.2911	-0.4621
Tmin °C	0.3153	0.2858	0.8108	-0.6867	-0.6211	-0.2075	-0.5234
RH_1 (%)	0.0452	0.179	0.3925	-0.3608	-0.2568	-0.1087	-0.3438
RH_2 (%)	0.231	0.3238	0.6086	-0.5718	0.0115	-0.0636	0.0225
RF (mm)	0.2614	0.2885	0.4681	-0.5321	-0.2194	-0.376	-0.2194

Table 2. Fall armyworm infestation under different sowing windows and weather parameters in maize

Date of sowing	Tmax (°C)		Tmin (°C)		RH-I (%)		RH-II (%)		RF (mm)		FAW infestation (%)		Yield (kg/ha)	
	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21
Mid July	33.7	31.9	25.3	21.4	88.9	88.0	74.0	72	700.4	612.8	5.12	53.3	4074.0	1055.6
Mid Aug.	32.4	31.8	23.1	20.3	90.9	85.4	78.6	68.9	572.5	520.8	82.2	56.5	1822.2	907.8
Mid Sept.	31.2	31.2	22.0	18.0	91.3	82.6	81.8	66.0	405.4	395.7	88.95	61.4	1066.7	800.2
Mid Oct.	31.6	30.9	20.4	16.5	88.2	83.0	75.3	63.3	170.8	309.0	100.0	90.8	0.0	0.0
Mid Nov.	31.9	31.8	20.0	15.9	88.9	83.9	71.3	56.2	14.8	98.6	40.66	20.2	3822.2	2147.7
Mid Dec.	32.4	31.8	20.1	15.9	88.5	85.0	66.6	56.1	14.8	91.4	35.92	14.1	4407.4	2035.7
Mid Jan.	34.3	35.1	22.3	18.5	87.6	86.2	55.6	55.8	7.6	68.7	29.38	28.62	3570.33	2089.6
S. Em±	-	-	-	-	-	-	-	-	-	-	-	-	123.13	132.04
C. D. (P=0.05)	-	-	-	-	-	-	-	-	-	-	-	-	379.33	278.93
C. V. (%)	-	-	-	-	-	-	-	-	-	-	-	-	8.00	13.25

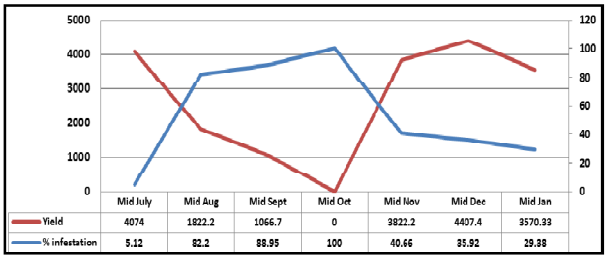

Fig. 2. Sowing-wise per cent infestation of fall armyworm on grain yield of maize.

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