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POPULATION DYNAMICS OF FRUIT AND SHOOT BORERS ON OKRA IN RELATION TO CLIMATIC CONDITIONS OF NORTHERN DRY ZONE OF KARNATAKA

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ABSTRACT
The field experiments were carried out with a view to study the fluctuation in the population of fruit and shoot borers of okra and their relation with prevailing weather conditions at Haveli Farm, College of Horticulture, Bagalkot during *rabi* 2014, summer and *kharif* 2015. Eggs and larvae of *Earias* spp. were noticed on five weeks old crop during all the cropping seasons while *H. armigera* was observed a week later. Larval population of *Earias* spp. (1.34 ±0.18 larvae/plant) and *H. armigera* (0.27 ±0.04 larvae/plant) was highest in *kharif* 2015, while highest mean percent fruit damage (22.83 ±0.64 %) and mean percent shoot damage (4.61 ±0.11 %) by *Earias* spp. was noticed in *rabi* 2014. Temperature and rainfall did not influence much on the population of borers in all the cropping seasons.

KEY WORDS: Population dynamics shoot and fruit borer, *Earias vittella*, *E. insulana*, *Helicoverpa armigera*.

INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench), also known as lady's finger or *bhendi* belonging to family Malvaceae, is an important warm season vegetable crop cultivated comprehensively in tropical and sub-tropical regions of the world. The total area under okra in the world is reported to be 1.11 lakh ha with a production of 8.70 lakh tonnes. In India, okra is cultivated over an area of 0.53 million ha with an annual production and productivity of 63.46 lakh tonnes and 11.9 tonnes per ha, respectively. The major okra producing states are Uttar Pradesh, Bihar, Orissa, West Bengal, Andhra Pradesh, Karnataka and Assam (Anon., 2014). Okra crop is ravaged by as many as 45 species of insect-pests throughout its growth period (Nair, 1984). Among them, shoot and fruit borers, *Earias vittella* (Fabricius), *E. insulana* (Boisduval) are quite serious and major restraining biotic factors in okra cultivation (Mandal *et al.*, 2006) and *Helicoverpa armigera* Hubner (Guru prasad, 2008). The fruit borers alone are reported to cause damage to the extent of 3.5 to 90 per cent to okra in different parts of the country (Mandal *et al.*, 2006). Nath *et al.* (2011) reported that the maximum damage in 41st standard week was caused by *Earias vitella* in okra, Sharma *et al.* (2010) reported that maximum numbers of larvae (7.5 larvae per 10 plants) were recorded in the 42nd standard week. Yadav *et al.* (2007) reported that the maximum fruit damage was observed in the third week of September. Hence, it prompted to study the population dynamics of okra fruit and shoot borer in relation to prevailing weather conditions in the Bagalkot region of Karnataka.

MATERIALS & METHODS

The experiments were carried out under field conditions at Haveli Farm, College of Horticulture, University of Horticultural Sciences (UHS), Bagalkot in three seasons (*rabi* 2014, summer and *kharif* 2015). Bagalkot is located in northern dry zone (Zone 3) of Karnataka state at 16^{o} 46' North latitude, 74^{o} 59' East longitudes and at an altitude of 534.0 m above the mean sea level. Experimental field with five guntas was prepared by thoroughly ploughing and harrowing to bring the soil to fine tilth. Seeds (Arka Anamika) were sown with row-to-row spacing and plant to plant spacing of 60 cm and 30 cm, respectively. The crop was raised as per the Package of Practices of UHS, Bagalkot, except the plant protection.

The egg and larval counts were recorded from randomly selected thirty plants after 30 days of sowing till maturity of the crop at weekly intervals. The central terminal growing shoot, buds, flowers and pods of the plants were thoroughly inspected with the help of hand lens for the presence of eggs. Larval population of *Earias* spp. and *H. armigera* was estimated by counting the number of larvae. Further, damaged shoots and fruits having entry holes or excreta were split open to record population per plant. The population was expressed as eggs and larvae per plant. Total number of shoots along with the infested ones were counted on 30 randomly selected plants at weekly intervals and expressed as percent shoot infestation. The fruit damage was computed by recording ratio of damaged fruits to total number of fruits on randomly selected 30 plants and was expressed as percentage. The percent damage was calculated as below:

$$\text{Per cent damage} = \frac{\text{No. of damaged plant parts}}{\text{Total plant parts}} \times 100$$

The data on fruit borers were subjected to correlation analysis with various abiotic factors, and the correlation coefficients thus obtained were compared for their significance following the method described by Fisher and Yates (1963).

RESULTS & DISCUSSION

Egg counts of *Earias* spp.

During *rabi* 2014, the oviposition by *Earias* spp. was first noticed on 5 weeks old crop at a very low population density of 0.25 eggs per plant during 44th SW. Thereafter, the eggs load on the crop increased with the age of the crop with two peaks in the ovipostion (Fig. 1) on 46th and 47th SW with mean of 1.73 and 1.23 eggs per plant, respectively. In summer 2015, the oviposition was first noticed on 5 weeks old crop with very low population density of 0.33 eggs per plant during 13th SW (Fig. 2). Thereafter, the egg laying increased with the age of the crop with two peaks in the ovipostion observed on 15th and 18th SW with mean of 1.60 and 1.80 eggs per plant, respectively. During *kharif* 2015, the maximum egg counts of *Earias* spp. was observed during 33rd SW with the mean of 2.13 eggs per plant. The mean value remained above one egg per plant up to 36th SW (Fig. 3). The wind speed and bright sun shine hours exhibited a significant negative correlation (r = -0.51 and r = -0.65) on oviposition during *kharif* and summer 2015. Further, the ovipostion by the pest was favoured by relative humidity as indicated by significant positive correlation with evening relative humidity during *rabi* 2014 and *kharif* 2015 (Table 1). Kumaranag (2015) reported the oviposition by the pest during 32nd SW, which increased gradually with the age of the crop and reached to a maximum in the succeeding weeks *i.e.*, 33rd and 34th SW in all the three years of study. The difference may be attributed to change in the crop ecosystem and ecological conditions of the study area.

Larval population of *Earias* spp.

During *rabi* 2014, the larval population of the *Earias* spp. was noticed on 44th SW and attained its peak on 48th standard week with mean of 1.87 larvae per plant (Fig. 1). Higher humidity favoured the larval population during the cropping season. The larvae on the summer crop appeared on 13th SW (first week of April) with peak density of 1.87 larvae per plant on 18th SW (first week of May) (Fig. 2). During *kharif* 2015, the larvae appeared on 31st SW (Fig. 3). The larval population of 1.87 and 2.20 larvae per plant was observed in the second and third week of August (32nd and 33rd SW) respectively. The observations are in accordance with findings of Yadav *et al.* (2009) who noticed the larval infestation on okra crop from the third week of August with its peak densities between the first and third week of September with slightly higher densities (24.70 to 20.50 larvae/ 5 plant) than in the present study. The probable reason for the low pest density during the present study could be due to differences in the agro-ecological conditions and cultivar used for the study. Larval population of *Earias* spp. had negative correlation with maximum temperature during *rabi* 2014, and significant positive correlation with minimum temperature during *kharif* 2015. Bright sun shine hours during summer 2015 influenced significantly on the larval population of *Earias* spp. Among the weather parameters, maximum and minimum temperature had a significant negative effect on the larval population of *Earias* spp. as reported by Pareek *et al.* (2001) and Sharma *et al.* (2010) from Rajasthan.

Egg counts of *Helicoverpa armigera*

The oviposition by the pest on crop was first noticed on 46th SW with density of 0.07 eggs per plant. The maximum number of eggs was observed on 49th SW (0.40 eggs /plant) during *rabi* 2014 (Fig. 1). During summer 2015, eggs of *H. armigera* were first observed on third week of April (15th SW) and the oviposition by the pest increased and reached a peak of 0.34 eggs per plant on 18th SW (Fig. 2). During *kharif* 2015, the oviposition by the pest on the crop was observed from 32nd SW onwards. The maximum oviposition by the pest (0.30 eggs / plant) was observed during 35th SW (Fig. 3). Among the different weather parameters, maximum temperature, average temperature and morning relative humidity had significant negative correlation while wind speed had positive significant correlation. Bright sun shine hours had significant negative correlation on oviposition of *H. armigera* during summer and *kharif*. However, Kumaranag (2015) reported the oviposition by *H. armigera* on okra from 34th, 35th and 34th SW during 2011, 2012 and 2013, respectively at relatively low densities and the wind speed affected the oviposition by the pest adversely. Relative humidity showed a significant positive relationship with oviposition by the pest. It may be due positive influence of relative humidity and rainfall on the moth emergence from overwintering pupae as reported in cotton crop (Kumar and Saini, 2007).

Larval population of *Helicoverpa armigera*

H. armigera larvae were noticed on 46th SW with a population of 0.03 larvae per plant. The larval population increased in the succeeding weeks to attain its peak population (0.30 larvae / plant) on 49th SW during *rabi* (Fig. 1). During summer, the larval population was observed on the crop between 15th and 21st standard week ranging from 0.07 to 0.33 larvae per plant with its highest population on 17th SW (Fig. 2).

The densities of larval population were observed between 32nd and 38th SW with highest larval density of 0.58 larvae per plant observed on 35th SW during *kharif* (Fig. 3). The present studies are supported by the observations recorded by Nath *et al.* (2011) from Uttar Pradesh. They reported that infestation of larvae of *H. armigera* appeared on the crop between third and fourth week of August reaching its peak densities on second and third week of September. Larval population of *H. armigera* exhibited a significant negative correlation with maximum temperature and relation was significant and positive with evening relative humidity and wind speed during *rabi* 2014. During summer 2015, minimum temperature and rainfall had significant negative correlation on larval population of *H. armigera.* During *kharif* 2015, evening relative humidity had significant positive correlation while bright sun shine hours had significant negative correlation on larval population of *H. armigera.* These findings are in accordance with Nath *et al.* (2011).

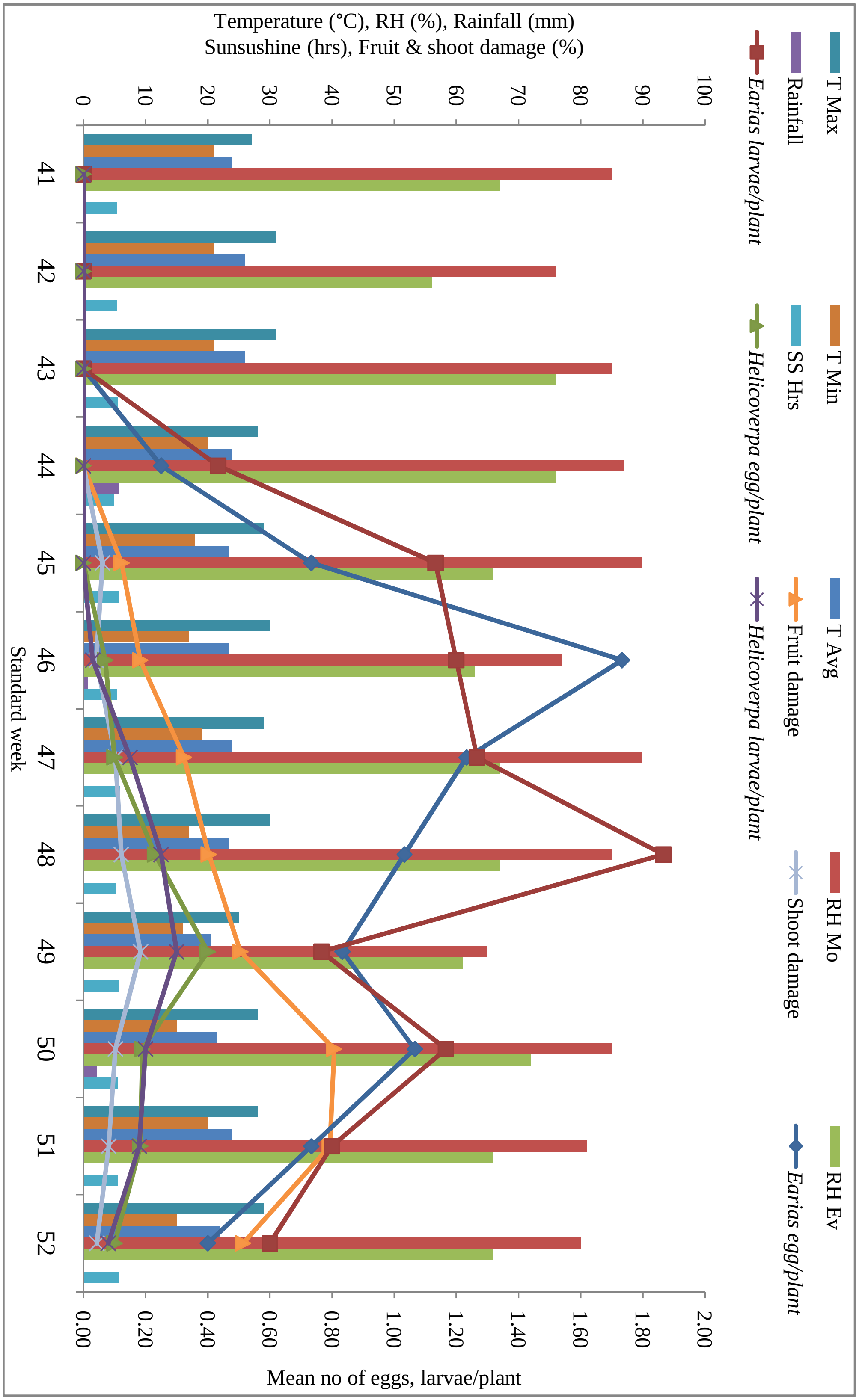

FIGURE 1. Egg, larval counts (*Earias* sp. and *Helicoverpa armigera*) and shoot and fruit damage caused by *Earias* sp. during different standard weeks on okra (*rabi* 2014)

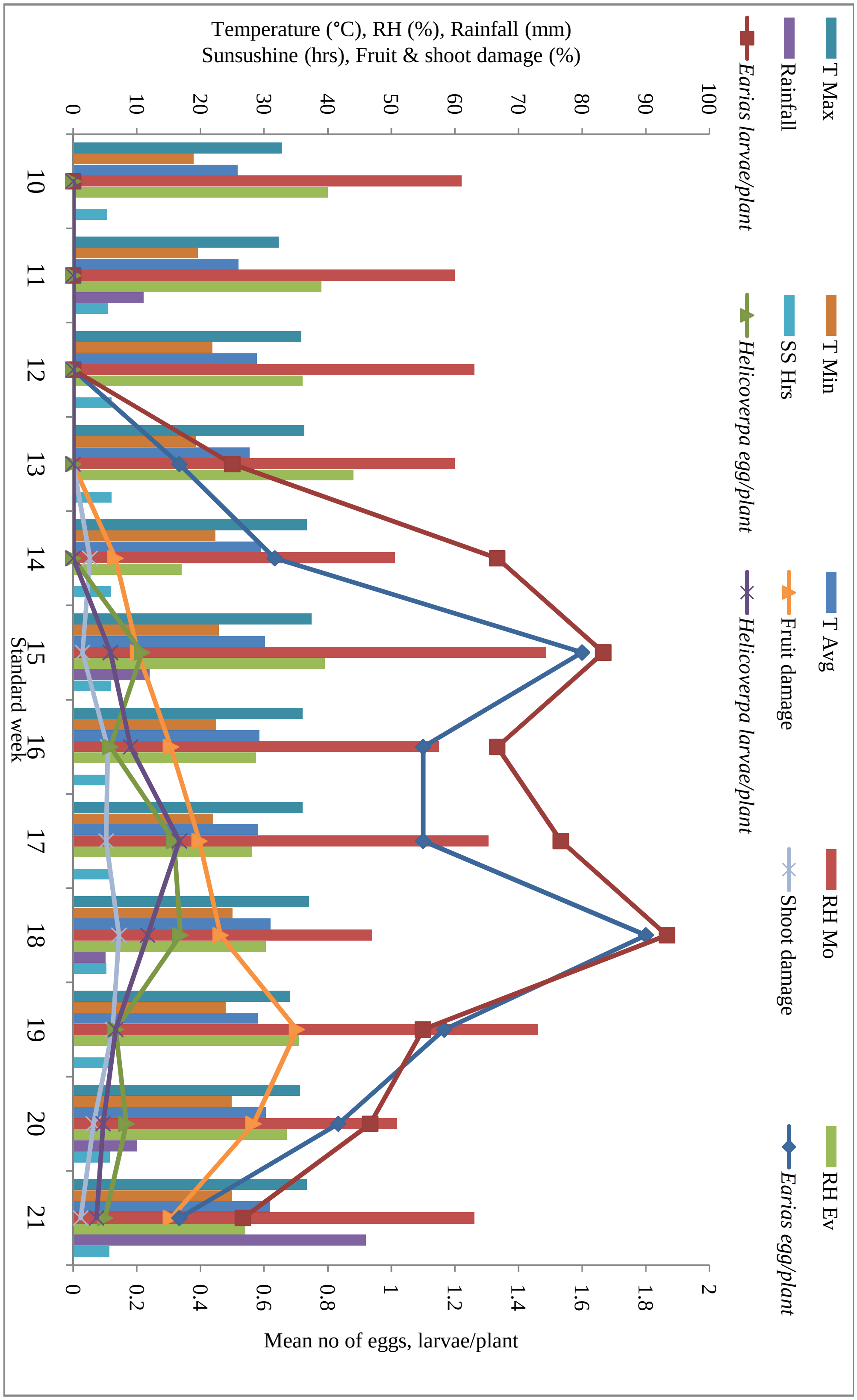

FIGURE 2. Egg, larval counts (*Earias* sp. and *Helicoverpa armigera*) and shoot and fruit damage caused by *Earias* sp. during different standard weeks on okra (summer 2015)

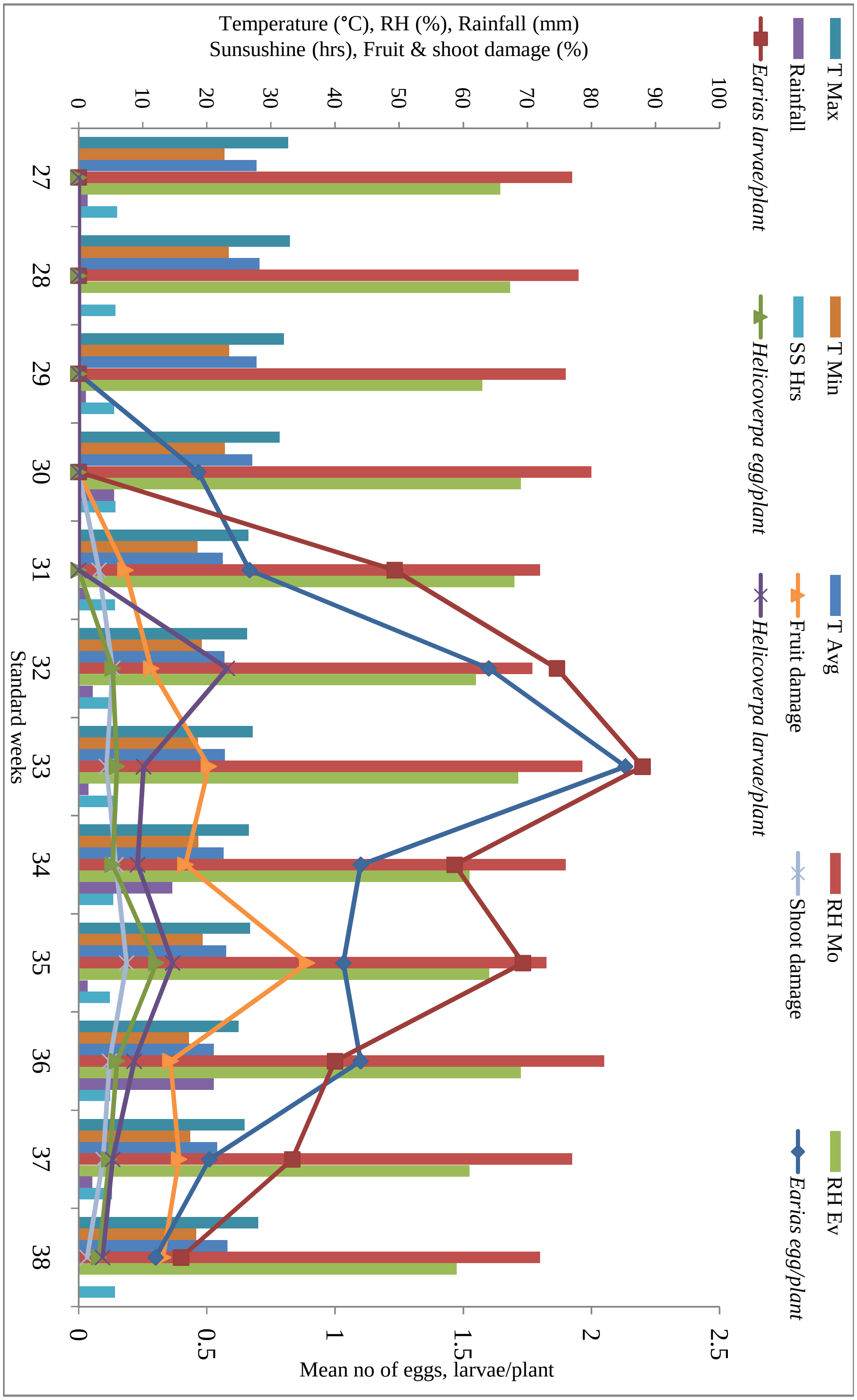

FIGURE 3. Egg, larval counts (*Earias* sp. and *Helicoverpa armigera*) and shoot and fruit damage caused by *Earias* sp. during different standard weeks on okra (*kharif* 2015)

TABLE 1. Correlation matrix between abiotic factors and population of borers on okra

Season	Max. temp. (°C)	Min. temp. (°C)	Avg. temp. (°C)	Morning RH (%)	Evening RH (%)	Rainfall (mm)	Wind speed (km/hr)	Bright Sun Shine (Hrs)
Egg counts of *Earias* spp.								
Rabi 2014	0.35	-0.16	0.09	0.07	0.57*	0.43	0.18	0.26
Summer 2015	0.01	0.36	0.34	0.09	0.20	-0.33	-0.15	-0.65*
Kharif 2015	-0.41	-0.17	-0.26	0.15	0.53*	0.05	-0.51*	-0.16
Larval population of *Earias* spp.								
Rabi 2014	-0.51*	-0.20	0.13	0.22	-0.24	-0.46	0.31	0.10
Summer 2015	0.20	0.19	0.19	-0.08	-0.26	-0.44	-0.34	-0.57*
Kharif 2015	-0.05	0.69*	0.41	0.30	0.43	-0.11	0.29	-0.01
Egg counts of *Helicoverpa armigera*								
Rabi 2014	-0.78**	-0.28	-0.68*	-0.70*	-0.43	-0.26	0.53*	0.01
Summer 2015	0.32	-0.12	0.135	-0.27	-0.04	-0.41	-0.28	-0.52*
Kharif 2015	-0.03	0.34	0.10	-0.05	0.32	-0.07	-0.41	-0.76*
Larval population of *Helicoverpa armigera*								
Rabi 2014	-0.64*	0.34	-0.41	-0.26	0.77*	-0.07	0.62*	0.01
Summer 2015	-0.03	-0.56*	-0.35	-0.13	-0.38	-0.59*	-0.51*	-0.38
Kharif 2015	0.21	0.35	0.05	0.26	0.51*	0.17	-0.37	-0.72*
Per cent fruit damage								
Rabi 2014	-0.42	-0.13	-0.35	-0.18	0.43	0.39	0.22	0.05
Summer 2015	-0.78**	0.53*	0.72*	0.09	0.45	-0.17	0.29	-0.35
Kharif 2015	0.38	0.45	0.43	-0.04	0.14	-0.20	-0.50*	-0.51*
Per cent shoot damage								
Rabi 2014	-0.72*	-0.08	-0.50*	-0.45	-0.19	-0.05	0.70*	0.57*
Summer 2015	-0.37	-0.02	-0.16	-0.31	-0.11	-0.62*	-0.32	-0.74*
Kharif 2015	-0.21	0.33	0.14	0.11	0.14	0.27	-0.13	-0.64*

* Significant at 5%, ** significant at 1%

Percent shoot damage *Earias* spp.

The infestation of *Earias* spp. on the shoots was initially observed on second week of November (45^{th} SW) and reached its peak (9.20%) on 70 days old crop during the second week of December (49^{th} SW) during *rabi* 2014 (Fig. 1). During summer and *kharif* 2015, the shoot infestation was initially noticed on 14^{th} (second week of April) and 31^{st} SW (first week of August) with 2.60 and 3.17 per cent, respectively (Fig. 2). The shoot infestation reached its peak of 7.17 and 7.57 per cent in first week of May (18^{th} SW) and first week of September (35^{th} SW) during summer and *kharif* 2015, respectively (Fig. 3). Maximum temperature (r = -0.72) and average temperature (r = -0.50) exhibited a significant negative correlation with per cent shoot damage during *rabi* 2014. Rainfall (r = -0.62) exhibited significant negative correlation during summer 2015. Wind speed had a significant positive correlation during *rabi* 2014. While correlation was significant and positive with bright sunshine hours during *rabi* but during summer (r = -0.74) and *kharif* 2015 (r = -0.64) it was significant and negatively correlated. This variation in the occurrence of per cent shoot damage can be ascribed to changes in ambient weather conditions. Nath *et al.* (2011) and Aziz *et al.* (2011) observed a difference in the correlation between the weather parameters and shoot damage over the study periods but it was significant.

Percent fruit damage *Earias* spp.

The fruit damage commenced from second week of November (45^{th} SW) with 6.13 per cent fruit damage and its peak with the cumulative fruit damage of 40.33 per cent recorded during third week of December (50^{th} SW) during *rabi* (Fig. 1). The initiation of fruit damage was observed at 14^{th} (Fig. 2) and 31^{st} (Fig. 3) SW with 6.60 and 7.33% damaged fruits during summer and *kharif* 2015, respectively. The fruit damage increased progressively and reached to maximum of 35.17 and 35.67 per cent at the crop maturity stage on 19^{th} (34.02^{0} C and 73.00 % RH) and 35^{th} SW (26.70^{0} C and 73.00 % RH) during both the respective seasons. The correlation analysis between the weather parameters and fruit damage revealed that the maximum temperature (r =-0.78) had a significant negative correlation, while minimum (r = 0.53) and average temperature (r = 0.72) had significant positive correlation with fruit damage during summer 2015. Wind speed (r = -0.50) and bright sunshine hours (r = -0.51) had a significant negative correlation with fruit damage during *kharif* 2015. Several workers reported similar observations regarding the fruit damage on the okra crop (Selvaraj *et al.*, 2010; Nath *et al.*, 2011, Dabhi *et al.*, 2013 and Gautam, *et al.*, 2014). The mean temperature below 31° C, mean relative humidity in the range of 70 to 80 per cent favoured fruit damage by shoot and fruit borer in the present study. The variation in the per cent damaged fruits across the seasons may be attributed to the variation in ambient weather conditions.

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