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Seasonal incidence of shoot and fruit borer, *Earias* spp. on okra var. Konkan bhendi and correlation with weather parameters

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Abstract
The studies on seasonal incidence of shoot and fruit borer, *Earias* spp. on okra var. Konkan bhendi revealed that percent shoot and fruit infestation was ranged from 2.0 to 6.0 and 6.56 to 27.57 percent, respectively. The highest shoot infestation of 6.0 percent was observed in 12th SMW corresponding to 6th week after sowing, whereas, the fruit infestation reached at its peak (27.57 percent) in 18th SMW corresponding to 12th week after sowing. The shoot infestation exhibited negative correlation with maximum temperature (-0.202), minimum temperature (-0.256), afternoon relative humidity (-0.018), wind speed (-0.160), rainfall (-0.079) and bright sunshine hours (-0.109), while non-significant positive correlation with morning relative humidity (0.318). Fruit infestation showed highly significant positive correlation with minimum temperature (0.812), afternoon relative humidity (0.793) and wind speed (0.758) and positive correlation with rainfall (0.278), whereas, it exhibited significant negative correlation with maximum temperature (-0.414) and negative correlation with morning relative humidity (-0.230) and bright sunshine hours (-0.155).

Keywords: Seasonal incidence, shoot and fruit borer, okra, Konkan bhendi

1. Introduction

Okra, *Abelmoschus esculentus* (L.) Moench, in Sanskrit designated as 'Tindisha' and 'Gandhmula' and commonly known as "Lady's finger" or "Bhindi" or "Gumbo" or "Quiabo" or "Quimgombo" or "Quimbombo" or "Qiukui" or "Okura" or "Igbo" worldwide is a flowering plant under Malvaceae family having multipurpose crop value which produces high valued edible green pods with good nutritional value. It is a native crop of Africa, South East Asia and North Australia to the Pacific (Boswell and Reed, 1962). The crop is cultivated in tropical, sub-tropical and warm temperate regions around the world. It is widely grown all over the globe including India for its immature tender fruits. It is quite popular in India because of easy cultivation, dependable yield and adaptability to varying moisture conditions (Singh *et al.*, 2014) [21].

Okra is also known as house of pests due to its two distinct i.e. vegetative and fruiting growing stages. The production and yield of this high valued crop is quite often very much hampered by various insect species and few mite species from its early stage to maturity. As high as 72 species of insect pests have been recorded on okra. Amongst them, the shoot and fruit borer, *Earias vittella* Fab. (Lepidoptera: Noctuidae) is one of the most damaging pest, causing significant damage to okra crop. It is widely distributed throughout India, Bangladesh, Pakistan, Indonesia, Burma, New Guinea, Myanmar and Fiji. It is also a major and regular pest of okra which causes up to 69 to 100 percent loss in marketable yield of fruits with an average loss of 60.09 percent in absence of plant protection umbrella (Butani and Jotwani, 1984; Kadam, 1993; Dhandge, 2018; Aman *et al.*, 2022) [4, 11, 6, 1].

For better understanding of the population behaviour, proper timing for adopting control strategy, consideration of biotic and abiotic factors is very much important. Seasonal abundance of the pest provides not only the information of the initiation of the pest but also provides the peak activity of the particular pest.

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Natural enemies also contribute in reducing the pestpopulation to some extent. Weather parameters *viz.*, temperature, relative humidity, rainfall, bright sunshine hours, wind speed, evaporation etc. play a pivoted role in population build-up of insect pest (Ghongade *et al.*, 2021) [8]. Correlation study helps in to provide positive or negative association of pest population with weather parameters. It also shows direct influence of particular parameter on pest population build-up as well as its indirect effect through other parameters.

2. Materials and Methods

The studies on seasonal incidence of shoot and fruit borer, *Earias* spp. on okra var. Konkan bhendi was carried out during the crop season of Summer 2023 at Instructional Farm, Department of Agronomy, College of Agriculture, Dapoli Tal. Dapoli Dist. Ratnagiri - 415 712 (M.S.). A separate plot of 200 m^2 (20 m x 10 m) was kept free from insecticides throughout the crop season for recording the observations on seasonal incidence of shoot and fruit borer, *Earias* spp. Fifty plants from the entire plot were selected randomly and tagged to record the observations on the incidence of shoot and fruit borer, *Earias* spp. The observations were recorded at weekly interval, commencing from initiation of infestation by the pest and continued up to harvest of the okra crop. The percent damage to the shoots and fruits were recorded separately using standard methodology.

Percent shoot infestation was calculated by following formula:

$$\text{Percent shoot infestation} = \frac{\text{No. of shoots infested}}{\text{Total no. of shoots}} \times 100$$

Percent fruit infestation was calculated by following formula:

$$\text{Percent fruit infestation} = \frac{\text{No.of shoots infested}}{\text{Total no.of fruits}} \times 100$$

Correlation studies between percent damage to shoots/fruits and prevailing abiotic factors *viz.*, maximum temperature, minimum temperature, relative humidity (morning), relative humidity (afternoon), rainfall, bright sunshine hours and wind speed were carried out and impact of these factors on percent infestation by *Earias* spp. were worked out by calculating the simple correlation (r) following standard procedure.

3. Result and Discussion

3.1 Seasonal incidence of shoot and fruit borer, *Earias* spp. on okra var. Konkan bhendi

The perusal of data indicated that there was very low shoot infestation observed during vegetative phase of crop growth ranging from 2.0 to 6.0 percent (Table 1). The shoot infestation by the pest was started in 10^{th} SMW with 2.0 percent shoot infestation corresponding to 4^{th} week after sowing. Thereafter, 4.0 percent shoot infestation was observed on okra crop in 11^{th} SMW corresponding to 5^{th} week after sowing. The highest shoot infestation of 6.0 percent was observed in 12^{th} SMW corresponding to 6^{th} week after sowing. Thereafter the shoot infestation went on decreasing and no shoot infestation was observed after fruiting started. Overall, the shoot infestation by *Earias* spp. was observed very low during the crop growth.

The present results on seasonal incidence and percent shoot infestation by shoot and fruit borer, *Earias* spp. are in close agreement with Mandal *et al.* (2006) [13] who reported that the activity of shoot and fruit borer on summer okra was observed from 11^{th} SMW (12-18 March) and the infested shoots ranged between 0.5 to 2.3 percent and 1.8 to 4.2 percent, respectively in 2000 and 2001, respectively. Meena *et al.* (2015) [15] revealed that the infestation of *Earias* spp. on the shoots started in the fourth week of March (4.49% shoot damage) being maximum in first week of April support the present findings though shoot infestation was low during present study. Dhandge *et al.* (2018) [6] found that the shoot infestation of *E. vittella* was seen from 11^{th} SMW with 1.3 and 0.9 percent shoot damage during 2016 and 2017, respectively. Ray *et al.* (2019) [19] reported that the prevalence of okra shoot and fruit borer was noticed on shoots during 10^{th} SMW (3.45% shoot infestation) and reached to its peak (5.0% shoot infestation) during the second week of March (11^{th} SMW). Nandaniya *et al.* (2022) [16] also observed that the shoot infestation of *E. vittella* commenced from 4^{th} week after sowing (9^{th} SMW) with maximum (25.71%) in 9^{th} week after sowing (14^{th} SMW). Gurjar *et al.* (2023) [9] reported that the shoot damage by shoot and fruit borer, *Earias* spp. increased gradually from 10^{th} SMW (5% each) and reached to its maximum in 14^{th} SMW (15 and 20%) i.e. first week of April during two years of study which more or less support the present findings.

The fruit infestation by the pest was ranged from 6.56 to 27.57 percent during the fruiting stage of the okra crop. Fruit infestation started from 12^{th} SMW corresponding to 7^{th} week after sowing with 6.56 percent fruit infestation. The fruit infestation gradually increased and reached at its peak in 18^{th} SMW corresponding to 12^{th} week after sowing with 27.57 percent infestation (Table 1). Thereafter fruit infestation went on decreasing up to 20.19 percent in 23^{rd} SMW corresponding to 17^{th} week after sowing.

The recent findings on seasonal incidence and percent fruit infestation by *Earias* spp. are in corroboration with those of Chaudhary and Dadheech (1989) [5] who observed that the incidence of fruit borer, *E. fabia* touched its peak on 10^{th} week old okra crop (57.14% infestation) corresponding to 64 days after planting. Mani and Singh (2012) [14] found that the fruit damage by *E. vittella* was noticed maximum during 16^{th} SMW which are more or less in line with present findings where the peak damage was observed in 18^{th} SMW. Meena *et al.* (2015) [15] reported that the infestation of *Earias* spp. on the fruits was recorded in the third week of April (seven weeks after germination) (avg. 5.58 infested fruits) and remained upto last week of June with a maximum in the first week of May (avg. 19.77 infested fruits). Gautam *et al.* (2016) [7] showed that the infestation of *E. vittella* on fruits appeared in first week of April (14^{th} SMW) in summer crop and the maximum damage was recorded in third week of May (27.2 and 28.2%) during two successive years of study. Venkanna and Balikai (2016) [23] found that on summer crop of variety Arka Anamika, 33.0 percent fruit damage was recorded during 11^{th} week after sowing where the fruit damage ranged from 1.0 to 33.0 percent, whereas, in case of genotype No-55, damage to fruits ranged from 2.0 to 26.0 percent where the peak percent fruit damage of 26.0 percent was seen during 11^{th} week after sowing. Dhandge *et al.* (2018) [6] observed that the fruit infestation by the noctuid pest was started during 13^{th} SMW with 2.8 and 3.6 percent fruit infestation during 2016 and 2017, respectively. Ray *et al.* (2019) [19] revealed that initial fruit infestation (6.89%) by pest was noticed during third week of March (12^{th} SMW) and thereafter the infestation level gradually increased and reached to highest (43.41%) during second week of April (15^{th} SMW) which more or less support the present study. Nandaniya *et al.* (2022) [16] reported that the fruit infestation due to *E. vittella* was seen from 6^{th} week after sowing (11^{th} SMW) with maximum (40.20%) in 11^{th} week after sowing (16^{th} SMW) which corroborate with the present findings. Gurjar *et al.* (2023) [9] found that the larvae of

Earias spp. started infesting the fruits of okra from 13th SMW (4th week of March) recorded on both number and weight basis and reached to its maximum in the 19th SMW (2nd week of May) during both the years of study.

Table 1: Seasonal incidence of shoot and fruit borer, *Earias* spp. infesting okra var. Konkan bhendi

WAS	SMW	*Earias* spp. (percent infestation)	
		Shoot	Fruit
1	7	0.00	0.00
2	8	0.00	0.00
3	9	0.00	0.00
4	10	2.00	0.00
5	11	4.00	0.00
6	12	6.00	6.56
7	13	2.00	9.82
8	14	0.00	16.93
9	15	0.00	21.44
10	16	0.00	23.25
11	17	0.00	26.13
12	18	0.00	27.57
13	19	0.00	25.65
14	20	0.00	24.51
15	21	0.00	22.23
16	22	0.00	22.78
17	23	0.00	20.19
S.D.		0.02	0.11

WAS: Week after sowing
SMW: Standard Meteorological Week

3.2. Correlation of weather parameters with infestation of *Earias* spp.

The coefficient of correlation between the pest incidence and weather parameters were worked out and results are presented in Table 2.

For shoot infestation, okra shoot and fruit borer, *Earias* spp. had exhibited negative correlation with maximum temperature (r = -0.202), minimum temperature (r = -0.256), afternoon relative humidity (r = -0.018), wind speed (r = -0.160), rainfall (r = -0.079) and bright sunshine hours (r = -0.109), while non-significant positive correlation with morning relative humidity (r = 0.318). All the weather parameters under study showed non-significant negative correlation with percent shoot infestation except morning relative humidity.

The correlation between percent fruit infestation by *Earias* spp. and weather parameters showed highly significant positive correlation with minimum temperature (r = 0.812), afternoon relative humidity (r = 0.793) and wind speed (r = 0.758) and positive correlation with rainfall (r = 0.278), whereas, it exhibited significant negative correlation with maximum temperature (r = -0.414) and negative correlation with morning relative humidity (r = -0.230) and bright sunshine hours (r = -0.155).

Table 2: Correlation coefficient between weather parameters and infestation of shoot and fruit borer, *Earias* spp.

Weather parameters	Correlation coefficient (r)	
	Shoot infestation	Fruit infestation
T_{max} (°C)	-0.202	-0.414*
T_{min} (°C)	-0.256	0.812**
RH-I (%)	0.318	-0.230
RH-II (%)	-0.018	0.793**
Wind speed (Kmph)	-0.160	0.758**
Rainfall (mm)	-0.079	0.278
BSS (hrs.)	-0.109	-0.155

* Significant at 5 percent level of significance (r = 0.389) N = 17
** Significant at 1 percent level of significance (r = 0.592)

The perusal of data on correlation of pest infestation with various weather parameters corroborate with those of Mandal *et al.* (2006) [13] who reported that correlation studies between okra shoot and fruit borer damage percentage (fruit number and weight basis) as well as the larval population per hundred fruits and prevailing weather parameters revealed significantly negative relationship with maximum temperature (-0.65*, -0.65* and -0.64*) and highly significant positive relationship with minimum temperature (0.77**, 0.76**, 0.75**). Aziz *et al.* (2011) [2] found that shoot infestation was negatively correlated with relative humidity (r= -0.606) and rainfall (r= -0.571). They further concluded that minimum temperature (r= 0.442) exerted a positive correlation and relative humidity (r= -0.513) showed negative effect on the fruit infestation. Jikamade (2017) [10] found that okra shoot and fruit borer showed significant negative correlation with minimum temperature, evening relative humidity and wind speed.

Raju *et al.* (2017) [18] observed that incidence of shoot damage was non-significantly negatively correlated with rainfall and relative humidity, whereas, larval population and fruit damage were significantly negatively correlated with maximum temperature and relative humidity.

Kalkal *et al.* (2018) [12] noticed that spotted bollworm population were found having significantly negative correlation with temperature (r= -0.81), relative humidity (r= -0.57) and rainfall (r= -0.07). Potai and Chandrakar (2018) [17] reported that the incidence of shoot and fruit borer showed negative non-significant correlation with maximum temperature (r= -0.16), positive correlation with minimum temperature (r= 0.13), positive but non-significant correlation with rainfall (r= 0.43), highly positive significant correlation with morning RH (r= 0.77**), negative correlation with evening RH (r= -0.005) and negative but significant correlation with wind velocity (r= -0.63*). Ray *et al.* (2019) [19] revealed that fruit infestation was significantly positively correlated with minimum temperature (r = 0.63) and non-significant positively correlated with rainfall (r= 0.37) and evening relative humidity (r= 0.22), non- significant negatively correlated with morning relative humidity (r = -0.33). Srivastav and Yadav (2019) [22] observed that shoot infestation showed negative correlation with evening humidity (r= -0.592), wind speed (r= -0.338) and sunshine hours/day (r= -0.624), respectively. Further the infestation of *E. vittella* on fruits of okra showed significant positive correlation with minimum temperature (r= 0.432) and negative correlation with sunshine hours/day (r= -0.620). Sheoran *et al.* (2021) [20] reported that larval population of *Earias* spp. exhibited a significant and negative correlation with maximum temperature (r = -0.568) and minimum temperature (r = -0.643) along with evening relative humidity (r = -0.590) and rainfall (r= -0.590). Gurjar *et al.* (2023) [9] found that the correlation coefficient between minimum temperature and shoot damage showed significant negative correlation (r= -0.647) during 2022, however, both maximum and minimum temperatures presented a significant negative influences (r= -0.638 and -0.648) with shoot damage during 2023. Minimum temperature (r = 0.924 and r = 0.931) exhibited significant positive correlation with percent fruit damage of okra recorded on number basis during two years of study which are more or less in line with present study.

4. Conclusion

The percent shoot and fruit infestation was ranged from 2.0 to 6.0 and 6.56 to 27.57 percent, respectively. There were slight differences in shoot infestation and fruit infestation by *Earias* spp. observed during the present investigation which might be due to different variety used and the differences in location of experiment, sowing period and environmental conditions i.e. weather parameters prevailing in these different locations. No natural enemies of the pest were recorded during the present investigation. Shoot infestation exhibited negative correlation with maximum temperature (-0.202), minimum temperature (-0.256), afternoon relative humidity (-0.018), wind speed (-0.160), rainfall (-0.079) and bright sunshine hours (-0.109), while non-significant positive correlation with morning relative humidity (0.318). Fruit infestation showed highly significant positive correlation with minimum temperature (0.812), afternoon relative humidity (0.793) and wind speed (0.758) and positive correlation with rainfall (0.278), whereas, it exhibited significant negative correlation with maximum temperature (-0.414) and negative correlation with morning relative humidity (-0.230) and bright sunshine hours (-0.155).

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