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Population dynamics of okra shoot and fruit borer (*Earias vittella*) of okra in agro-climatic condition of Pantnagar

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Abstract
The present investigation was carried out to study the population dynamics of Okra shoot and fruit borer **(***Earias vittella*) and influence of various weather parameters on them at Vegetable research centre, Gobind Ballabh Pant University of Agriculture & Technology, Pantnagar, Uttarakhand, during 2016-2017. The incidence of Okra shoot and fruit borer was recorded at 28th SMW (standard meteorological week) to 39th SMW. The result revealed that peak incidence of Okra shoot and fruit borer population was observed 5.9 larvae/ plant in 37th standard meteorological week. Correlation of Okra shoot and fruit borer **(***Earias vittella*) population with weather parameters revealed that there was non-significant negative correlation with Minimum temperature (r = -0.162), evening relative humidity (r = -0.545) and sunshine hour (r = -0.572) while significant negative correlation with rainfall (r = -0.610*). While maximum temperature(r = 0.513), morning relative humidity (r =-0.201) and wind velocity (r =-0.411) showed non-significant positive correlation. The linear regression analysis using weather parameters as independent variables and Okra shoot and fruit borer as dependent variables could explain the variability up to 78% (R^2= 0.76), respectively.

Keywords: Okra, okra shoot and fruit borer, population

Introduction

Vegetables are the substantial part of human diet. Vegetables contain almost all nutritional requirements that our body needs. The health benefits of vegetable nutrition are enormous. They are the affluent and cheaper source of vitamins, minerals, antioxidants, dietary fibers and trace elements. As vegetables contain these health benefitting phyto-chemical compounds, they not only protect the human body from oxidant stress, diseases, and cancers, but also help our body in developing the capacity to fight against these diseases by boosting its immunity.

Among the divergent group of vegetables, Okra *Abelmoschus esculentus* L. (Moench) is the second largest cultivated crop, a potential export earner and accounting for about 60 percent of export of the total fresh vegetables (Peirce, 1987) [13]. India is the second largest producer of vegetables in the world after China, while it ranks first in Okra production which is 61.9% of the total global production followed by Nigeria (22.2% of the total global production). In India, production was about 6073 thousand MT from 506 thousand ha of area during 2017-2018 (Anonymous, 2018) [1].

In India, major leading state in Okra production is Andhra Pradesh. It has production of around 1184.2 thousand tons followed by West Bengal (862.1 thousand tons) and Bihar (788.3 thousand tons) (Anonymous, 2018) [1]. Uttakhand's share in total okra production is about 3%. It is grown in almost all the districts of Uttrakhand. Amongst them, Dehradun is the major okra producing district followed by Udham Singh Nagar, Pithoragarh, Tehri, Nainital, Haridwar and Chamoli.

Among the biotic factors insect-pests are predominant and occur regularly at different stages of crop growth. Among other various factors responsible for lower yield of Okra, insect pests viz., the fruit borer, *Helicoverpa armigera* (Hubner), Okra shoot and fruit borer, *Earias vittella* (Fabricius) and sucking insect pests viz., whitefly *Bemesia tabaci* (Gennadius)., Jassids, *Amrasca biguttulla biguttula* (Ishida) and thrips *Thrips tabaci* (Lind) are highly destructive causing serious damage and are responsible for lowering the yield of Okra crop (Lal *et al.*, 1990) [9].

The important limiting factor in the successful cultivation of Okra is the damage caused by insect-pests, mainly fruit borers and sucking insects. The important species of fruit borers are *Earias vittella* (Fabricius) (Krishnaiah *et al.*1980 [8], Rawat and Sahu, 1973 [15]), *E. insulana* (Bioduval) (Tripathi and Singh, 1990) [20], and *Helicoverpa armigera* (Hubner) (Rawat and Sahu, 1973) [15]. The larvae of Okra shoot and fruit borer, *E. vittella* (Fab.) are the major constraint in maximizing production in summer grown okra. Damage due to the borer pests in summer season has been reported to range from 4.65 to 17.15% (Dhamdhre *et al.*, 1984) [4]. It causes up to 41.60% cop loss in different parts of India (Srinivasan and Krishnakumar, 1988) [19]. However, according to Hiremath and Thontadarya (1984) [5] the damage caused by *Earias spp.* may reach as high as 60.68%. Besides the fruits, it also damages growing shoots which adversely affects the overall health of plants and yield

In the light of above facts this experiment was carried out to determination of population dynamics of okra shoot and fruit borer and impact of weathers parameters on them.

Material and method

Experimental site

The field experiments were carried out to observe the population dynamics and correlation of weather parameter with Okra shoot and fruit borer (*Earias spp*) of Okra crop (variety Parbhani Kranti) at Vegetable Research centre (VRC), G. B. Pant University of Agriculture and Technology, Pantnagar Udham Singh Nagar (Uttarakhand) during *kharif* crop season 2017. Observations on population of pests were recorded after 15 days of sowing (15 DAS) at weekly interval up to harvesting. These observations of number of lavae per plant, from five randomly selected plants per plot selected leaving border rows. The mean weekly weather data during crop season was collected from meteorological observatory, N.E. Borlaug Crop Research Centre, Pantnagar.

Fruit borers percent infestation

The observation on healthy and the infested Shoots/Fruits the percentage of infested fruit on number basis. The presence of hole/holes was the criteria for separating damaged fruits from healthy ones. The percentage of infestation was calculated by the following formula as adopted by Karmakar *et al.* (2007) [7].

$$\text{Percent infestation} = \frac{\text{Infested fruit/shoot}}{\text{Infested fruit/shoot} + \text{Healthy fruit/shoot}} \times 100$$

Results and Discussion

Population dynamics and fluctuation in population of Okra shoot and fruit borers, *Earias vittella* Fab of Okra during *kharif*, 2017

In *kharif*, 2017 the pooled incidence of *Earias spp.* was observed from 28th standard metrological week (SMW) to 39th standard metrological week (SMW) (Table 1). The pest marked its first appearance by average of 2.1 larvae/plant at 32nd standard metrological week (SMW) when the maximum-minimum temperature, morning-evening relative humidity (RH), rainfall, sunshine hrs, wind velocity were 33.0 ^{0}C, 26.3 ^{0}C, 89% (0712am), 70% (1412pm), 040.2mm, 06.8hrs, 5.7km/hr, respectively. The population gradually increased and attained maximum (5.9 larvae/plant) in the 37th standard metrological week (SMW) when the maximum-minimum temperature, morning-evening relative humidity (RH), rainfall, sunshine hrs, wind velocity were 32.1 ^{0}C, 24.5 ^{0}C, 89% (0712am), 71% (1412pm), 059.4 mm, 04.3 hrs, 4.5 km/hr respectively followed by gradual decrease in population till 39th standard metrological week (SMW) (Fig 4.3). So the ecological parameters prevailed during 37th standard metrological week (SMW) appeared to be congineal for this pest.

Data presented in Table 1. revealed that the larval population of Okra shoot and fruit borer appeared from second metrological week of August (32nd standard metrological week) to last week of September (39th standard metrological week). However, the maximum population of the pest was recorded in 37th standard metrological week. These observations are close to study of Bajad *et al.* (2014) [3] their observation was that *Earias vittella* incidence were from 34th standard metrological week (i.e fourth week of August) on five week old crop and continued till 43rd standard metrological week and peak population was observed in 38th standard metrological week (63 DAS), followed by a marked decline in population. While Sharma *et al.* (2010) [16] in Rajasthan, observed that the first infestation of *Earias vittella* started in 29th standard week while peak infestation of plants (91.6%) by *Earias vittella* occurred during 45th (112 DAS) standard metrological week. Also the maximum number of larvae (7.5 larvae/10 plants) was recorded in the 42th standard metrological week (91 DAS). The present finding are also supported by Meena *et al.* (2010) [11] studied the activity of *Earias vittella* in Rajasthan from the beginning of August till harvesting also peak population was observed in 3rd week of October. Padwal *et al.*, (2015) [13] reported the population of *Earias vittella* on Okra commenced on the mid of August *i.e.*33rd standard metrological week followed by a gradual increase in population till the first week of October (40th standard metrological week). Yadvendu (2001) [21] reported that pest population attained its peak in first and fourth week of September.

Per cent shoot and fruit infestation by *Earias spp*

The per cent infestation of shoot and fruit by *Earias spp* in *kharif*, 2017 was observed highest in 37th standard metrological week (Table 2 & Table 3). Thus the second week of September was found to be the most favourable period for infestation on shoot and fruit(31.0 and 39.83) when the maximum-minimum temperature, morning-evening relative humidity(RH), rainfall, sunshine hrs, wind velocity were 32.1 ^{0}C, 24.5 ^{0}C, 89% (0712am), 71% (1412pm), 059.4 mm, 04.3 hrs, 4.5 km/hr respectively.

Correlation between population dynamics of Okra shoot and fruit borers, *Earias vittella* of Okra with weather parameters (2014)

Simple correlation worked out between the weather parameters and larval population of *Earias vittella* Table. 1 revealed that there was non-significant negative correlation with Minimum temperature (r = -0.162), evening relative humidity(r = -0.545) and and sunshine hour (r = -0.572) while significant negative correlation with rainfall (r = -0.610*). While maximum temperature (r = 0.513), morning relative humidity (r =-0.201) and wind velocity (r =-0.411) showed non-significant positive correlation. These studies indicating that the *Earias vittella* population increased with increasing maximum temperature (r =0.513), morning relative humidity (r =-0.201) and wind velocity (r =-0.411) while decreased by increasing Minimum temperature (r = -0.162), evening relative humidity (r = -0.545) and and sunshine hour (r = -0.572) and rainfall (r = -0.610*). The result found was similar to the study of Dhamdhere *et al.*, (1984) [4] who also observed a negative correlation between Okra shoot and fruit borer population and relative humidity. Aziz *et al*., (2011) [2] studied the fluctuations of fruit and shoot infestation *(Earias spp.)* with the abiotic factors during 2006 and 2007 and found that the infestation of fruit and shoot borer was negatively correlated with the relative humidity and rainfall also significantly positively correlated with temperature this observation is similer to our observation. Sharma *et al*. (2010) [16] also found that fruit and shoot borer infestation was negatively correlated with the relative humidity and rainfall. Laichattiwar *et al.* (2014) [10] observed that fruit and shoot borer infestation showed a negative correlation with relative humidity also non-significant with temperature and rainfall. Sardana and Kumar (1989) [17] also showed positive correlation with this pest and temperature. Radke and Undirwade (1981) [14] also reported higher incidence of *Earias sp* with increasing temperature whereas Kadam and Khaire (1995) [6] reported significantly negative correlation between the incidence of fruit and shoot borer and relative humidity.

Correlation of weather parameters with per cent shoot and fruit infestation

The impact of weather factor on the present shoot infestation caused by *Earias spp.* on Okra during *kharif*, 2017 is presented in Table 2. The result revealed that there was significantly negative correlation with wind velocity and non-significant negative correlation with maximum temperature while minimum temperature, with relative humidity, rainfall and sun-shine hours showed a non-significant positive correlation with fruit infestation by shoot and fruit borer.

While the impact of weather factor on shoot caused *Earias spp.* on Okra during *kharif*, 2017 is presented in Table 3. It revealed that there was non-significantly negative correlation of shoot infestation with maximum temperature and minimum temperature while showed a non- significant positive correlation of relative humidity, rainfall, sun-shine hours with fruit infestation by shoot and fruit borer and significantly negative correlation with wind velocity.

Following regression equation was developed to predict the incidence of Okra shoot and fruit borers, *Earias vittella*

Y (FSB) = 232.82 - 6.34 X1 + 3.21 X2 + 0.24 X3 – 1.44 X4 – 0.07X5 – 1.24 X6 – 2.64X7

The regression equation revealed that the various abiotic factors were found to be most influencing factors which contributed R^2= 0.76 (76%) variation in Okra shoot and fruit borers, *Earias vittella*

The regression equation was fitted to the study the effectiveness of weather parameters indicated that for every 1 ^{0}C decrease in maximum temperature 6.34 number of borers increased while increase in 1 ^{0}C in minimum temperature 3.21 number of borers increased. While 1 ^{0}C increase in morning relative humidity 0.24 number of borers increased. Whereas, 1 ^{0}C decrease in evening relative humidity, rainfall, sunshine hours and wind velocity decrease in 1.44, 0.07, 1.24 and 2.64 number of borers, respectively.

Conclusion

Okra is one of the succeeding cultivated crop in India**.** This central crop is infested by various insects pests but among them okra shoot and fruit borer cause severe damage resulting in lowering the yield of crop. It has been from 28th standard metrological week (SMW) to 39th standard metrological week (SMW). The population gradually increased and attained maximum (5.9 larvae/plant) in the 37th standard metrological week (SMW). **S**imple correlation worked out between the weather parameters and larval population of *Earias vittella* revealed that there was non-significant negative correlation with Minimum temperature (r = -0.162), evening relative humidity(r = -0.545) and and sunshine hour (r = -0.572) while significant negative correlation with rainfall (r = -0.610*). While maximum temperature(r = 0.513), morning relative humidity (r =-0.201) and wind velocity (r =-0.411) showed non-significant positive correlationVariations in insect population viz., borer 77% (R^2 = 0.77). Hence it can be concluded that this insect population were greatly influenced by weather parameters.

Table 1: Fluctuation in population of Okra shoot and fruit borer in relation to weather parameters at VRC, Pantnagar, during *Kharif*, 2017

Month	Date	SMW	Temperature (^{0}C)		Relative Humidity (%)		Rainfall (mm)	Sun-Shine Hrs.	Wind Velocity (km/hr.)	FSB population/plant
			Max.	Min.	0712 am	1412 pm				
July	09-15	28	33.0	26.2	89	72	052.6	05.6	4.2	0
July	16-22	29	32.0	25.5	91	76	119.2	05.9	2.8	0
July	23-29	30	30.8	24.9	89	76	125.9	06.5	3.9	0
July-Aug	30-05	31	31.7	25.7	86	69	150.8	07.1	5.5	0
Aug	06-12	32	33.0	26.3	89	70	040.2	06.8	5.7	2.1
Aug	13-19	33	32.9	25.9	93	69	100.6	03.9	4.7	4.6
Aug	20-26	34	33.1	26.3	87	67	002.4	04.7	7.8	4.8
Aug-Sept	27-02	35	34.0	25.5	89	65	026.6	03.8	5.5	4.5
Sept	03-09	36	32.7	25.3	91	68	002.4	06.2	6.2	4.9
Sept	10-16	37	32.1	24.5	89	71	059.4	04.3	4.5	5.9
Sept	17-23	38	32.7	24.2	90	66	076.6	03.6	5.9	3.9
Sept	24-30	39	32.6	23.2	87	62	003.4	02.9	8.9	2.5
Correlation			0.513^{NS}	-0.162^{NS}	0.201^{NS}	-0.545^{NS}	-0.610^{*}	-0.572^{NS}	0.411^{NS}	-
R^2 (Regression Coefficient)			0.76							

* Significant at 0.01 level; ** Significant at 0.05 level; Max- Maximum temperature; Min. - Minimum temperature; FSB- Fruit and shoot borer

Regression Equation:-

FSB: Y= 232.82- 6.34 X1+ 3.21 X2+ 0.24 X3 – 1.44 X4 – 0.07X5 – 1.24 X6– 2.64X7

Where, X_1 = Maximum Temperature, X_2 = Minimum Temperature, X_3 = Relative Humidity (Morning), X_4 = Relative Humidity (Evening), X_5 = Rainfall, X_6 = Sun-Shine Hours, X_7 = Wind velocity

Table 2: Per cent fruit infestation by shoot and fruit borer in relation to weather parameters at VRC, Pantnagar, during *kharif*, 2017

Month	Date	SMW	Temperature (^{0}C)		Relative Humidity (%)		Rainfall (mm)	Sun- Shine Hrs.	Wind Velocity (km/hr.)	Fruit Infestation (%)
			Max.	Min.	0712 am	1412 pm				
Aug	20-26	34	33.1	26.3	87	67	002.4	04.7	7.8	21.25
Aug-Sept	27-02	35	34.0	25.5	89	65	026.6	03.8	5.5	30.12
Sept	03-09	36	32.7	25.3	91	68	002.4	06.2	6.2	32.51
Sept	10-16	37	32.1	24.5	89	71	059.4	04.3	4.5	39.83
Sept	17-23	38	32.7	24.2	90	66	076.6	03.6	5.9	29.05
Sept	24-30	39	32.6	23.2	87	62	003.4	02.9	8.9	20.16
Correlation Fruit infestation (%)			-0.301^{NS}	0.045^{Ns}	0.682^{Ns}	0.797^{Ns}	0.561^{Ns}	0.367^{NS}	-0.937^{*}	

Table 3: Per cent shoot infestation by shoot and fruit borer in relation to weather parameters at VRC, Pantnagar, during *kharif*, 2017

Month	Date	SMW	Temperature (^{0}C)		Relative Humidity (%)		Rainfall (mm)	Sun- Shine Hrs.	Wind Velocity (km/hr.)	Shoot infestation (%)
			Max.	Min.	0712 am	1412 pm				
Aug	20-26	34	33.1	26.3	87	67	002.4	04.7	7.8	17.35
Aug-Sept	27-02	35	34.0	25.5	89	65	026.6	03.8	5.5	24.7
Sept	03-09	36	32.7	25.3	91	68	002.4	06.2	6.2	27.05
Sept	10-16	37	32.1	24.5	89	71	059.4	04.3	4.5	31.0
Sept	17-23	38	32.7	24.2	90	66	076.6	03.6	5.9	27.19
Sept	24-30	39	32.6	23.2	87	62	003.4	02.9	8.9	19.13
Correlation shoot infestation (%)			0.351^{NS}	0.149^{NS}	0.784^{NS}	0.661^{NS}	0.691^{NS}	0.253^{Ns}	-0.902^{*}	

* Significant at 0.01 level; ** Significant at 0.05 level, Max - Maximum temperature, Min. - Minimum temperature

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