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Role of Different Abiotic Factors Influencing Fluctuations of Fruit and Shoot Infestation Caused by *Earias vittella* on Okra (*Abelmoschus esculentus* L.)

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A B S T R A C T

Role of different abiotic factors on the temporal fluctuations of shoot and fruit infestation by *Earias vittella* on okra crop were studied under field conditions at Vegetable Research Farm, Banaras Hind University, Varanasi during *Kharif* season 2014-15 and 2015-16. Shoot infestation was observed during 37^{th} SW (one month after sowing) where as fruit infestation was observed during 39^{th} SW (6 weeks after sowing). The maximum shoot infestation has been observed at 40^{th} SW while fruit infestation was maximum at 42^{nd} S.W. Thereafter, fruit infestation was gradually declined but persisted up to third week of November. Further, shoot infestation found to have significant positive correlation with morning R.H. during 2014-15 cropping season and maximum temperature during 2015-16. Other weather parameters did not significantly influence the shoot borer damage. Further, weather parameters did not significantly influence the fruit damage by the borer during both the years.

Introduction

Vegetables contribute as an important constitute of our food supplying vitamins, carbohydrates and minerals needed for a balanced diet. Their value is important especially in under developed and developing countries like India, where malnutrition abounds (Randhawa, 1974 and Khan *et al.*, 2001).

In India vegetables are cultivated in an area of 9541 '000 ha with production of 1, 68,300 '000 MT and productivity of 17.3 MT ha^{-1}. West Bengal occupies first place in area and production of vegetables followed by Uttar Pradesh, while productivity was highest in Tamilnadu (30 MT/ha) and U.P occupies 5^{th} place (21.6 MT ha^{-1}) in productivity during 2015-16 (Indian Horticulture Database, 2015-16).

In India okra is being cultivated in an area of 507 '000 ha, with production of 5853 '000 MT, productivity of 11.5 MT ha^{-1} during 2015-16. In okra production West Bengal occupies the 1^{st} place (877 '000 MT) followed by Bihar (783.54 '000 MT) and U.P occupies the 13^{th} place (148.64 '000 MT). Okra shares 5.9 % in total vegetable area and 3.9 % of total vegetable production in India (Indian Horticulture Database, 2015-16).

Okra, commonly known as "Bhendi" or "Ladies finger", is a native of tropical and subtropical Africa (Purseglove, 1984). It has been grown in the Mediterranean region as well as in the tropical and sub tropical regions of the world (Alam and Hossain, 2008). 'Okra' is fat and cholesterol free, very low in sodium, low in calories, and good source of vitamin A, vitamin C, vitamin B6 and of the thiamin. Okra green fruits contain water (88%), carbohydrate (7.7%), protein (2.2%), calcium (0.09%), phosphorus (0.04%), iron (0.0051%), vitamin A-58 IU, vitamin B- 63 IU and vitamin C 16 mg/100g (Baloch *et al*., 1990).

The crop, however, is vulnerable to attack of important insect pests, among which fruit borer (*Earias vittella* Fabricius) is the most important pest causing direct damage to marketable fruits. It alone is reported to cause 57.1 per cent fruit infestation and 54.04 per cent net yield loss in okra (Chaudhary and Dadheech, 1989). *Earias* spp. are distinguished from other pests of okra by their marked tendency for stem boring. The larvae enter the terminal bud of vegetable shoot and channel down from the growing point. Severe attack, results in the wilting of top leaves and collapsing of the main stem. The larvae also bore into the flower buds, flowers and fruits of the crop. According to an estimate this pest can cause 36-90% loss in fruit yield of okra (Misra *et al*., 2002).

There are many abiotic factors that favour the growth, development and reproduction of various insect pests including *E. vittella*, thus limiting the production of okra thus limit the production of okra. Present studies have been conducted to record the incidence of shoot and fruit infestation during okra cropping season in accordance with seasonal fluctuations of various abiotic factors and the results thus obtained may be useful for formulating sustainable management practices of *E. vittella* on okra crop.

Materials and Methods

An area of 50 m^2 was raised with local susceptible okra variety "VRO-6" to study the role of different abiotic factors on population fluctuation and fruit and shoot infestation caused by *Earias vittella* during *Kharif* season, 2014-15 and 2015-16 at Vegetable Research Farm, BHU, Varanasi. Okra seeds were sown at a distance of 60 x 30 cm. The experimental plot was kept unsprayed during the course of investigation and all agronomical practices were adopted to render suitable crop growth.

The shoot and fruit infestation was recorded in this un-protected plot of okra at 7 days interval from the occurrence or initiation of the pest infestation and was continued up to end of the crop. A total of 25 plants from five locations in the bulk plot @ 5 plants per each sampling area were selected and tagged for recording the observations on per cent shoot and fruit infestation. Total number of shoots along with the infested ones were counted and expressed as per cent shoot infestation at different sampling dates. During each picking carried out at weekly intervals, per cent fruit infestation was determined by counting total number of fruits along with the infested ones.

Per cent shoot infestation =

$$\frac{\text{Number of damaged shoots}}{\text{Total number of shoots}} X\ 100$$

Per cent fruit infestation =

$$\frac{\text{Number of damaged fruits}}{\text{Total number of fruits}} X\ 100$$

Weather data has been collected from the metrological observatory available at Agriculture Research Farm, Institute of Agricultural Sciences, BHU, Varanasi and correlated with the per cent shoot and fruit infestation. Among weather parameters, relative humidity, temperature, rainfall and sunshine hours were considered for correlating with the occurrence of the per cent shoot and fruit infestation of okra. To work out the relationship between the occurrence of the per cent shoot and fruit infestation of okra and the weather parameters, simple correlation method suggested by Pearson (1896) was adopted.

Results and Discussion

Impact of abiotic factors on the fluctuations of shoot infestation

The incidence and severity shoot infestation caused by *E. vittella* on okra crop along with meteorological observations during *Kharif* season 2014-15 has been presented in table 1 and figure 1. The data showed that the shoot infestation by *E. vittella* first appeared one month after sowing *i.e.* 37^{th} S.W with mean per cent infestation of 5.00. Thereafter, shoot infestation was gradually raised and attained the peak (23.33%) during 40^{th} S.W *i.e.*, 1^{st} week of October, after that the population gradually declined and disappeared after 42 S.W.

The corresponding meterological parameters during peak shoot infestation were observed as maximum temperature 32.20 ^{0}C, minimum temperature 24.20 ^{0}C, morning R.H. 91.00%, evening R.H. 64.00% and sunshine hours 6.30 hours and there was no rainfall during this period.

The simple correlation was worked out between weather factors and infestation of shoot during *Kharif* season 2014-15 and presented in table 1 and figure 1 revealed that there was no significant impact of weather factors on shoot damage except one *i.e.* morning R.H. that exhibited a positive significant correlation with shoot infestation (r = 0.725).

During second season also the incidence of the pest on shoots was recorded at weekly interval throught the crop duration and based on data, the percentage was worked out. The data presented in table 2 and figure 2 indicated that during *Kharif* season 2015-16 the damage of *E.vittella* to shoots was observed from four weeks after sowing *i.e.* 37^{th} S.W (2^{nd} week of September) to 42^{nd} S.W (3^{rd} week of October). As high as 21.67% shoot infestation was recorded in 40^{th} S.W. (1^{st} week of October).

It is also evident from the table 2 and figure 2 that, maximum temperature (r = 0.649) had significant positive influence on the infestation of shoot borer during *Kharif* season 2015-16 while other factors had non-significant impact.

Mandal *et al.*, (2006) and Zala *et al.*, (1999) reported the activity of shoot borer in the field at four weeks after sowing. The present results were also found to be in close association with results obtained by Shukla *et al.*, (1997) who reported that, initial shoot infestation occurred 3 weeks after sowing. These results are more or less similar with earlier findings made by Chandra and Singh (2012) who reported that the peak mean per cent shoot infestation was observed as 20.20%.

Mandal *et al.*, (2006) and Aziz *et al.*, (2009) while working out the influence of weather parameters on population fluctuations and subsequent degree of damage, reported that shoot infestation was significantly positively correlated with relative humidity and maximum temperature, respectively. The present results are in close accordance with Aziz *et al.*, (2011) who observed that shoot infestation exhibited a negative correlation with rainfall.

Table.1 Impact of abiotic factors on seasonal incidence of shoot infestation on okra during 2014-15

S.W	Month and Date	Temperature (^{0}C)		Relative Humidity (%)			Rainfall (mm)	Sunshine (Hours)	Average* per cent infestation	
		Max.	Min.	Morn.	Even.	Avg.			Shoot	Fruit
35	Aug 27-Sep 02	33.00	27.10	84.00	71.00	77.50	6.50	6.00	0.00	0.00
36	Sep 03-09	32.70	26.40	85.00	69.00	77.00	34.90	5.30	0.00	0.00
37	Sep 10-16	31.90	25.80	86.00	80.00	83.00	11.00	4.00	5.00	0.00
38	Sep 17-23	33.30	26.00	87.00	72.00	79.50	13.70	5.20	11.67	0.00
39	Sep 24-30	33.40	24.30	90.00	56.00	73.00	2.10	8.40	16.67	7.58
40	Oct 01-07	32.20	24.20	91.00	64.00	77.50	0.00	6.30	23.33	11.73
41	Oct 08-14	31.20	24.00	88.00	68.00	78.00	50.70	6.10	15.00	15.34
42	Oct 15-21	29.80	19.80	88.00	69.00	78.50	0.00	7.20	11.67	26.84
43	Oct 22-28	29.80	19.20	83.00	58.00	70.50	6.20	6.80	6.67	22.05
44	Oct 29-Nov 04	30.40	18.00	85.00	41.00	63.00	0.00	6.80	0.00	18.02
45	Nov 05-11	31.40	16.30	86.00	39.00	62.50	0.00	6.80	0.00	14.63
46	Nov12-18	27.50	13.60	83.00	37.00	60.00	0.00	5.40	0.00	6.28
Correlation coefficient (r)						Maximum Temperature (0C)			0.381	-0.18
						Minimum Temperature (0C)			0.595	0.140
						Morning Relative Humidity (%)			0.725*	0.079
						Evening Relative Humidity (%)			0.555	0.534
						Average Relative Humidity (%)			0.628	0.480
						Rainfall (mm)			-0.327	-0.56
						Sunshine (Hours)			0.365	-0.34

Average* of three replications SW= Standard Week *Significant at $p \leq 0.05$

Table.2 Impact of abiotic factors on seasonal incidence of shoot infestation on okra during 2015-16

S.W	Month and Date	Temperature (^{0}C)		Relative Humidity (%)			Rainfall (mm)	Sunshine (Hours)	Average* per cent infestation	
		Max.	Min.	Morn.	Even.	Avg.			Shoot	Fruit
35	Aug 27-Sep 02	33.40	26.70	83.00	52.00	67.50	42.20	4.50	0.00	0.00
36	Sep 03-09	33.50	26.30	79.00	59.00	69.00	0.00	8.80	0.00	0.00
37	Sep 10-16	24.60	27.50	80.00	64.00	72.00	0.00	8.60	6.67	0.00
38	Sep 17-23	31.10	26.90	82.00	59.00	70.50	11.90	6.90	11.67	0.00
39	Sep 24-30	33.30	22.00	89.00	54.00	71.50	0.00	9.00	15.00	7.15
40	Oct 01-07	34.00	22.80	90.00	66.00	78.00	0.00	8.80	21.67	10.68
41	Oct 08-14	34.60	23.80	93.00	82.00	87.50	0.00	7.30	16.67	18.62
42	Oct 15-21	33.00	21.80	88.00	51.00	69.50	0.00	8.00	13.33	26.85
43	Oct 22-28	32.10	19.00	80.00	56.00	68.00	0.00	8.30	6.67	21.14
44	Oct 29-Nov 04	30.60	16.60	87.00	74.00	80.50	23.00	5.20	0.00	16.36
45	Nov 05-11	28.00	18.60	89.00	49.00	69.00	0.00	5.70	0.00	12.14
46	Nov12-18	30.40	16.60	86.00	40.00	63.00	0.00	7.60	0.00	5.42
Correlation coefficient (r)						Maximum Temperature (^{0}C)			0.649*	0.495
						Minimum Temperature (^{0}C)			0.591	-0.457
						Morning Relative Humidity (%)			0.366	0.342
						Evening Relative Humidity (%)			0.377	0.127
						Average Relative Humidity (%)			0.439	0.217
						Rainfall (mm)			-0.334	-0.058
						Sunshine (Hours)			0.626	-0.143

Figure.1 Impact of abiotic factors on seasonal incidence of shoot and fruit infestation (%) on okra during 2014-15

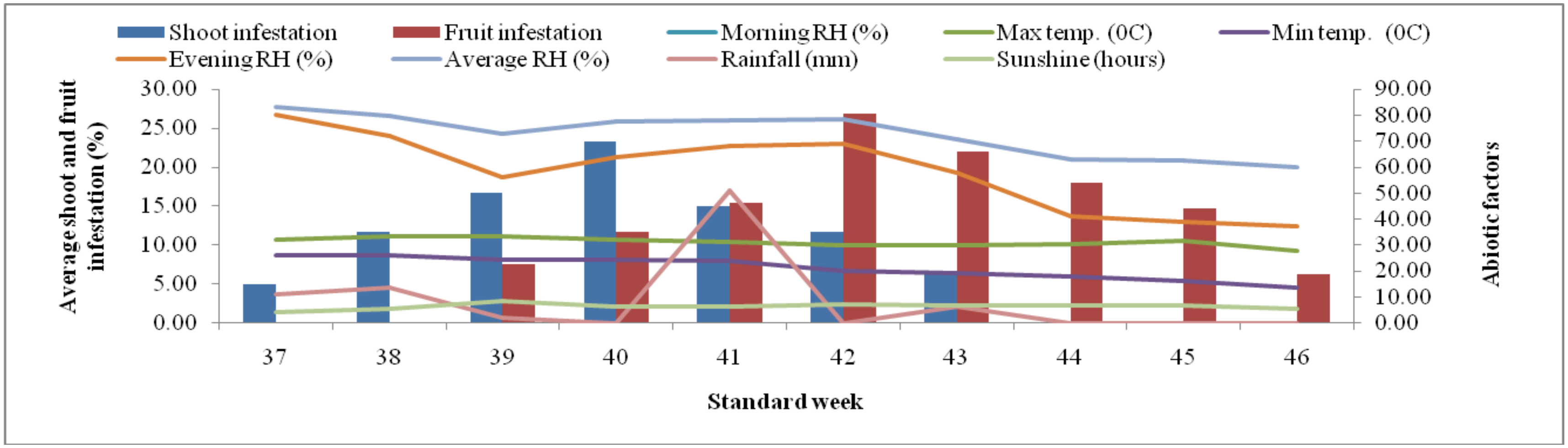
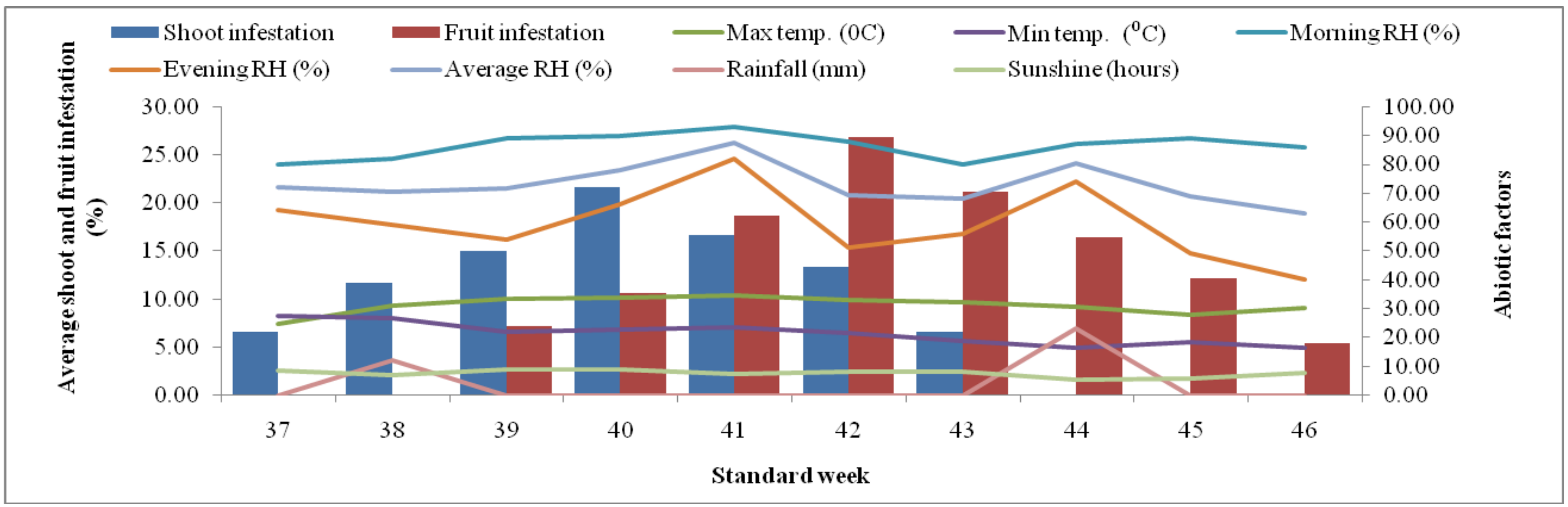


Figure.2 Impact of abiotic factors on seasonal incidence of shoot and fruit infestation (%) on okra during 2015-16



Impact of abiotic factors on the severity of fruit infestation

During 2014-15 the occurrence and intensity of fruit infestation observed was presented in table 1 and figure 1 which revealed that the damage of fruit borer started from 39th S.W (6 weeks after sowing) lasted till end of crop season *i.e.* 46th S.W (3rd week of November). The peak fruit infestation (26.84%) was reported during 42nd S.W (3rd week of October). Thereafter the fruit infestation gradually declined and attained very less infestation at 46th S.W. The maximum temperature, minimum temperature, morning R.H., evening R.H., sunshine hours during peak fruit infestation were recorded to be 29.80 ^{0}C, 19.80 ^{0}C, 88.00%, 69.00% and 7.20 hrs, respectively. There was no rainfall during peak infestation. The simple correlation was worked out between weather parameters and fruit infestation during *Kharif* season 2014-15 presented in table 1 and figure 1 revealed that there was no significant impact of weather parameters on fruit infestation.

During second year experimentation (2015-16) also fruit infestation appeared six weeks after sowing (39th S.W) with a mean per cent infestation as 7.15%. The peak fruit infestation was recorded during 42nd S.W (3rd week of October) with a mean per cent infestation as 26.85%, during this time, the maximum temperature, minimum temperature, morning R.H., Evening R.H., rainfall and sunshine hours recorded as 33.00 ^{0}C, 21.80 ^{0}C, 88.00%, 51.00%, 0.00 mm, 8.00 hrs respectively. Thereafter the fruit infestation gradually declined up to end of crop *i.e.* 3rd week of November. The effect of weather parameters on fruit infestation caused by *E.vittella* presented in table 2 and figure 2 that maximum temperature (r = 0.495), morning R.H. (r = 0.342), evening R.H. (r = 0.127) and average R.H. (r = 0.217) had non-significant, positive effect while minimum temperature (r = -0.457), rainfall (r = -0.058) and sunshine hours (r = -0.143) had non-significant but negative impact with fruit infestation.

The present findings were in partial agreement with those of Yadav *et al.*, (2007) and Singh *et al*. (2015) who reported that fruit infestation commenced on five weeks old crop. Singh *et al.*, (2015) also reported that fruit infestation prevail in field up to nine weeks old crop, these results are also nearly similar with the present findings. The present results are also corroborated with the results of Pareek *et al.*, (2001) who reported that fruit infestation started in the month of September and peak infestation was observed in third week of October. The present results are in close association with Singh *et al.*, (2015) and Nath *et al.*, (2011) who reported that temperature and related humidity exhibited non-significant and positive correlation with fruit infestation. Further Kumar and Urs (1988) reported a negative non-significant correlation between rain fall and fruit infestation.

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