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Seasonal incidence and management of okra shoot and fruit borer, *Earias vittella* (Fabricius)

MG Nandaniya, HV Patel and SK Chawda

Abstract

Studies were carried out on "Seasonal incidence and management of okra shoot and fruit borer, *Earias vittella* (Fabricius)" on okra (GAO 5) at N. M. College of Agriculture, Navsari Agricultural University, Navsari during summer 2022. The shoot infestation commenced from 4^{th} week after sowing (9^{th} SMW) with maximum (25.71%) in 9^{th} week after sowing (14^{th} SMW). Whereas, fruit infestation noticed from 6^{th} week after sowing (11^{th} SMW) with maximum (40.20%) in 11^{th} week after sowing (16^{th} SMW). Shoot damage showed positive and significant correlation with maximum temperature (0.509), while fruit damage was found positive and highly significant correlation with minimum temperature (0.685). Shoot damage exhibited negative and non-significant correlation with morning relative humidity (-0.030) and wind velocity (-0.286). Among the different insecticides, spinosad 45 SC (0.018%) was the best treatment and recorded significantly lowest fruit damage (8.05%), which was at par with chlorantraniliprole 18.5 SC (0.005%) and lambda-cyhalothrin 4.90 CS (0.003%) having 8.85 and 9.17 per cent fruit damage, respectively. Treatment pyridalyl 10 EC (0.01%) was found least effective against fruit borer (13.96%).

Keywords: Okra, shoot and fruit borer, *Earias vittella* (Fabricius), Seasonal incidence, population dynamics, management, insecticides and spinosad 45 SC

Introduction

Okra, *Abelmoschus esculentus* (L.) Moench is one of the most important vegetable crops has its own importance, on account of its taste, flavour and nutritional values as human food grown in tropical and sub-tropical parts of the world. It is quite popular in India because of easy cultivation, dependable yield and adaptability to varying moisture conditions. Okra is good source of vitamin A, B, C and also rich in calcium, phosphorus, potassium, protein, carbohydrates, fats, minerals, iron and iodine (Baloch *et al*., 1990) [4]. Gujarat, Maharashtra, Andhra Pradesh, Uttar Pradesh, Tamil Nadu, Karnataka, Haryana and Punjab are the most prominent okra growing states in India, where it is grown as a *kharif* and summer season crop. It is grown on 5.44 lakh hectares in India, with an annual production of 64.94 lakh tonnes and a productivity of 11.93 tonnes per hectare (Anon., 2021) [3]. The area, production and productivity of Gujarat are 85,145 hectares, 10,19,422 tonnes and 11.97 tonnes per hectare, respectively (Anon., 2020) [2]. According to Dhamdhere *et al.* (1984) [8], the crop is attacked by several species of insect pests causing considerable damage. All the plant stages are susceptible to insect pests and more than seventy two species of insect pests have been recorded on okra crop (Naik *et al*., 2012) [15]. Incidence of insect pests is one of the prime factors in lower production of okra. Among various insect pests, shoot and fruit borer commonly known as spotted bollworm is the most destructive one, as it causes direct loss of okra fruits. Mainly two species *viz*., *E. vittella* and *E. insulana* are found to cause serious damage to the crop but *E. vittella* is the predominant species in Gujarat. *E. vittella* is an oligophagous pest and its main hosts are okra and cotton. It is also found feeding on a large number of cultivated and wild malvaceous plants species. The pest is active almost the year round and prefers high humidity and high temperature for its growth and development. In India, an estimated loss of 69.00 per cent in marketable yield was due to attack of this insect on okra alone (Ray *et al*., 2019) [18]. The incidence of *E. vittella* shows violent fluctuations due to changes in the climatic conditions. Information on impact of abiotic factors on incidence of *E. vittella* is very useful for management of this pest under South Gujarat Agro-climatic Zone. The seasonal incidence study will help to determine the relation between the weather factors and population of this pest. It is a fact that farmers have to depend upon synthetic insecticides for the control of this pest.

The study of efficacy of some newer insecticides will be helpful in finding out the best chemical for managing the *E. vittella*. Keeping in view the importance of okra and incidence of shoot and fruit the present work was carried out to know the seasonal incidence and effective management through different insecticides in field condition and results obtained were documented here under.

Materials and Methods

Methodology

All the recommended agronomical practices were followed. However, experimental area was kept free from insecticide spray throughout the crop season in order to record the incidence of shoot and fruit borer. To find out the incidence of shoot and fruit borer on okra, fifty plants were randomly selected and tagged from the entire experimental area. Population of okra shoot and fruit borer was record at weekly interval from tagged plant after as soon as it started infesting shoot and continued till the harvest of the crop. Shoot and fruit borer being an internal feeder of shoot and fruit in okra so larval population was not recorded. Therefore, per cent shoot damage was worked out on the basis of number of healthy and damage shoots from all the fifty tagged plants (Photo 1). Thus, data obtain was converted to per cent shoot damage. The infestations of fruits were observed at each picking. Yield of healthy and damage fruits were record separately at each picking from all the fifty tagged plants (Photo 2). The data obtained was converted to per cent fruit damage and the statistically analyze.

$$\text{Per cent shoot damage} = \frac{\text{Total number of damage shoots}}{\text{Total number of shoots}} \times 100$$

$$\text{Per cent fruit damage} = \frac{\text{Total number of damage fruits}}{\text{Total number of fruits}} \times 100$$

Correlation with Weather Parameters

Data on maximum and minimum temperatures (°C), morning and evening relative humidity (%), sunshine hours (hrs.) and wind speed (km/hrs.) recorded at the Meteorological observatory, College farm, Navsari Agricultural University, Navsari were used to study the effect of weather parameters on population dynamics of shoot and fruit borer. The simple correlation coefficients were worked out between pest population and various weather parameters.

$$\text{Correlation coeficient } (r_{xy}) = \frac{\text{Cov (XY)}}{\sqrt{\text{var(x) var(y)}}}$$

Where,
r = correlation coefficient,
Cov(XY) = Covariance of the characters X and Y,
Var (x) and Var (y) = Variance of the characters of X and Y, respectively.

Effectiveness of different insecticides against shoot and fruit borer of okra

Details of Insecticide Treatments

Tr. No.	Insecticides	Concentration (%)	Dose (ml/10 l of water)
T_1	Thiacloprid 21.7 SC	0.033	15.00
T_2	Spinosad 45 SC	0.018	4.00
T_3	Chlorantraniliprole 18.5 SC	0.005	2.50
T_4	Fenpropathrin 30 EC	0.01	3.50
T_5	Pyridalyl 10 EC	0.01	10.00
T_6	Cyantraniliprole 10.26 OD	0.018	18.00
T_7	Lambda-cyhalothrin 4.90 CS	0.003	6.00
T_8	Control (Water spray)	-	-

Methodology

All the insecticides were applied in the form of foliar spray with the help of knapsack sprayer (15-liter capacity). Spray fluid prepared by mixing measure quantity of water and insecticides. First application was given at build up sufficient population of shoot and fruit borer in okra. Similarly, the second spray was made after 15 days of first application. For taking observation, ten okra plants from each plot leaving border rows were randomly tagged for taking observation on shoot and fruit borers. Incidence of shoot and fruit borer was recorded in terms of per cent of fruit damaged by borer. For this purpose, the data on healthy and damaged fruits in numbers were recorded from each plot during each picking at before spray and 1, 3, 5, 7, 10 and 14 days after each spray from each replication.

Results and Discussion

Observations on seasonal activity of *E. vittella* were recorded on okra crop sown at ‘B’ block, College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari during summer 2022.

Photo 1: Shoot infestation by *E. vittella*

Photo 2: Fruit infestation by *E. vittella*

Shoot Damage

The weekly average per cent shoot damage are given in Table 1 and graphically depicted in fig.1. The infestation on shoot was commence from 4th week after sowing (9th SMW) to 14th week after sowing (19th SMW). The average shoot infestation ranged from 2.56 to 25.71 per cent with maximum in 14th SMW *i.e.*, the 9th week after sowing. Thus, from the result of seasonal incidence, it can be inferred that the infestation on shoot by *E. vittella* started during February and reached peak level in the month of April. In past, Dabhi *et al.* (2013) [7] found that incidence of shoot borer was found from 6th WAS (12th MSW). Whereas, Roy *et al*. (2018) [19] observed that borer activity on shoot was stated in 4th WAS and peak was found during 9th WAS. Ankur *et al*. (2022) [1] reported that shoot damage started after 4th week of sown. Thus, above worker found more or less similar result.

Table 1: Population dynamics of *E. vittella*

Sr. No.	Date of observation	SMW	WAS	Shoot infestation (%)	Fruit infestation (%)
1	07-02-2022	6	1	0.00	0.00
2	14-02-2022	7	2	0.00	0.00
3	21-02-2022	8	3	0.00	0.00
4	28-02-2022	9	4	2.56	0.00
5	07-03-2020	10	5	5.56	0.00
6	14-03-2022	11	6	10.48	5.97
7	21-03-2022	12	7	10.95	6.25
8	28-03-2022	13	8	17.24	13.68
9	03-04-2022	14	9	25.71	17.48
10	11-04-2022	15	10	20.79	28.71
11	18-04-2022	16	11	17.22	40.20
12	25-04-2022	17	12	14.97	29.70
13	02-05-2022	18	13	11.62	23.64
14	09-05-2022	19	14	6.37	17.53
15	16-05-2022	20	15	0.00	13.48
16	23-05-2022	21	16	0.00	8.57

SMW: Standard meteorological week
WAS: Week after sowing

Table 2: Correlation coefficient of *E. vittella* with weather parameters

Parameters	Temperature		Relative humidity (%)		Wind speed (km/hrs)	Sunshine hours
	Max.	Min.	Morning	Evening		
Shoot damage	0.509*	0.327	-0.030	0.060	-0.286	0.058
Fruit damage	0.484	0.685**	0.136	0.566*	0.120	0.216

* Significant at 5% level of significant

** Significant at 1% level of significant

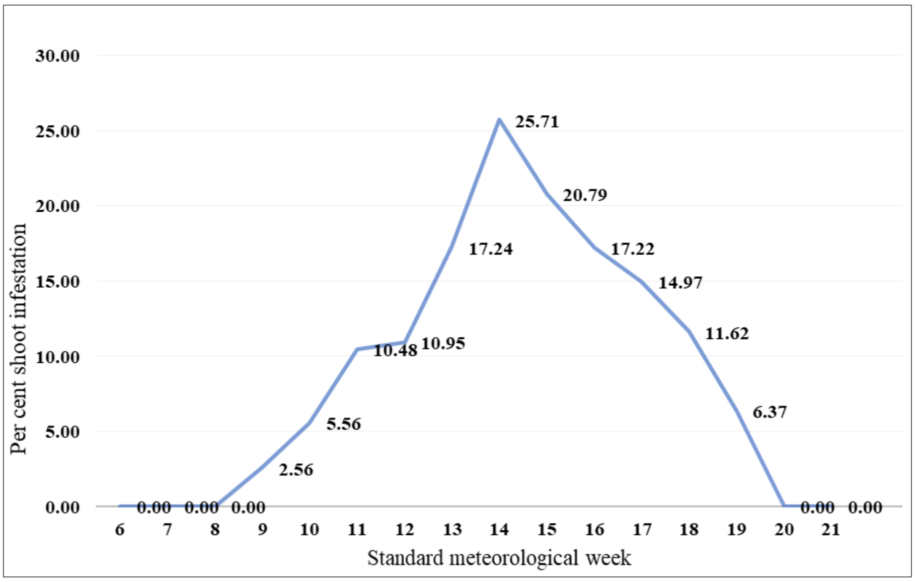


Fig 1: Population dynamics of shoot and fruit borer (shoot infestation) on okra during summer 2022

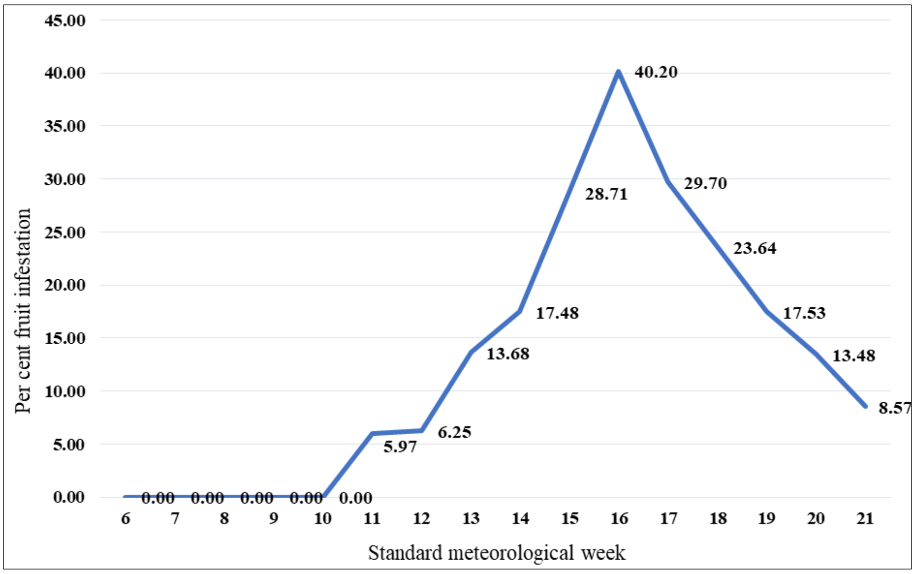


Fig 2: Population dynamics of shoot and fruit borer (fruit infestation) on okra during summer 2022

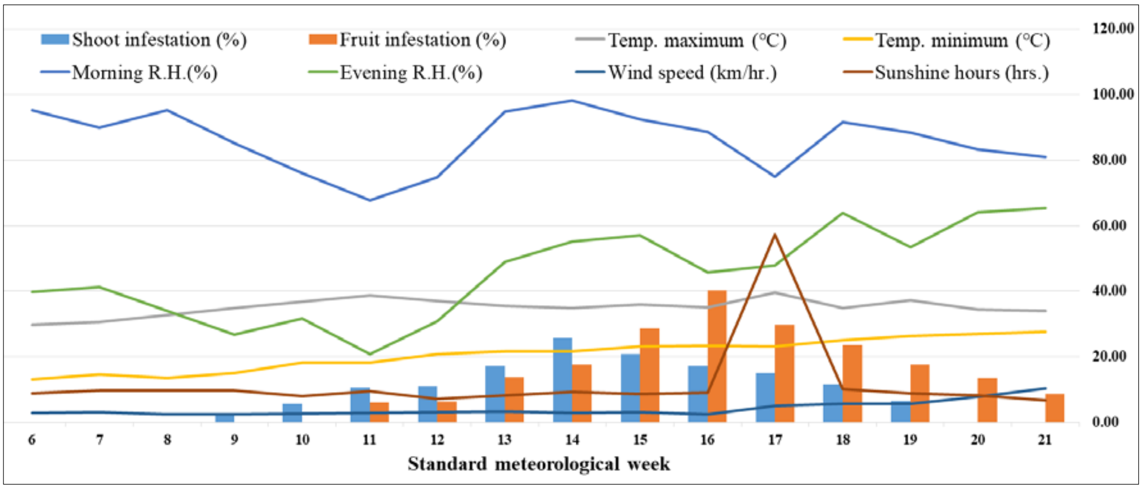


Fig 3: Population dynamics of shoot and fruit borer (shoot infestation & fruit infestation) on okra with weather parameters during summer 2022

Fruit Damage

The data presented in Table 1 and graphically depicted in fig.2 revealed that the per cent fruit infestation by *E. vittella* was started from 11th SMW *i.e.*, the 6th week after sowing with 5.97 per cent fruit damage. Fruit damage increased and reached peak (40.20%) in 16th SMW *i.e.*, the 11th week after sowing. Thereafter, the fruit damage showed declining trend but infestation continues till removal of crop. From the results of seasonal incidence, it can be inferred that infestation of fruits by *E. vittella* starting during March and reached peak level in the month of April. Dhabhi *et al.* (2013) [7] revealed that the peck fruit incidence was observed during 7th WAS (13th SMW). Ankur *et al.* (2022) [1] reported that fruit damage started after 7th week of sown okra crop. Thus, above worker found more or less similar result.

Correlation of Shoot and Fruit Borer with Weather Parameters

Correlation of shoot damage with weather parameters

The result on influence of weather parameters on shoot damage by *E. vittella* summarized in Table 2 and graphically depicted in fig. 3 indicated that the incidence of shoot damage was significant and positively correlated with maximum temperature (0.509). Whereas, it had shown positive and non-significant correlation with minimum temperature (0.327), evening relative humidity (0.060) and sunshine hours (0.058). Correlation between shoot damage and morning relative humidity (-0.030) and wind speed (-0.286) were negative and non-significant.

Thus, the present findings are in close conformity with the report of Lal *et al.* (2020) [13] who reported that the significant positive correlation was found between shoot infestation and maximum temperature. Whereas, Challa *et al.* (2020) [5] observed that positive and non-significant correlation was found with minimum temperature. Rawat *et al.* (2020) [17] found that non-significant negative correlation of okra shoot and fruit borer with morning and evening relative humidity. Pandey and Koshta (2017) [16] observed that shoot and fruit borer showed non-significant negative correlation with wind speed. Shoot damage exhibited positive and non-significant correlation with minimum temperature (Ankur *et al.*, 2022) [1].

Correlation of fruit damage with weather parameters

The data are presented in Table 2 and graphically depicted in fig. 3 indicated that minimum temperature (0.685) and evening relative humidity (0.566) were found significant and positive correlation with fruit damage. While, it exhibited positive and non-significant correlation with maximum temperature (0.484), morning relative humidity (0.136), wind speed (0.120) and sunshine hours (0.216). In past, Dhandge *et al*. (2018) [9] found highly significant and positive correlation between fruit damage and minimum temperature and evening relative humidity. While, Vastav and Yadav (2019) [20] observed that fruit damage was found non- significant and positive correlation with maximum temperature. Ankur *et al*. (2022) [1] showed that fruit infestation correlated non-significant and positive with morning relative humidity and sunshine hours. According to Mutkule *et al*. (2017) [14] found that fruit damage showed non-significant and positive correlation with wind speed.

Effectiveness of different insecticides against shoot and fruit borer of okra

First Spray

The observation of *E. vittella* on okra fruits were recorded after first and second sprays. Data on per cent fruit damage after two sprays and pooled over the period are presented in Table 3 and graphically depicted in fig. 4

The fruit infestation of okra recorded before imposing of insecticidal treatments showed non-significant results indicated uniform distribution of the *E. vittella* population.

The data on fruit infestation indicated one day after spray found non-significant among all treatment that indicated all the treatment effects are same at one day after spray. The reason behind this is that the larvae of shoot and fruit borer is internal feeder. Therefore, on first day after spraying the non-significant result was found.

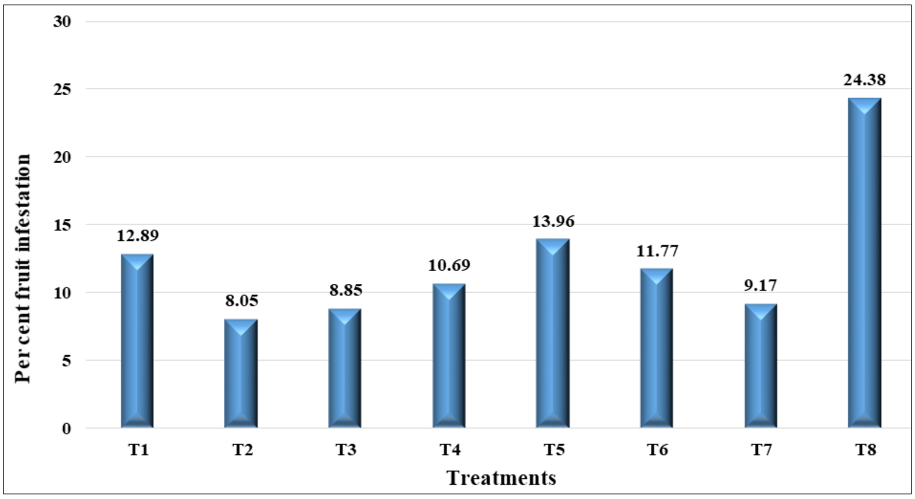
On 3rd day of spray, all the insecticidal treatments significantly reduce the fruit damage by shoot and fruit borer over control. The minimum fruit infestation (12.46%) was recorded in treatment chlorantraniliprole 0.005 per cent and it was at par with spinosad 0.018 per cent (13.43%), lambda-cyhalothrin 0.003 per cent (13.57%) and fenpropathrin 0.01 per cent (14.20%). The treatments *viz.*, cyantraniliprole 0.018 per cent (15.04%), thiacloprid 0.033 per cent (16.31%) and pyridalyl 0.01 per cent (16.56%) were found less effective. Maximum per cent fruit infestation observed in treatment control (19.00%).

The result of 5th day after spray indicated that spinosad 0.018 per cent recorded lowest fruit damage (10.80%) which was at par with chlorantraniliprole 0.005 per cent (11.95%) and lambda-cyhalothrin 0.003 per cent (12.90%). However, chlorantraniliprole 0.005 per cent was found at par with lamda-cyhalothrin 0.003 per cent (12.90%), fenpropathrin 0.01 per cent (13.83%) and cyantraniliprole 0.018 per cent (14.17%). The treatments *viz.*, thiacloprid 0.033 per cent (15.80%) and pyridalyl 0.01 per cent (16.07%) were found least effective. Maximum fruit infestation was found in control (20.68%).

Table 3: Effect of different insecticidal treatment against *E. vittella* in okra

Per cent fruit damage/plot															
Tr. No.	Treatment	BS	First spray						Second spray						Pooled mean
			1 DAT	3 DAT	5 DAT	7 DAT	10 DAT	14 DAT	1 DAT	3 DAT	5 DAT	7 DAT	10 DAT	14 DAT	
1	Thiacloprid 21.7 SC (0.033%)	24.25* (16.87)	24.14 (16.73)	23.77^{bc} (16.31)	23.38^{c} (15.80)	22.31^{cd} (14.47)	21.82^{cd} (13.87)	20.82^{cd} (12.63)	20.76^{cd} (12.57)	20.15^{cd} (11.87)	20.00^{de} (11.70)	19.26^{bc} (10.90)	18.56^{de} (10.15)	17.44^{cd} (9.00)	21.04^{cd} (12.89)
2	Spinosad 45 SC (0.018%)	22.15 (14.47)	21.96 (14.27)	21.50^{ab} (13.43)	19.18^{a} (10.80)	18.26^{a} (9.83)	17.34^{a} (8.90)	15.99^{a} (7.60)	15.79^{a} (7.42)	15.44^{a} (7.10)	14.75^{a} (6.50)	14.00^{a} (5.87)	12.47^{a} (4.67)	11.13^{a} (3.73)	16.48^{a} (8.05)
3	Chlorantraniliprole 18.5 SC (0.005%)	21.94 (13.96)	21.64 (13.60)	20.65^{a} (12.46)	20.21^{ab} (11.95)	18.77^{ab} (10.37)	18.29^{ab} (9.87)	16.98^{a} (8.57)	16.93^{ab} (8.52)	16.38^{ab} (7.98)	15.69^{a} (7.33)	15.39^{a} (7.07)	14.01^{ab} (5.90)	12.73^{ab} (4.87)	17.31^{ab} (8.85)
4	Fenpropathrin 30 EC (0.01%)	22.56 (14.74)	22.48 (14.64)	22.12^{ab} (14.20)	21.83^{abc} (13.83)	20.83^{bc} (12.67)	20.21^{bc} (11.93)	19.02^{bc} (10.63)	18.85^{bc} (10.45)	18.18^{bc} (9.73)	17.92^{bc} (9.47)	17.36^{b} (8.90)	15.73^{bc} (7.38)	14.37^{b} (6.17)	19.08^{bc} (10.69)
5	Pyridalyl 10 EC (0.01%)	24.12 (16.82)	24.03 (16.70)	23.93^{bc} (16.56)	23.54^{c} (16.07)	23.21^{d} (15.63)	22.73^{d} (15.00)	22.09^{d} (14.22)	22.00^{d} (14.10)	21.52^{d} (13.52)	21.45^{e} (13.43)	20.89^{c} (12.77)	19.52^{e} (11.20)	18.36^{d} (9.93)	21.94^{d} (13.96)
6	Cyantraniliprole 10.26 OD (0.018%)	23.50 (15.93)	23.29 (15.66)	22.79^{abc} (15.04)	22.10^{bc} (14.17)	21.41^{cd} (13.33)	21.02^{cd} (12.87)	20.09^{c} (11.80)	19.93^{c} (11.62)	19.17^{c} (10.80)	18.99^{cd} (10.60)	18.27^{b} (9.83)	17.39^{cd} (8.93)	16.28^{c} (7.87)	20.06^{cd} (11.77)
7	Lambda- cyhalothrin 4.90 CS (0.003%)	21.98 (14.03)	21.90 (13.93)	21.60^{ab} (13.57)	21.04^{abc} (12.90)	19.16^{ab} (10.83)	18.38^{ab} (9.97)	17.37^{ab} (8.93)	17.31^{ab} (8.87)	16.40^{ab} (8.00)	16.05^{ab} (7.67)	15.32^{a} (7.03)	14.26^{ab} (6.10)	12.81^{ab} (4.98)	17.63^{ab} (9.17)
8	Control (Water Spray)	23.60 (16.03)	24.59 (17.33)	25.83^{c} (19.00)	27.05^{d} (20.68)	28.02^{e} (22.08)	28.97^{e} (23.47)	29.81^{e} (24.72)	29.99^{e} (25.00)	30.69^{e} (26.07)	31.40^{f} (27.17)	31.96^{d} (28.03)	32.83^{f} (29.40)	33.90^{e} (31.13)	29.59^{e} (24.38)
S. Em ± T		1.05	1.09	0.96	0.82	0.81	0.75	0.62	0.63	0.65	0.64	0.64	0.64	0.62	0.42
P		-	-	-	-	-	-	-	-	-	-	-	-	-	0.12
(P × T)		-	-	-	-	-	-	-	-	-	-	-	-	-	0.34
C. D. at 5% T		NS	NS	2.90	2.48	2.45	2.27	1.88	1.89	1.95	1.93	1.92	1.94	1.87	1.22
P		-	-	-	-	-	-	-	-	-	-	-	-	-	0.33
(P × T)		-	-	-	-	-	-	-	-	-	-	-	-	-	0.94
C.V.%		7.93	8.20	7.28	6.37	6.51	6.17	5.31	5.36	5.66	5.66	5.77	6.14	6.26	12.49

* Figures in the parenthesis are original value while those outside parentheses are arcsine transformed value
BS- Before spray, DAT- Days after treatment, NS- Non-significant
In each column means followed by same alphabet are not statistically different from each other



T1- Thiacloprid 21.7 SC, T2- Spinosad 45 SC, T3- Chlorantraniliprole 18.5 SC, T4- Fenpropathrin 30 EC, T5- Pyridalyl 10 EC, T6- Cyantraniliprole 10.26 OD, T7- Lambda-cyhalothrin 4.90 CS, T8- Control

Fig 4: Per cent fruit damage by *E. vittella* in okra (Pooled)

On 7th day after spray, fruit infestation was ranged from 9.83 to 22.08 per cent. Minimum infestation (9.83%) was recorded in spinosad 0.018 per cent and it was statistically at par with chlorantraniliprole 0.005 per cent (10.37%) and lambda-cyhalothrin 0.003 per cent (10.83%). Moreover, next effective treatments *viz.*, fenpropathrin 0.01 per cent, cyantraniliprole 0.018 per cent, thiacloprid 0.033 per cent and pyridalyl 0.01 per cent were recorded 12.67, 13.33, 14.47 and 15.63 per cent, respectively. Maximum fruit damage (22.08%) was found in control.

On 10th day after spray, the application of spinosad 0.018 per cent recorded minimum fruit borer infestation (8.90%) and it was at par with chlorantraniliprole 0.005 per cent (9.87%) and lambda-cyhalothrin 0.003 per cent (9.97%). Followed by fenpropathrin 0.01 per cent, cyantraniliprole 0.018 per cent, thiacloprid 0.033 per cent and pyridalyl 0.01 per cent were recorded 11.93, 12.87, 13.87 and 15.00 per cent, respectively.

The data recorded on 14th day after spray, the application of spinosad 0.018 per cent recorded lowest fruit damage (7.60%), which was at par with chlorantraniliprole 0.005 per cent (8.57%) and lambda-cyhalothrin 0.003 per cent (8.93%). The next effective treatment was fenpropathrin 0.01 per cent (10.63%) and it was at par with cyantraniliprole 0.018 per cent (11.80%) and thiacloprid 0.033 per cent (12.63%). Maximum fruit infestation was found in control (24.72%).

Second Spray

One day after spray, fruit infestation was ranged from 7.42 to 25.00 per cent. Minimum fruit infestation (7.42%) was observed in treatment spinosad 0.018 per cent and it was statistically at par with treatment chlorantraniliprole 0.005 per cent (8.52%) and lambda-cyhalothrin 0.003 per cent (8.87%). Pyridalyl 0.01 per cent was found lest effective treatments (14.10%). Maximum fruit damage recorded in control (25.00%).

The data recorded on 3rd day after spray revealed that spinosad 0.018 per cent showed lowest fruit damage (7.10%) and it was at par with chlorantraniliprole 0.005 per cent (7.98%) and lambda-cyhalothrin 0.003 per cent (8.00%). Thiacloprid 0.033 per cent (11.87%) and pyridalyl 0.01 per cent (13.52%) were found least effective treatments against fruit borer. Maximum fruit infestation (26.07%) was recorded in control.

On 5th day after spray, spinosad 0.018 per cent recorded minimum fruit infestation (6.50%), which was at par with chlorantraniliprole 0.005 per cent (7.33%) and lambda-cyhalothrin 0.003 per cent (7.67%). The next effective treatment was fenpropathrin 0.01 per cent (9.47%) and it was at par with cyantraniliprole 0.018 per cent (10.60%). Pyridalyl 0.01 per cent was found least effective treatment (13.43%). The highest fruit damage percentage (27.17%) was recorded in control.

The data recorded on 7th day after spray indicated that spinosad 0.018 per cent was recorded lowest fruit damage (5.87%) and it was statistically at par with treatment lambda-cyhalothrin 0.003 per cent (7.03%) and chlorantraniliprole 0.005 per cent (7.07%). The next effective treatments were fenpropathrin 0.01 per cent (8.90%) and cyantraniliprole 0.018 per cent (9.83%). The treatments *viz*., thiacloprid 0.033 per cent (10.90%) and pyridalyl 0.01 per cent (12.77%) were found least effective. Maximum fruit infestation (28.03%) was found in control.

On 10th day after spray, lowest fruit damage (4.67%) was found in treatment spinosad 0.018 per cent and it was at par with chlorantraniliprole 0.005 per cent (5.90%) and lambda-cyhalothrin 0.003 per cent (6.10%). The next effective treatment was fenpropathrin 0.01 per cent (7.38%), which was at par with cyantraniliprole 0.018 per cent (8.93%). The treatments *viz*., thiacloprid 0.033 per cent (10.15%) and pyridalyl 0.01 per cent (11.20%) were recorded least effective but superior over control (29.40%).

The data recorded on 14th day after spray indicated that spinosad 0.018 per cent recorded significantly lower fruit damage (3.73%) and it was at par with chlorantraniliprole 0.005 per cent (4.87%) and lambda-cyhalothrin 0.003 per cent (4.98%). The next effective treatment was fenpropathrin 0.01 per cent (6.17%). The treatments *viz*., thiacloprid 0.033 per cent (9.00%) and pyridalyl 0.01 per cent (9.93%) were found least effective. Maximum fruit damage was recorded in control (31.13%).

The Pooled Data

The result of the pooled data (Table 3 and fig.4) indicated that significantly lower fruit damage (8.05%) was recorded in the spinosad 0.018 per cent and it was at par with chlorantraniliprole 0.005 per cent (8.85%) and lambda-cyhalothrin 0.003 per cent (9.17%). The next effective treatment was fenpropathrin 0.01 per cent (10.69%) which was at par with cyantraniliprole 0.018 per cent (11.77%) and thiacloprid 0.033 per cent (12.89%). The least effective treatment was pyridalyl 0.01 per cent (13.96%). The maximum (24.38%) fruit damage was recorded in control.

Results of two spray and polled data clearly indicated that among the seven insecticides used to control of fruit damage by okra shoot and fruit borer, *E. vittella* in the present investigation, spinosad 0.018 per cent found best insecticide and recorded minimum fruit damage followed by chlorantraniliprole 0.005 per cent, lambda-cyhalothrin 0.03 per cent, fenpropathrin 0.01 per cent, cyantraniliprole 0.018 per cent, thiacloprid 0.033 per cent and pyridalyl 0.01 per cent. The result is closely conforming with the finding of Kumar *et al*. (2017) [12] and Choudhury *et al*. (2021) [6] reported that spinosad 45 SC was found superior against *E. vittella*. Whereas, Ghuge *et al.* (2020) [10] found that that chlorantraniliprole 18.5 SC recorded minimum mean per cent fruit infestation and it was at par with spinosad 45 SC. Kaur and Chandi (2021) [11] reported that mean per cent infestation of okra shoot and fruit borer was lower in chlorantraniliprole 18.5 SC.

Conclusions

The infestation on shoot was commenced from 4th week after sowing (9th SMW) with maximum (25.71%) in 9th week after sowing (14th SMW). Whereas, fruit infestation was noticed from 6th week after sowing (11th SMW) with maximum (40.20%) in 11th week after sowing (16th SMW). Shoot damage exhibited positive and significant correlation with maximum temperature, while fruit damage was found positive and significant correlation with minimum temperature. Shoot damage exhibited negative and non-significant correlation with morning relative humidity (-0.030) and wind speed (-0.286).

Among the different insecticides, spinosad 45 SC (0.018%) was the best treatment and recorded significantly lower fruit damage (8.05%), which was at par with chlorantraniliprole 18.5 SC (0.005%) and lambda-cyhalothrin 4.90 CS (0.003%) and recorded 8.85 and 9.17 per cent fruit damage, respectively. Treatment pyridalyl 10 EC (0.01%) was recorded least effective against frit borer (13.96%). The maximum fruit damage was found in control (24.38%).

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Appendix 1: Meteorological data recorded at Agricultural Meteorological Cell, N.A.U., Navsari during experimental period

Sr. No.	SMW	Temperature (°C)		Relative humidity (%)		Wind speed (km/hr.)	Sunshine hours
		Max.	Min.	Morning	Evening		
1	6	29.6	13.0	95	40	2.7	8.8
2	7	30.6	14.6	90	41	3.0	9.7
3	8	32.7	13.4	95	34	2.3	9.7
4	9	34.9	15.1	85	27	2.4	9.7
5	10	36.8	18.3	76	32	2.6	7.9
6	11	38.7	18.1	68	21	2.8	9.5
7	12	36.9	20.9	75	31	3.0	7.1
8	13	35.5	21.5	95	49	3.2	8.2
9	14	34.8	21.6	98	55	2.8	9.2
10	15	35.9	23.1	93	57	3.1	8.6
11	16	35.2	23.3	89	46	2.4	9.0
12	17	39.5	23.2	75	48	4.9	57.3
13	18	34.9	25.1	92	64	5.7	10.2
14	19	37.2	26.3	88	53	5.6	8.8
15	20	34.3	27.0	83	64	7.8	8.2
16	21	33.9	27.7	81	65	10.2	6.7
17	22	33.8	27.8	81	63	10.3	6.9