International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(6): 1527-1533

Received: 26-08-2020
Accepted: 12-10-2020

VR Tathode
Post Graduate Student, Department of Agricultural Entomology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

RS Wasu
Post Graduate Student, Department of Agricultural Entomology, Mahatama Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India

Uttarwar Sai Prasoona
Post Graduate Student, Department of Agricultural Entomology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Dr. SK Aherkar
Professor of entomology, Department of Agricultural Entomology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Corresponding Author:
VR Tathode
Post Graduate Student, Department of Agricultural Entomology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Evaluation of effect of non-pesticidal methods against shoot and fruit borers of okra in comparison with chemical control

VR Tathode, RS Wasu, Uttarwar Sai Prasoona and Dr. SK Aherkar

DOI: https://doi.org/10.22271/chemi.2020.v8.i6v.10979

Abstract
The field experiment was carried out to investigate effect of some phototropical, mechanical and botanical control measures in comparison with chemical treatment against okra shoot and fruit borers on okra under field condition during *kharif*, 2019. The minimum shoot infestation due to *Earias vittella* were reported in Recommended insecticidal spray (Ist Spray and IIIrd Spray with Imidacloprid 17.8% SL, IInd Spray and IVth Spray with Fenvalerate 20% EC) which was at par with non-pesticidal treatment Removal of infested shoots + Light Traps + NSE (5%) + Yellow sticky trap followed by treatment Light traps + NSE (5%) and Removal of infested shoots + Light traps + Yellow sticky trap. While minimum fruit damage on number as well as weight basis due *Earias vittella* and *Helicoverpa armigera* were also observed in above order of treatments.

Keywords: Fenvalerate, Imidacloprid, Light trap, NSE 5%, Okra shoot and fruit borer, *Helicoverpa armigera*

Introduction
Okra, *Abelmoschus esculentus* (L.) Moench a tall growing vegetable belongs to family Malvaceae, an economically important vegetable crop grown in tropical and sub-tropical parts of the world. Whose *A. esculentus* (L.) Moench species are cultivated commercially in India. Okra fruits are principally good source of vitamins A, B and C with traces of zinc, calcium, Iron, Iodine minerals. It possesses diuretic properties with iodine control goiter, genitourinary disorders and also manages diabetes and many. Besides these it's fibres and stalks are used in paper industry (Singh *et al*., 2014) [14] and it' seed used as substitute for coffee in some countries (Gemede *et al*., 2015) [4]. In India okra has been cultivated since 12th century BC during *Kharif*, *rabi* and *summer* season. At present okra is cultivated on an area of 5,09,020 ha with an annual production 60,94,940 MT with productivity of 12 MT/ha in India. The major okra producing states are Gujrat, Maharashtra, Andhra Pradesh, Uttar Pradesh, Bihar, Orissa, West Bengal, Karnataka and Assam. In Maharashtra, okra occupies prominent position covering an area of 13.98 thousand ha with an annual production of 139.40 thousand MT with productivity 9.97 MT/ha in 2017-18and mainly grown in Pune, Jalgaon, Thane, Nashik, Satara, Aurangabad, Solapur, Dhule and Osmanabad districts (Anonymous, 2018) [1].
The major cause of low productivity is damage inflicted by insect pest from early time to maturity. The pest complex of okra varies from region to region and the number of recorded species ranges from 13 to 72 species of insects of infesting on okra depending on the agro-climatic conditions. Along with damage due to sucking pests majorly fruit borers of okra are extremely damaging including *Earias* spp. and *Helicoverpa armigera* (Hubner). The recorded yield losses are up to 36 to 90 per cent due to *Earias* spp. (Meenambigai *et al*., 2017) [10]. There are two species of shoot and fruit borer *Earias vittella* Fabricius and *Earias insulana* Boisduval which are notorious and cause more than 40-50 per cent losses to okra in various parts of India. *Helicoverpa armigera* (Hubner) is alone reported to cause damage to the extent of 3.5 to 90 per cent to okra in different parts of the country. In general, the overall damage due to insect pests accounts to 48.97 per cent loss in fruit yield (Subbireddy *et al*., 2018) [15]. Majorly to manage these pests there is abusive use of broad spectrum chemicals which lead to tribulations of resistance, resurgence of secondary pest, phyto-toxicity, toxicity to beneficial

organisms, intoxication of farm personnel and environmental pollution. During recent years, the problems of pesticide residues in harvested produce of okra assume importance. The surging concern towards environmental security and pesticide residue free food push up interest of farmers towards organic farming. Although use of insecticides cannot be exclude completely as it play a major role in management strategies. So it become need of an hour to look towards safer technique to manage pest effectively.

By considering all this facts, present study was executed to study the effects of photo-tropical, mechanical and botanical control measures for effective management of shoot and fruit borers of okra.

Materials and method

The present investigation was conducted at Department of Vegetable Science, Dr. PDKV, Akola during *kharif* 2019. The experiment was randomized block design with 9 treatment and six replication. In which PDKV-Pragati variety was sown at 60*45 cm^2 in gross plot size of 5.4*5.4 cm^2, net plot size 5.28*4.50 cm^2. All recommended agronomical practices was followed to raise crops except, plant protection measures.

Table 1: Treatment details as follows

S. No.	Treatments
T_1	Removal of infested shoots only + Yellow sticky trap
T_2	Light trap only
T_3	Neem Seed Extract (5%) only
T_4	Removal of infested shoots + Light traps + Yellow sticky trap
T_5	Removal of infested shoots + NSE (5%) + Yellow sticky trap
T_6	Light traps + NSE (5%)
T_7	Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap
T_8	Control (no treatment)
T_9	Recommended insecticidal spray (I^{st} Spray and III^{rd} Spray with Imidacloprid 17.8% SL, II^{nd} Spray and IV^{th} Spray with Fenvalerate 20% EC)

All these treatments were design in order to control major insect pests of okra but in this paper only data related fruit borers of okra is discussed. The observations on shoots infestation was recorded by selecting five plants randomly from net plot replication wise up to 30 days after sowing and observations were continued at seven days interval up to 45 days after sowing. This was worked out by formula

$$(\%)\ \text{Per-cent shoot infestation} = \frac{\text{Number of infested shoots}}{\text{Number of total shoots}} \text{ X } 100$$

Damaged and healthy okra fruits due to *Earias vittella* Fabricius and *Helicoverpa armigera* (Hubner) were counted and weight treatment and replication wise during each fruit picking from net plot.

Also border fruits were removed, weight and kept separated. The observations converted into per cent fruit damage on number basis and weight basis by following formula.

$$\text{Fruit borer infestation (Number basis)} = \frac{\text{Number of infested fruits}}{\text{Total no. of fruits plucked}} \text{ X } 100$$

$$\text{Per cent fruit damage (Weight basis)} = \frac{\text{Weight of damaged fruits}}{\text{Total weight of fruits plucked}} \text{ X } 100$$

Thus, the data so far generated were subjected to corresponding square root or arc sine value and subjected to statistical analysis for testing the level of significance. Thus, the data so far generated were subjected to proper transformation and then statistically analyzed (Gomez and Gomez, 1984) [5].

Result and discussion

Shoot damage by *E. vittella* to okra up to 30 and 45 days after germination

Shoot damage by *E. vittella* to okra up to 30 DAS

The data presented in Table 2 indicated that after 30 DAS least infestation of shoot damage to okra was due to T_9 (Recommended insecticidal spray) treatment 4.85 per cent and was at par with treatment T_7 (Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap) 5.12 per cent. Both these treatments recorded significantly least shoot infestation over all the treatments. The next group of treatments which recorded least shoot infestation were T_6 (Light traps + NSE (5%)) followed by T_4 (Removal of infested shoots + Light traps + Yellow sticky trap), T_2 (Light trap only), T_5 (Removal of infested shoots + NSE (5%) + Yellow sticky trap) and T_3 (Neem seed extract (5%) only) recording 7.24, 8.03, 8.03, 8.28 and 9.30 per cent shoot infestation, respectively. The latter treatment T_3 (Neem seed extract (5%) only) was also at par with treatment T_1 (Removal of infested shoots only + Yellow sticky trap) with 11.20 per cent damage. Significantly maximum damage due to shoot borer over all the treatments was recorded in treatment control (16.56 per cent).

Shoot damage by *E. vittella* to okra from 30 to 45 DAS

Significantly maximum shoot infestation due to *E. vittella* was observed in treatment T_8 (Control) 14.99 per cent, over all the treatments. Significantly least shoot infestation between 30 to 45 DAS was observed in treatment T_9 (Recommended insecticidal spray) and T_7 (Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap) 4.71 and 5.56 per cent, respectively and were at par with each other. However, the latter treatment was also at par with treatment T_6 (Light traps + NSE (5%)) recording 7.12 per cent shoot damage. Treatments T_4 (Removal of infested shoots + Light traps + Yellow sticky trap), T_2 (Light trap only), T_5 (Removal of infested shoots + NSE (5%) + Yellow sticky trap), T_3 (Neem seed extract (5%) only) recorded 8.49, 8.59, 8.68 and 9.97 per cent shoot infestation, respectively and were at par with each other. However, the former treatment T_4 was significantly superior to treatment T_1 (Removal of infested shoots only + Yellow sticky trap) recording 11.57 per cent shoot infestation (Table 2).

Cumulative effect of various treatments on shoot damage by *E. vittella* to okra

Significantly maximum 15.77 per cent shoot infestation by *E. vittella* was recorded in the treatment T_8 control over all the treatments.

Significantly minimum shoot damage was recorded in treatment T_9 (Recommended insecticidal spray) and T_7 (Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap) 4.78 and 5.34 per cent, respectively and were at par with each other and significantly superior over rest of the treatments in reducing the shoot damage to okra.

The next group of treatment T_6 (Light traps + NSE (5%)), T_4 (Removal of infested shoots + Light traps + Yellow sticky trap), T_2 (Light trap only), T_5 (Removal of infested shoots + NSE (5%) + Yellow sticky trap) recorded 7.18, 8.26, 8.31 and 8.48 per cent shoot damage were at par with each other but the former treatment T_6 was significantly superior to treatment T_3 (Neem seed extract (5%) only) and T_1 (Removal of infested shoots only + Yellow sticky trap) in which 9.63 and 11.39 per cent shoot infestation was recorded, respectively (Table 2 & Fig. 1).

Waghmode *et al*. (2020) [16] who revealed that treatment Fenvalerate 20% EC @ 2ml/L found significantly effective in recording lower percentage of shoot damage due to shoot and fruit borer at 30 DAG and 45 DAG. Gautam *et al*. (2015) [3] reported minimum shoot damage 5 per cent with insecticidal treatment imidacloprid against *E. vittella* on okra. Mazed *et al*. (2017) [9] managed infestation of *E. vittella* on okra with mechanical control and recorded 12.79 per cent shoot infestation. Navale (2012) [11] studied on eco-friendly management of *E. vittella* on okra. The result revealed that lowest infestation (shoot and fruit infestation) and highest yield over control was observed in treatment with NSE 5% alternated with cypermethrin 0.007%, followed by *T. chilonis* (T_5), Clipping of shoots+ NSE 5% (T_4), NSE 5% (T_1), neem oil 2% (T_2), Bt 1000 ml/ha (T_6), clipping of shoot alone (T_3). Kumar (2019) [6] reported that T_7 (Removal of infested shoots + Light trap + NSE (5%)) was the best alternative to T_8 (Pesticides spray including cypermethrin 25 EC) for maximum marketable fruits with minimum shoot and fruit infestation and effective for the non-pesticidal management of brinjal shoot and fruit borer in brinjal.

Table 2: Cumulative effect of various treatments on shoot damage due to *E. vittella* in okra at 30 and 45 DAS

S. No.	Treatment details	Mean Per cent Infestation to shoots		
		30 DAS	45 DAS	Cumulative Mean
T_1	Removal of infested shoots only + Yellow sticky trap	11.20 (3.34)	11.57 (3.40)	11.39 (3.37)
T_2	Light trap only	8.03 (2.83)	8.59 (2.92)	8.31 (2.88)
T_3	Neem Seed Extract (5%) only	9.30 (3.04)	9.97 (3.15)	9.63 (3.09)
T_4	Removal of infested shoots + Light traps + Yellow sticky trap	8.03 (2.83)	8.49 (2.91)	8.26 (2.87)
T_5	Removal of infested shoots+ NSE (5%) + Yellow sticky trap	8.28 (2.87)	8.68 (2.94)	8.48 (2.91)
T_6	Light traps + NSE (5%)	7.24 (2.69)	7.12 (2.66)	7.18 (2.67)
T_7	Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap	5.12 (2.26)	5.56 (2.35)	5.34 (2.31)
T_8	Control (No treatment)	16.56 (4.06)	14.99 (3.86)	15.77 (3.96)
T_9	Recommended insecticidal spray	4.85 (2.20)	4.71 (2.17)	4.78 (2.19)
'F' test		Sig.	Sig.	Sig.
SE (M) ±		0.12	0.13	0.11
C. D. at 5%		0.37	0.38	0.34

Note: Figures in parenthesis are corresponding square root transformation values, DAS- Days after sowing

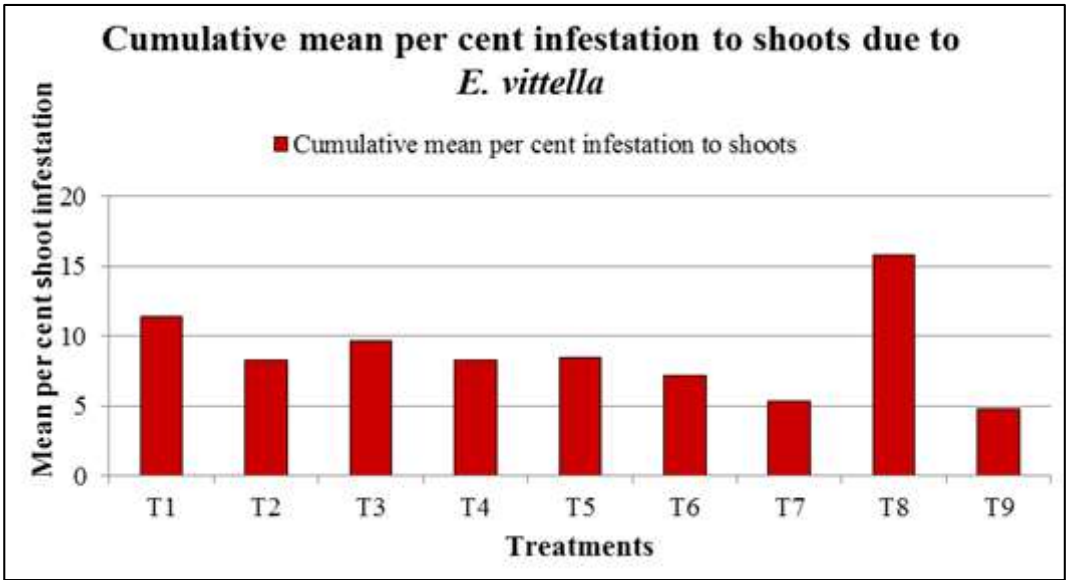

Fig 1: Cumulative effect of various treatments on shoot infestation due to E. vittella on okra

Cumulative mean per cent fruit damage on number and weight basis by *E. Vittella*

Cumulative mean per cent fruit damage on number basis *E. vittella*

The data revealed that significantly maximum damage over all treatments was recorded in treatment T_8 (Control) in which 35.52 per cent fruit damage was observed.

The most effective treatment T_9 (Recommended insecticidal spray) recorded 14.96 per cent fruit damage and was at par with treatment T_7 (Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap) with 19.11 per cent fruit damage. However, treatment T_7 (Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap) was also superior to T_3 (Neem Seed Extract (5%) only) with 25.73 per

cent fruit damage. Both these treatments were at par with the groups of treatments T_6 (Light traps + NSE 5%), T_4 (Removal of infested shoots + Light traps + Yellow sticky trap), T_5 (Removal of infested shoots + NSE (5%) + Yellow sticky trap) and T_2 (Light trap only) with 21.04, 21.75, 23.01, 23.38 per cent fruit damage, respectively.

Least effective treatment T_1 (Removal of infested shoots only + Yellow sticky trap) recorded 29.22 per cent fruit damage (Table 3 & Fig. 2).

Cumulative mean per cent fruit damage on weight basis by *E. vittella.*

The results revealed that significantly maximum per cent fruit damage due to *E. vittella* was recorded in treatment T_8 (Control) with 34.67 per cent fruit damage and was at par with treatment T_1 (Removal of infested shoots only + Yellow sticky trap) recording 28.48 per cent damage fruits. Significantly least damage on weight basis was due to treatment T_9 (Recommended insecticidal spray) 14.56 per cent fruit damage and was at par with treatment T_7 (Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap) with 18.77 per cent fruit damage (Table 4 & Fig. 2).

In the group of treatments T_6 (Light traps + NSE (5%)) recorded 20.55 per cent fruit damage on weight basis, and was significantly superior to treatment T_1 (Removal of infested shoots only + Yellow sticky trap) recording 28.48 per cent fruit damage.

However, both the treatments were at par with treatments T_4 (Removal of infested shoots + Light traps + Yellow sticky trap), T_5 (Removal of infested shoots + NSE (5%) + Yellow sticky trap), T_2 (Light trap only) and T_3 (Neem seed extract (5%) only) recording 21.30, 22.62, 23.35 and 25.59 per cent fruit damage on number basis, respectively.

Similar results are reported by Parmar *et al*. (2013) [12] reported that imidacloprid (0.0053%) treatment recorded 15.94 per cent fruit damage had the lowest infestation of *E. vittella* to fruits and the highest yields of healthy okra fruits. Waghmode *et al*. (2020) [16] observed lowest fruit infestation on number basis and weight basis with fenvalerate 20% EC among all treatment over other treatments including NSE (5%) reported 16.46 and 20.81 per cent fruit infestation due to *E. vittella* on okra.

However, Lakhamapure *et al*. (2018) [7] and Lakhamapure *et al*. (2018) [8] managed fruit infestation on number basis as well as on weight basis with NSKE (5%) by *Earias vittella* on okra. Navale (2012) [11] reported effectiveness of clipping of shoot + NSE (5%), neem seed extract 5% and clipping of shoots with 22.52, 23.67 and 31.40 per cent fruit infestation on number basis against *E. vittella* on okra. Findings of the present treatments in the studies are in consistency of above reported findings.

Table 3: Cumulative mean per cent fruit damage by shoot and fruit borer *E. vittella* at each picking on number basis

S. No.	Treatment details	Fruit damage (%)							
		Number of pickings							Cumulative mean
		1	2	3	4	5	6	7	
T_1	Removal of infested shoots + Yellow sticky trap	27.99 (31.83)	29.45 (32.80)	30.30 (33.34)	30.09 (33.19)	28.86 (32.39)	29.02 (32.47)	28.87 (32.41)	29.22 (32.66)
T_2	Light trap only	22.84 (28.55)	23.39 (28.92)	23.87 (29.19)	23.69 (29.11)	22.92 (28.59)	24.03 (29.35)	22.98 (28.63)	23.38 (28.91)
T_3	Neem Seed Extract (5%) only	25.33 (30.20)	25.80 (30.51)	26.33 (30.86)	26.28 (30.83)	25.75 (30.47)	26.26 (30.80)	24.39 (29.59)	25.73 (30.47)
T_4	Removal of infested shoots + Light traps + Yellow sticky trap	21.95 (27.92)	21.70 (27.72)	21.79 (27.77)	21.36 (27.49)	21.52 (27.59)	21.73 (27.79)	22.22 (28.10)	21.75 (27.78)
T_5	Removal of infested shoots + NSE (5%) + Yellow sticky trap	23.74 (29.15)	23.07 (28.68)	22.71 (28.45)	22.92 (28.58)	22.36 (28.08)	23.82 (29.20)	22.43 (28.25)	23.01 (28.64)
T_6	Light traps + NSE (5%)	20.60 (26.98)	21.75 (27.79)	20.73 (27.05)	21.08 (27.30)	21.38 (27.47)	21.19 (27.37)	20.58 (26.96)	21.04 (27.28)
T_7	Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap	18.84 (25.70)	20.20 (26.69)	18.30 (25.32)	19.80 (26.41)	19.66 (26.32)	19.14 (25.94)	17.85 (24.97)	19.11 (25.92)
T_8	Control (Untreated)	35.47 (36.53)	36.25 (37.00)	35.76 (36.71)	36.00 (36.85)	34.94 (36.21)	34.52 (35.96)	35.71 (36.68)	35.52 (36.56)
T_9	Recommended insecticidal spray	14.91 (22.61)	15.61 (23.22)	15.40 (23.08)	15.08 (22.68)	14.72 (22.56)	15.22 (22.89)	13.78 (21.71)	14.96 (22.70)
'F' test		Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE (M) ±		1.30	1.25	1.32	1.46	1.60	1.36	1.26	1.17
C. D. at 5%		3.89	3.74	3.95	4.38	4.79	4.06	3.79	3.50

Note: Figures in parenthesis are corresponding arc sine transformations values.

Table 4: Cumulative mean per cent fruit damage by shoot and fruit borer *E. vittella* at each picking on weight basis

S. No.	Treatment details	Fruit damage (%)							
		Number of pickings							Cumulative mean
		1	2	3	4	5	6	7	
T_1	Removal of infested shoots only + Yellow sticky trap	27.63 (31.61)	28.64 (32.27)	29.39 (32.75)	29.12 (32.55)	28.35 (32.05)	28.23 (31.97)	27.96 (31.82)	28.48 (32.15)
T_2	Light trap only	23.67 (29.11)	23.27 (28.83)	23.51 (28.96)	23.57 (29.03)	22.74 (28.46)	23.45 (28.96)	23.27 (28.84)	23.35 (28.89)
T_3	Neem Seed Extract (5%) only	24.94 (29.94)	25.41 (30.26)	26.29 (30.84)	26.16 (30.76)	25.33 (30.20)	26.00 (30.64)	25.00 (29.99)	25.59 (30.38)
T_4	Removal of infested shoots + Light traps + Yellow sticky trap	21.60 (27.68)	21.24 (27.40)	21.35 (27.46)	20.99 (27.23)	21.58 (27.58)	21.37 (27.53)	20.99 (27.23)	21.30 (27.45)
T_5	Removal of infested shoots + NSE (5%) + Yellow	23.31	22.65	22.32	22.58	22.35	23.37	21.76	22.62

	sticky trap	(28.86)	(28.39)	(28.18)	(28.35)	(28.10)	(28.89)	(27.78)	(28.37)
T_6	Light traps + NSE (5%)	20.16 (26.67)	21.36 (27.52)	20.19 (26.66)	20.70 (27.04)	20.92 (27.18)	20.69 (27.02)	19.85 (26.43)	20.55 (26.94)
T_7	Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap	18.45 (25.42)	19.30 (26.04)	18.28 (25.31)	19.42 (26.14)	19.40 (26.13)	18.82 (25.71)	17.72 (24.87)	18.77 (25.67)
T_8	Control (Untreated)	34.78 (36.12)	33.45 (35.31)	35.37 (36.47)	35.10 (36.31)	34.45 (35.91)	35.82 (36.72)	33.75 (35.49)	34.67 (36.05)
T_9	Recommended insecticidal spray	14.58 (22.35)	15.26 (22.94)	14.58 (22.43)	14.51 (22.19)	14.29 (22.18)	14.96 (22.67)	13.76 (21.69)	14.56 (22.37)
'F' test		Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE (M) ±		1.26	1.27	1.34	1.54	1.65	1.42	1.37	1.33
C. D. at 5%		3.77	3.80	4.02	4.63	4.95	4.26	4.09	3.97

Note: Figures in parenthesis are corresponding arc sine transformations values.

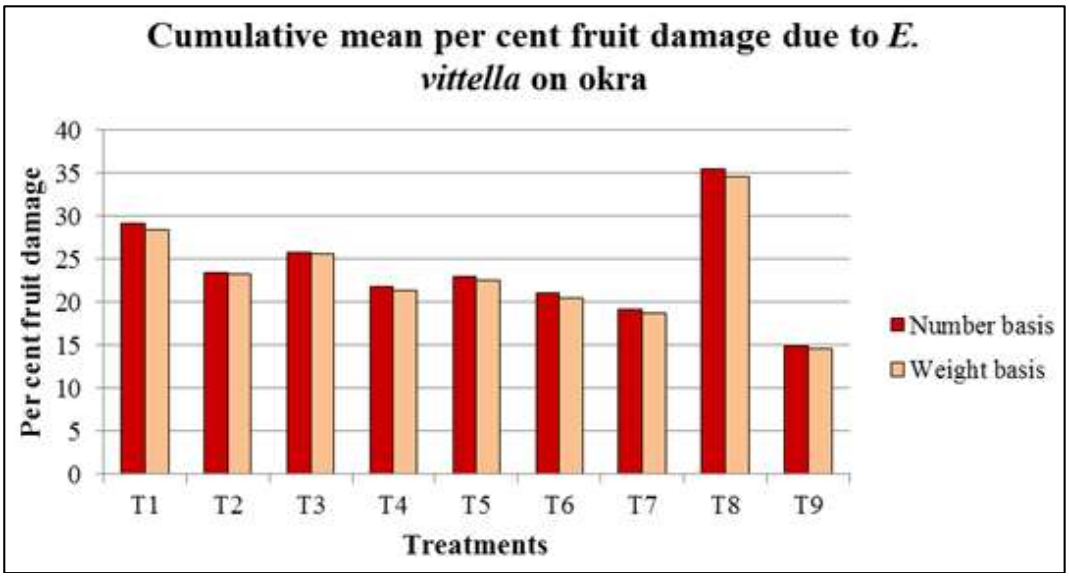

Fig 2: Cumulative mean per cent fruit damage by *E. vittella* on number basis and weight basis on okra

Cumulative mean per cent fruit damage on number and weight basis by fruit borer (*Helicoverpa armigera*)

Cumulative mean per cent fruit damage on number basis by *H. armigera*

The results of cumulative effect of various treatments on fruit damage on number basis against *H. armigera* on okra indicate that treatment T_8 (control) recorded significantly maximum fruit damage on number basis over all the treatments and was at par with treatment T_1 (Removal of infested shoots only + Yellow sticky trap) recorded 31.07 and 27.88 per cent fruit damage on number basis over control. Minimum fruit damage was observed in treatment T_9 (Recommended insecticidal spray) with 10.44 per cent fruit damage on number basis and was at par with the treatment T_7 (Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap) with 11.88 per cent fruit damage on number basis.

Treatment T_6 (Light traps + NSE (5%)) with 15.9 per cent fruit damage was at par with treatment T_4 (Removal of infested shoots + Light traps + Yellow sticky trap), T_5 (Removal of infested shoots + NSE (5%) + Yellow sticky trap) and T_2 (Light trap only) with 16.89, 17.13 and 17.72 per cent fruit damage and was significantly superior over treatment T_3 (Neem seed extract (5%) only) with 20.19 per cent fruit damage on number basis (Table 5 & Fig. 3).

Cumulative mean per cent fruit damage on weight basis by *H. armigera*

The cumulative effect of various treatments indicates that significantly maximum per cent fruit damage was observed in untreated control T_8 with 30.28 per cent fruit damage due to *H. armigera* and was at par with treatment T_1 (Removal of infested shoots only + Yellow sticky trap) with 27.20 per cent fruit damage. The lowest fruit damage 10.12 per cent was recorded in treatment T_9 (Recommended insecticidal sprays) and was at par with T_7 (Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap) with 11.48 per cent fruit damage on weight basis (Table 6 & Fig. 3).

The next most effective treatment with minimum fruit damage was T_6 (Light traps + NSE (5%)) with 15.65 per cent fruit damage and was at par with treatments T_4 (Removal of infested shoots + Light traps + Yellow sticky trap), T_5 (Removal of infested shoots + NSE (5%) + Yellow sticky trap), T_2 (Light trap only) and T_3 (Neem Seed Extract (5%) only) recording damage with 16.46, 16.75, 17.30 and 19.73 per cent fruit damage on weight basis, respectively.

Dhar and Bhattacharya (2015) [2] evaluated that single application of Imidacloprid 17.8% SL followed by twice applications of Spinosad 45% SC gave maximum reduction in infestation of fruit borer in okra. Subbireddy et al. (2018) [15] observed lowest number of larvae and per cent fruit damage on number as well as on weight basis of fruit borer on okra in neem oil 0.3%, azadirachtin 0.15 EC 0.00006% followed by NSKE 5% and garlic bulb extract 3% during *kharif* and *summer* season. Senguttuvan and Rajendran (2001) [13] reported that treatment NSE (5%) recorded lower fruit damage to the extent of 11.3% over untreated check (31.3%) due to fruit boring pests in okra. The result of above researchers lends support the present findings.

Table 5: Cumulative mean per cent fruit damage by *H. armigera* at each picking on number basis.

S. No.	Treatment details	Fruit damage (%)							
		Number of pickings							Cumulative mean
		1	2	3	4	5	6	7	
T_1	Removal of infested shoots + Yellow sticky trap	26.04 (30.66)	26.34 (30.84)	29.65 (32.98)	29.15 (32.64)	29.47 (32.86)	27.59 (31.66)	26.96 (31.26)	27.88 (31.84)
T_2	Light trap only	16.35 (23.81)	17.40 (24.61)	17.92 (25.00)	18.95 (25.77)	18.86 (25.72)	18.08 (25.14)	16.51 (23.91)	17.72 (24.85)
T_3	Neem Seed Extract (5%) only	19.40 (26.10)	20.15 (26.64)	21.09 (27.31)	20.69 (27.02)	20.36 (26.81)	20.35 (26.79)	19.27 (26.01)	20.19 (26.67)
T_4	Removal of infested shoots + Light traps + Yellow sticky trap	15.80 (23.41)	16.85 (24.23)	17.82 (24.97)	16.94 (24.30)	17.79 (24.95)	16.94 (24.31)	16.08 (23.63)	16.89 (24.26)
T_5	Removal of infested shoots + NSE (5%) + Yellow sticky trap	16.24 (23.73)	17.14 (24.42)	18.20 (25.23)	17.62 (24.81)	17.77 (24.88)	16.83 (24.18)	16.15 (23.66)	17.13 (24.41)
T_6	Light traps + NSE (5%)	14.18 (22.08)	15.74 (23.32)	16.27 (23.73)	16.42 (23.79)	16.58 (23.91)	16.83 (24.12)	15.64 (23.25)	15.95 (23.46)
T_7	Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap	10.83 (19.21)	11.75 (20.03)	12.38 (20.53)	11.90 (20.18)	11.96 (20.22)	12.59 (20.77)	11.77 (20.05)	11.88 (20.14)
T_8	Control (Untreated)	29.89 (33.12)	31.06 (33.85)	31.68 (34.24)	31.49 (34.13)	31.66 (34.21)	31.45 (34.09)	30.29 (33.37)	31.07 (33.86)
T_9	Recommended insecticidal spray	9.15 (17.60)	10.31 (18.72)	11.22 (19.57)	11.54 (19.82)	11.26 (19.61)	10.26 (18.67)	9.34 (17.79)	10.44 (18.82)
'F' test		Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE (M) ±		0.92	1.02	1.02	1.11	1.03	1.07	1.04	1.03
C. D. at 5%		2.76	3.07	3.05	3.34	3.09	3.20	3.12	3.09

Note: Figures in parenthesis are corresponding arc sine transformations values.

Table 6: Cumulative mean per cent fruit damage by *H. armigera* at each picking on weight basis

Sr. No.	Treatment details	Fruit damage (%)							
		Number of pickings							Cumulative mean
		1	2	3	4	5	6	7	
T_1	Removal of infested shoots + Yellow sticky trap	25.51 (30.32)	25.95 (30.59)	29.01 (32.58)	28.05 (31.92)	28.95 (32.50)	27.23 (31.43)	25.69 (30.42)	27.20 (31.39)
T_2	Light trap only	16.01 (23.54)	17.06 (24.35)	17.56 (24.74)	18.55 (25.47)	18.53 (25.47)	17.65 (24.82)	15.78 (23.33)	17.30 (24.53)
T_3	Neem Seed Extract (5%) only	19.01 (25.83)	19.57 (26.21)	20.70 (27.04)	20.35 (26.78)	19.96 (26.52)	19.86 (26.44)	18.70 (25.59)	19.73 (26.34)
T_4	Removal of infested shoots + Light traps + Yellow sticky traps	15.45 (23.13)	16.49 (23.96)	17.38 (24.63)	16.59 (24.03)	17.41 (24.66)	16.44 (23.92)	15.46 (23.14)	16.46 (23.92)
T_5	Removal of infested shoots + NSE (5%) + Yellow sticky trap	15.93 (23.49)	16.83 (24.18)	17.79 (24.92)	17.28 (24.55)	17.42 (24.62)	16.46 (23.83)	15.58 (23.20)	16.75 (24.11)
T_6	Light traps + NSE (5%)	13.98 (21.88)	15.35 (23.01)	15.94 (23.47)	16.60 (23.95)	16.16 (23.59)	16.42 (23.85)	15.12 (22.83)	15.65 (23.22)
T_7	Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap	10.42 (18.83)	11.48 (19.79)	12.07 (20.25)	11.62 (19.93)	11.70 (19.99)	12.29 (20.51)	10.79 (19.17)	11.48 (19.78)
T_8	Control (Untreated)	29.33 (32.77)	30.50 (33.50)	31.06 (33.86)	30.69 (33.64)	30.88 (33.73)	30.62 (33.57)	28.90 (32.50)	30.28 (33.37)
T_9	Recommended insecticidal spray	8.90 (17.36)	10.05 (18.48)	10.94 (19.31)	10.91 (19.26)	10.99 (19.36)	9.99 (18.42)	9.06 (17.51)	10.12 (18.53)
'F' test		Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE (M) ±		0.99	1.05	1.04	1.12	1.18	1.09	1.11	1.08
C. D. at 5%		2.97	3.15	3.12	3.35	3.52	3.27	3.31	3.24

Note: Figures in parenthesis are corresponding arc sine transformations values.

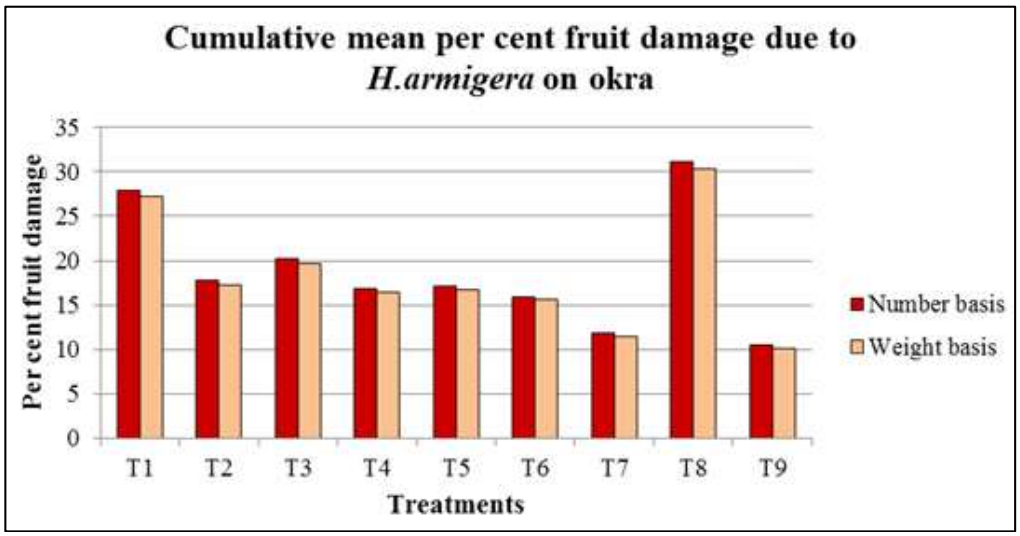

Fig 3: Cumulative mean per cent fruit damage by *H. armigera* on number basis and weight basis on okra

Conclusion

Non-pesticidal treatment T_7 (Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap) successfully managed shoot damage as well as fruit damage due to okra shoot and fruit borers on okra. This findings can be explore as replacement for insecticidal treatment in organic farming. Also it helps in producing pesticide residue free okra fruits. The order of effectiveness in reducing shoot damage due to *Earias vittella* at 30 DAS and 45 DAS and in case of fruit damage on number as well as weight basis due *E. vittella* and *H. armigera* was T_9 (Recommended insecticidal spray) < T_7 (Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap) < T_6 (Light traps + NSE (5%)) < T_4 (Removal of infested shoots + Light traps + Yellow sticky trap). However other treatments also helped in effective management of shoot damage due to okra shoot and fruit borer as well as fruit damage due to okra shoot and fruit borers of okra.

Acknowledgement

The author gratefully acknowledge Department of Vegetable Science and Agricultural Entomology, Dr. PDKV, Akola for providing necessary facilities during the course of my study. I am also grateful to my esteem chairman and members of my advisory committee.

References

1. Anonymus. Horticulture statistics at a glance https://www.agri.nic.in. 2018.
2. Dhar T, Bhattacharya S. Efficacy of Imidacloprid and Spinosad against pest complex of okra and tomato. International Journal Of Bio-Resource, Environment And Agricultural Sciences (IJBEAS) 2015;1(3):126-131.
3. Gautam HK, Singh NN, Rai AB. Effect of some plant extract and an insecticide on the incidence of *Earias vittella* in okra. Indian Journal Agricultural Research 2015;49(2):175-179.
4. Gemede HF, Negussie R, Gulelat DH, Ashagrie ZW, Fekadu B. Nutritional quality and health benefits of okra (*Abelmoschus esculentus*): a review. International Journal of Nutrition and Food Science 2015;4(2):208-215.
5. Gomez KA, Gomez AA. Statistical procedures for Agricultural Research, Second edition. John willey and Sons. New York, 1984, 582.
6. Kumar VA. Non-pesticidal management of *Lecinodes orbonalis* in brinjal. M.Sc. (Agri.) Thesis (unpub.), Dr. PDKV, Akola, 2019.
7. Lakhamapure AR, Lavhe NV, Barde PS, Deotale RO, Panchabhai PR. Assessment of shoot and fruit damage on number basis in okra. International Journal of Current Microbiology and Applied Sciences 2018;7(12):3513-3523.
8. Lakhamapure AR, Lavhe NV, Panchabhai PR, Barde PS, Deotale RO. Assessment of fruit infestation of A*belmoschus esculentus* by shoot and fruit borer on weight basis. International Journal of Current Microbiology and Applied Sciences 2018;7(12):2319-7706.
9. Mazed MA, Alam MZ, Miah MRU, Hossain MS, Awal MA. Effectiveness of some selected insecticide and botanicals against okra shoot and fruit borer. J Agricultural Research. 2017;42(2):353-362.
10. Meenambigai C, Bhuvaneswari K, Kumar KM, Sangavi R. Pesticides usage pattern of okra, *Abelmoschus esculentus* (L.) Moench in Tamilnadu. Journal of Entomology and Zoology Studies 2017;5(6):1760-1765.
11. Navale PJ. Ecofriendly management of *Earias vittella* (Fabricius) on okra. M.Sc. Thesis (Unpub.) Dr. PDKV, Akola (MS), 2012.
12. Parmar KD, Korat DM, Joshi MN, Patel AR, Shah PG. Relative bio-efficacy of insecticides/miticides against pest complex of okra. Karnataka Journal of Agricultural Sciences 2013;26(3):375-378.
13. Senguttuvan T, Rajendran R. Plant products for the control of bhendi fruit borers in: proceedings of the second national symposium on integrated pest management in horticultural crops: new molecules, bio-pesticides and environment, Bangalore, Karnataka, India, 2001, 17-18.
14. Singh P, Chauhana V, Tiwaria BK, Chauhan SS, Simon S, Bilal S, *et al*. An overview on okra and it's importance as nutritive vegetable in the world. International Journal of Pharmacy And Biological Science 2014;4(2):227-233.
15. Subbireddy KB, Patel HP, Patel NB, Bharpoda TM. Utilization of plant extract for managing fruit borer in okra. International Journal of Current Microbiology and Applied Science 2018;7(5):2786-2793.
16. Waghmode SB, Lande GK, Jawanjal KN, Gavhane RM. Effect of insecticides and botanicals alone and in combination with fungicide against okra shoot and fruit borer. Journal of Entomology and Zoology Studies 2020;8(2):511-518.