International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2021; 9(1): 647-653

Received: 30-10-2020
Accepted: 09-12-2020

Vaishnavi R 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, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India

Pradnya V Dabhade
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

Sirisha V Thakare
Post Graduate Student, Department of Plant Pathology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

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

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

Evaluation of effect of non-pesticidal methods on population of sucking pest complex on okra in comparison with chemical control

Vaishnavi R Tathode, RS Wasu, Pradnya V Dabhade, Dr. SK Aherkar, Sirisha V Thakare and Poonam H Deshmukh

DOI: https://doi.org/10.22271/chemi.2021.v9.i1i.11301

Abstract
Investigations were carried out to evaluate phototropical, mechanical and botanical control measures in comparison with chemical treatment for managing sucking pest complex of okra under field condition in Dr. PDKV, Akola during *kharif*, 2019. The results regarding the cumulative effect revealed that treatment Recommended insecticidal spray (Ist Spray and IIIrd Spray with Imidacloprid 17.8% SL, IInd Spray and IVth Spray with Fenvalerate 20% EC) emerged as the most effective treatment against aphids, leafhoppers and whiteflies with realized yield of 52.23 q/ha. It was at par with non-pesticidal treatment Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap with yield of 44.49 q/ha followed by Light traps + NSE (5%) in case of leafhopper population whereas in case of aphid and whitefly population treatment Removal of infested shoots + NSE (5%) + Yellow sticky trap at 3, 7 and 14 days after application. This treatments can be better alternative for organic farmers.

Keywords: Aphid, leafhopper, whiteflies, insecticide, NSE 5%, yellow sticky trap

1. 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, mineral, also have various medicinal properties, use as fuel, useful in paper industry and it's seed used as substitute for coffee in some countries (Gemede *et al*., 2015) [6]. 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 2017-18 providing continuous and good source of income to the farmers. In Maharashtra okra is mainly grown in Pune, Jalgaon, Thane, Nashik, Satara, Aurangabad, Solapur, Dhule and Osmanabad districts (Anonymous, 2018) [2].
Growers of okra frequently complain yield losses due to insect pests. 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. The recorded yield losses are up to 32.06 to 56.0 per cent due to *Amrasca (sundapteryx) biguttula* (Ishida), 94.0 per cent by *Bemisia tabaci* (Gennadius), 54.04 per cent by *Aphis gossypii* (Glover) and *Earias* spp. 36 to 90 per cent (Meenambigai *et al*., 2017) [9]. 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. In vegetable crops like okra, there is always little time lag between pesticide application and harvest. Thus, the use of pesticides at fruiting stage and non-adoption of safe waiting period, leads to possible accumulation of pesticide residues. 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. By considering all this facts, present study was executed.

2. 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 spacing of 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

Sr. 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 sucking pests of okra is discussed. Four applications were given at fortnightly interval throughout crop growth period. Application of above treatments were initiated as soon as the sucking pests infestation was observed. The observations on population of sucking pests (aphid, leafhopper, whitefly) were made on three leaves, each selected randomly on 5 plants from top, middle and bottom canopy. The sucking insect pest's population was recorded before as well as 3, 7 and 14 days after each spraying. Observations on whitefly adults were recorded without disturbing the plants to minimum observational errors. Population of sucking pest was recorded from each net plot area. At the end of last picking, total yield from each net plot was calculated and computed on hectare basis (q/ha). The data obtained on the pests and fruit yield was subjected to statistical analysis after suitable transformations as per statistical guidelines given by Gomez and Gomez (1984) [7].

3. Result and Discussion

3.1 Effect of treatments on the population of aphids on okra after three, seven and fourteen days of application

3.1.1 Cumulative effect of treatments on the population of aphids after three days of application

The overall mean result represented in the table reveals that significantly maximum population of aphids over all the treatments was found in treatment T_2 (Light trap only) and T_8 (Control) recording 11.88 and 10.73 aphids per leaf and were at par with each other (Table 2 & Fig. 1).

Significantly least aphid population after 3 days of application was observed in T_9 (Recommended insecticidal spray) and T_7 (Removal of infested shoots + Light Traps + NSE (5%) + Yellow sticky trap) recording 1.56 & 2.20 aphids per leaf and at par with each other. However, the latter treatment T_7 was also at par with T_5 (Removal of infested shoots + NSE (5%) + Yellow sticky trap), T_3 (Neem seed extract (5%) only), T_6 (Light traps + NSE (5%)) & T_4 (Removal of infested shoots + Light traps + Yellow sticky trap), recording 2.71, 2.93, 3.15 & 3.45 aphids per leaf, respectively. However, T_7 was significantly superior to treatment T_1 (Removal of infested shoots only + Yellow sticky trap) recording 3.80 aphids per leaf.

3.1.2 Cumulative effect of treatments on the population of aphids after seven days of application

Significantly least 1.97 aphids per leaf was observed in treatment T_9 (Recommended insecticidal spray) & was at par with treatment T_7 (Removal of infested shoots + Light Traps + NSE (5%) + Yellow sticky trap) in which 2.82 aphids per leaf was observed. However, this treatment T_7 was also at par with T_5 (Removal of infested shoots + NSE (5%) + Yellow sticky trap), T_6 (Light traps + NSE (5%)), T_3 (Neem seed extract (5%) only), T_4 (Removal of infested shoots + Light traps + Yellow sticky trap) recording 3.41, 3.91, 3.97, and 4.69 aphids per leaf, respectively.

In next group of treatment T_5 (Removal of infested shoots + NSE (5%) + Yellow sticky trap) was significantly superior to treatment T_1 (Removal of infested shoots only + Yellow sticky trap) recording 3.41 & 5.27 aphids per leaf. However, both these treatments were at par T_6 (Light traps + NSE (5%)), T_3 (Neem seed extract (5%) only) & T_4 (Removal of infested shoots + Light traps + Yellow sticky trap) recording 3.91, 3.97 and 4.69 aphids per leaf, respectively. Significantly maximum aphids overall the treatments were observed in the treatment T_8 (Control) & was at par with T_2 (Light trap only) recording 13.96 and 13.29 aphids per leaf. (Table 2 & Fig. 1).

3.1.3 Cumulative effect of treatments on the population of aphids after fourteen days of application

After 14 days of treatments application significantly least population of aphids was recorded in treatment T_9 (Recommended insecticidal spray) & was at par with T_7 (Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap) recording 3.85 and 5.14 aphids per leaf, respectively.

In next group of treatments, treatment T_5 (Removal of infested shoots + NSE (5%) + Yellow sticky trap) recorded significantly less population of aphids over treatments T_1 (Removal of infested shoots only + Yellow sticky trap) recorded 5.65 and 8.90 aphids per leaf, respectively. However, treatment T_5 (Removal of infested shoots + NSE (5%) + Yellow sticky trap) was at par with T_6 (Light traps + NSE (5%)), T_3 (Neem seed extract only (5%) only) & T_4 (Removal of infested shoots + Light traps + Yellow sticky trap) recording 5.65, 6.20, 6.37, 7.42 aphids per leaf, respectively.

Significantly maximum aphids over all the treatment was observed in treatment T_8 (Control) 14.51 aphids per leaf and was at par with treatment T_2 (Light trap only) recording 13.05 aphids per leaf (Table. 2 & Fig. 1).

Our results supported by findings of Jadhav *et al*. (2016) [8] proved the superiority of imidacloprid 70 WG over other treatments against aphid population on okra at 3, 7 and 14 days after spraying, respectively. Preetha *et al*. (2007) [15] revealed that significantly imidadoprid 17.8 SL at the recommended dose of 25 g a.i./ha was effective in controlling the population of bhendi aphids up to 25 days. Deepika *et al*. (2018) [5] revealed that the chemical imidacloprid @ 0.005% and NSKE (5%) were found at par with each other in reducing the aphid population on okra. Pareek *et al*. (1987) [12] and Mishra (1991) [10] evaluated fenvalerate (0.02%) and fenvalerate (0.05%) recording 0.33 aphids/plant was effectively managed aphid population. Also Naik *et al*. (2012) [11] reported 5.91 aphids/three leaves after three DAS with NSE (5%) spraying on okra. Bhonde *et al*. (2017) [3] found that the treatment YST at 15 cm height above crop canopy + Azadirachtin 10,000 ppm (1% w/w) @ 2 ml/L was more effective over treatment Yellow sticky trap 15 cm above crop canopy in reducing population of okra aphids.

Table 2: Cumulative effect of treatments on the population of aphids on okra after three, seven and fourteen days of application

Sr. No.	Treatment details	Cumulative effect		
		Number of aphids/leaf		
		3 DAA	7 DAA	14 DAA
T_1	Removal of infested shoots only + Yellow sticky trap	3.80 (1.95)	5.27 (2.30)	8.90 (2.98)
T_2	Light trap only	11.88 (3.44)	13.29 (3.65)	13.05 (3.60)
T_3	Neem Seed Extract (5%) only	2.93 (1.71)	3.97 (1.99)	6.37 (2.52)
T_4	Removal of infested shoots + Light traps + Yellow sticky trap	3.45 (1.86)	4.69 (2.16)	7.42 (2.72)
T_5	Removal of infested shoots + NSE (5%) + Yellow sticky trap	2.71 (1.65)	3.41 (1.84)	5.65 (2.38)
T_6	Light traps + NSE (5%)	3.15 (1.77)	3.91 (1.97)	6.20 (2.49)
T_7	Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap	2.20 (1.48)	2.82 (1.68)	5.14 (2.27)
T_8	Control (No treatment)	10.73 (3.23)	13.96 (3.71)	14.51 (3.79)
T_9	Recommended insecticidal spray	1.56 (1.25)	1.97 (1.40)	3.85 (1.96)
F Test		Sig	Sig	Sig
SE (m) ±		0.13	0.12	0.11
CD at 5%		0.39	0.38	0.35

Note: Figures in parenthesis are corresponding square root transformation, DAA – Days after application

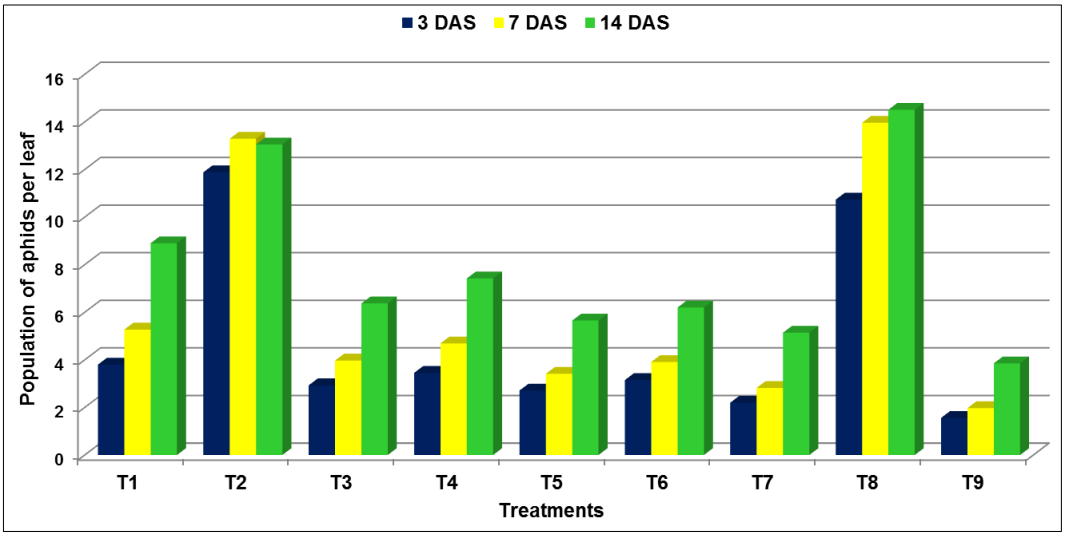

Fig 1: Cumulative effect of treatments on population of aphids on okra after three, seven and fourteen days after application

3.2 Effect of treatments on the population of leafhoppers on okra after three, seven and fourteen days of application

3.2.1 Cumulative effect of treatments on the population of leafhoppers on okra after three days of application

After 3 days of application significantly maximum leafhoppers population over all the treatments was recorded in the treatment T_8 (Control) 13.71 leafhoppers per leaf.

Significantly minimum leafhoppers population 1.26 leafhoppers per leaf was observed in treatment T_9 (Recommended insecticidal spray) and was at par with treatment T_7 (Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap) & T_6 (Light traps + NSE (5%)) recording 1.72 and 1.87 leafhoppers per leaf.

In next group treatment T_4 (Removal of infested shoots + Light traps + Yellow sticky trap) recorded 2.31 leafhoppers per leaf and was significantly superior to treatment T_1 (Removal of infested shoots only + Yellow sticky trap) recording 3.65 leafhoppers per leaf both those treatments were at par with treatment T_5 (Removal of infested shoots + NSE (5%) + Yellow sticky trap), T_2 (Light trap only) & T_3 (Neem seed extract (5%) only) recording 2.49, 2.59 and 3.14 leafhoppers per leaf, respectively (Table 3 & Fig. 2).

3.2.2 Cumulative effect of treatments on the population of leafhoppers on okra after seven days of application

Significantly minimum leafhoppers population over all treatments was observed in T_9 (Recommended insecticidal spray) 1.76 leafhoppers per leaf whereas, significantly maximum leafhoppers over all the treatments was observed in treatment T_8 (Control) 15.11 leafhoppers per leaf.

In the group of other treatments, Treatment T_7 (Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap) recorded significantly least leafhoppers population 2.92 leafhoppers per leaf over 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), T_3 (Neem seed extract (5%) only) & T_1 (Removal of infested shoots only + Yellow sticky trap) but was at par with treatment T_6 (Light traps + NSE (5%)) recording 4.47, 5.13, 5.63, 5.89, 7.09 and 3.56 leafhoppers per leaf, respectively (Table 3 & Fig. 2).

3.2.3 Cumulative effect of treatments on the population of leafhoppers on okra after fourteen days of application

Significantly least population of leafhoppers after 14 days of application was observed in treatment T_9 (Recommended insecticidal spray) recording 5.11 leafhoppers per leaf were as significantly maximum population of leafhoppers 14.10 per leaf was observed in treatment T_8 (Control) and was at par with treatment T_1 (Removal of infested shoots only + Yellow sticky trap) in which 12.60 leafhoppers were recorded per leaf (Table 3 & Fig. 2).

In the next group of treatment T_7 (Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap) recorded significantly least leafhoppers population (6.73 leafhoppers per leaf) over treatments T_2 (Light trap only) and T_3 (Neem seed extract (5%) only) in which 8.71 and 9.01 leafhoppers per leaf was recorded. However, all these treatments were at par with T_6 (Light traps + NSE (5%)), T_4 (Removal of infested shoots + Light traps + Yellow sticky trap) and treatments T_5 (Removal of infested shoots + NSE (5%) + Yellow sticky trap) in which 7.46, 7.81, 8.01 leafhoppers per leaf was recorded, respectively.

Our results are in collaboration with results of Pawar *et al*. (2018) [14] who reported imidacloprid 17.8 SL @ 30 g a.i./ha emerged as the most effective treatment against aphids and jassids infesting okra with realized yield of 60.49 q/ha. Similarly, Chaitanya *et al*. (2018) [4] reported imidacloprid 17.8% SL was the most effective treatment in reducing population of leafhoppers on okra followed by NSKE (5%). Prem Kumar and Ashwani Kumar (2017) [16] also found that imidacloprid 17.8 SL was most effective treatment indicating reduction in population of leafhoppers on okra after first spray at 3, 7 & 14 days after spraying. Naik *et al*. (2012) [11] and Adhilakshmi *et al*. (2008) [1] proved effectiveness of NSKE (5%) in reduction of mean population of leafhoppers on okra. According Pareek *et al*. (1987) [12] and Mishra (1991) [10] reported fenvalerate (0.02%) and fenvalerate (0.05%) recording 0.27 jassids/plant was effectively managed leafhopper population. Bhonde *et al*. (2017) [3] found that the treatment YST at 15 cm height above crop canopy + Azadirachtin 10,000 ppm (1% w/w) @ 2 ml/L was more effective over treatment Yellow sticky trap 15 cm above crop canopy in reducing population of okra leafhoppers.

Table 3: Cumulative effect of treatments on the population of leafhoppers on okra after three, seven and fourteen days of application

Sr. No.	Treatment details	Cumulative effect Number of Leafhoppers/leaf		
		3 DAA	7 DAA	14 DAA
T_1	Removal of infested shoots only + Yellow sticky trap	3.65 (1.89)	7.09 (2.66)	12.60 (3.55)
T_2	Light trap only	2.59 (1.66)	5.63 (2.37)	8.71 (2.95)
T_3	Neem Seed Extract (5%) only	3.14 (1.75)	5.89 (2.42)	9.01 (3.00)
T_4	Removal of infested shoots + Light traps + Yellow sticky trap	2.31 (1.50)	4.47 (2.10)	7.81 (2.79)
T_5	Removal of infested shoots + NSE (5%) + Yellow sticky trap	2.49 (1.56)	5.13 (2.26)	8.01 (2.83)
T_6	Light traps + NSE (5%)	1.87 (1.36)	3.56 (1.87)	7.46 (2.73)
T_7	Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap	1.72 (1.30)	2.92 (1.70)	6.73 (2.59)
T_8	Control (No treatment)	13.71 (3.69)	15.11 (3.87)	14.10 (3.74)
T_9	Recommended insecticidal spray	1.26 (1.12)	1.76 (1.32)	5.11 (2.26)
F Test		Sig	Sig	Sig
SE (m) ±		0.11	0.11	0.10
CD at 5%		0.35	0.35	0.32

Note: Figures in parenthesis are corresponding square root transformation, DAA – Days after application

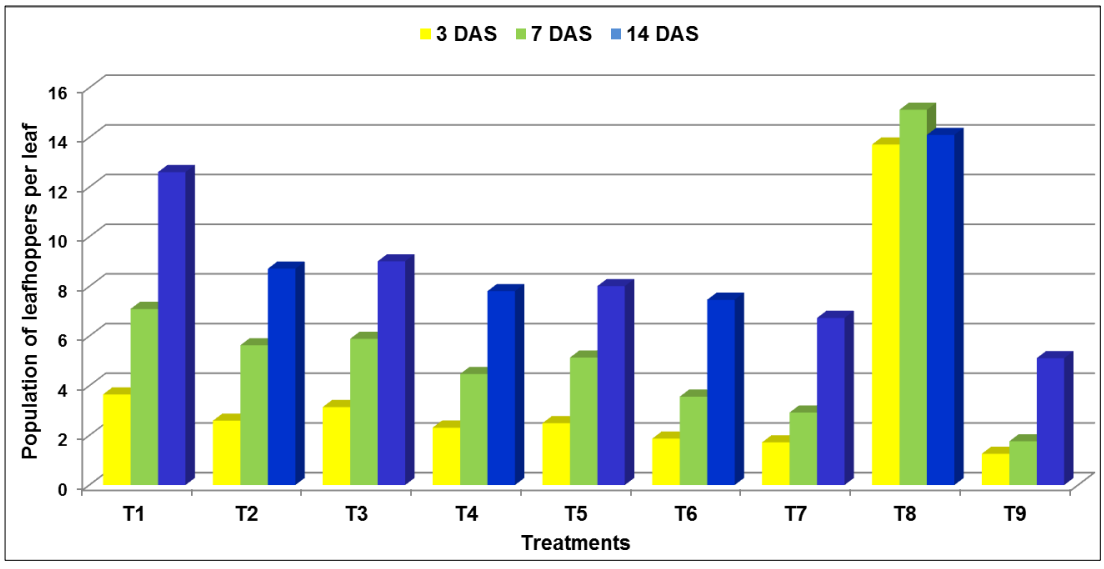

Fig 2: Cumulative effect of treatments on population of leafhoppers on okra after three, seven and fourteen days after application

3.3 Effect of treatments on the population of whitefly on okra after three seven and fourteen days of application

3.3.1 Cumulative effect of treatments on the population of whitefly on okra after three days of application

Significantly maximum whitefly population was observed in the treatment T_8 (Control) and was at par with treatments T_2 (Light trap only) recording 7.90 and 7.85 whiteflies per leaf. Significantly T_1 (Removal of infested shoots only + Yellow sticky trap) was at par with T_4 (Removal of infested shoots only + Light traps + Yellow sticky trap) reported 2.95 and 2.77 whiteflies per leaf.

Significantly minimum population of whitefly was observed in the treatment T_9 (Recommended insecticidal spray) with 1.23 whiteflies per leaf and was at par with treatment T_7 (Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap) & T_5 (Removal of infested shoots + NSE (5%) + Yellow sticky trap) recording 1.64 and 1.91 whiteflies per leaf, respectively. However, treatment T_7 was also at par with treatment T_3 (Neem seed extract (5%) only) and T_6 (Light traps + NSE (5%)) recording 2.03 & 2.05 whiteflies per leaf (Table 4 & Fig. 3).

3.3.2 Cumulative effect of treatments on the population of whitefly on okra after seven days of application

Significantly maximum whitefly was recorded in the treatments T_8 (Control) 9.45 whiteflies per leaf and T_2 (Light trap only) 8.96 whiteflies per leaf and both the treatments were at par with each other.

Significantly minimum 1.22 whiteflies per leaf was observed in treatment T_9 (Recommended insecticidal spray) and was at par with treatment T_7 (Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap) recording 1.90 whiteflies per leaf. However, this treatment was also at par with T_5 (Removal of infested shoots + NSE (5%) + Yellow sticky trap), T_3 (Neem seed extract (5%) only), T_6 (Light traps + NSE (5%)) recording 2.13, 2.36 and 2.46 whiteflies per leaf, respectively but was significantly superior to treatment T_4 (Removal of infested shoots + Light traps + Yellow sticky trap) & T_1 (Removal of infested shoots only + Yellow sticky trap) recording 2.93 and 3.71 whiteflies per leaf, respectively (Table 4 & Fig. 3).

3.3.3 Cumulative effect of treatments on the population of whitefly on okra after fourteen days of application

Significantly maximum whitefly was recorded in the treatments T_8 (Control) and T_2 (Light trap only) recording 10.10 and 9.96 whiteflies per leaf, respectively.

Significantly minimum 2.74 whiteflies per leaf was recorded in treatment T_9 (Recommended insecticidal spray) over treatments T_4 (Removal of infested shoots + Light traps + Yellow sticky trap) and T_1 (Removal of infested shoots only + Yellow sticky trap) recording 4.70 and 5.90 whiteflies per leaf, respectively. Treatment T_9 was found at par with treatments, T_7 (Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap), T_5 (Removal of infested shoots + NSE (5%) + Yellow sticky trap), T_3 (Neem seed extract (5%) only) and T_6 (Light traps + NSE (5%)) recording 3.19, 3.32, 3.67 and 3.88 whiteflies per leaf, respectively (Table 4 & Fig. 3).

Our findings are in confirmation with findings of Naik *et al*. (2012) [11] proved effectiveness of NSKE (5%) over other treatments at three DAS and reported 3.00 whiteflies/three leaves after first spray and 3.77 whiteflies/three leaves after second spray on okra. Prem Kumar and Ashwani Kumar (2017) [16] found imidicloprid 17.8 SL was most effective treatment over azadirachtin 5% EC indicating reduction in population of whitefly on okra. Chaitanya and Kumar (2018) [4] reported imidacloprid 17.8 SL was most effective treatment over the neem seed extract (5%) against whitefly on okra. Bhonde *et al*. (2017) [3] found that the treatment YST at 15 cm height above crop canopy + Azadirachtin 10,000 ppm (1% w/w) @ 2 ml/L was more effective over treatment Yellow sticky trap 15 cm above crop canopy in reducing population of okra whiteflies.

Table 4: Cumulative effect of treatments on the population of whitefly on okra after three days of application

Sr. No.	Treatment details	Cumulative effect		
		Number of whiteflies/leaf		
		3 DAA	7 DAA	14 DAA
T_1	Removal of infested shoots only + Yellow sticky trap	2.95 (1.72)	3.71 (1.92)	5.90 (2.42)
T_2	Light trap only	7.85 (2.79)	8.96 (2.97)	9.96 (3.16)
T_3	Neem Seed Extract (5%) only	2.03 (1.42)	2.36 (1.53)	3.67 (1.91)
T_4	Removal of infested shoots + Light traps + Yellow sticky trap	2.77 (1.66)	2.93 (1.71)	4.70 (2.17)
T_5	Removal of infested shoots + NSE (5%) + Yellow sticky trap	1.91 (1.38)	2.13 (1.46)	3.32 (1.82)
T_6	Light traps + NSE (5%)	2.05 (1.43)	2.46 (1.56)	3.88 (1.97)
T_7	Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap	1.64 (1.28)	1.90 (1.37)	3.19 (1.79)
T_8	Control (No treatment)	7.90 (2.80)	9.45 (3.07)	10.10 (3.16)
T_9	Recommended insecticidal spray	1.23 (1.11)	1.22 (1.10)	2.74 (1.65)
F Test		Sig.	Sig.	Sig.
SE (m) ±		0.09	0.10	0.11
CD at 5%		0.28	0.30	0.33

Note: Figures in parenthesis are corresponding square root transformation, DAA - Days after application

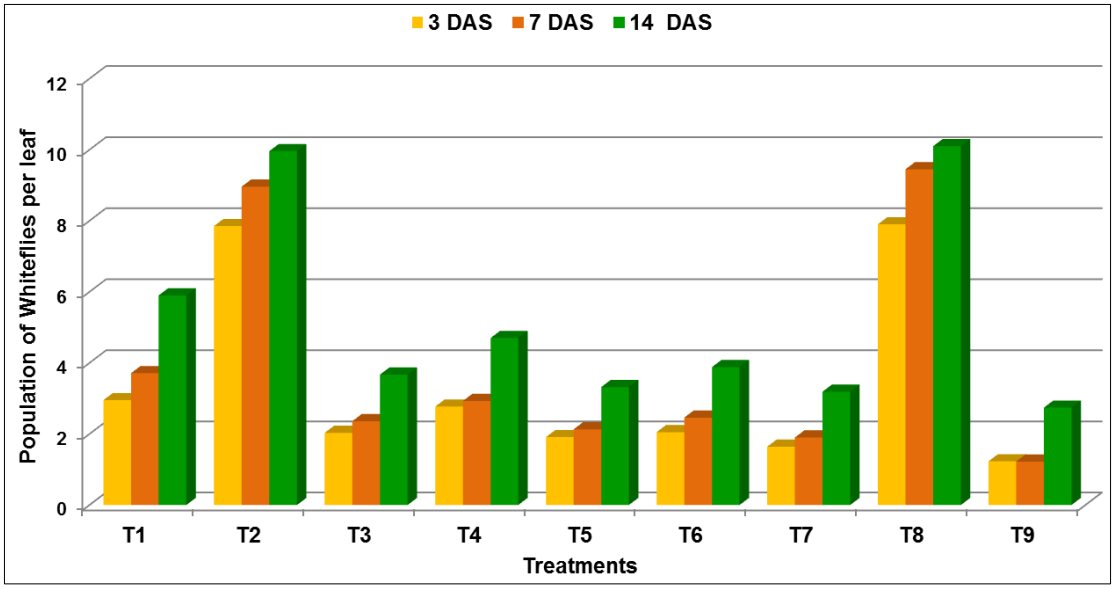

Fig 3: Cumulative effect of treatments on population of whiteflies on okra after three, seven and fourteen days after application

3.4 Effect of various treatment on okra fruit yield

The data represented in Table 5 revealed that there was significant effect of treatments on the yield of okra fruits. Significantly less yield over all the treatments was observed in treatment T_8 (Control) recording 17.38 q/ha yields of green okra fruits. However, it was at par with treatment T_1 (Removal of infested shoots only + Yellow sticky trap) recording 19.45 q/ha yields of okra fruits.

Significantly maximum yield of 52.23 q/ha was recorded in the treatment T_9 (Recommended insecticidal spray) and was at par with Treatments T_7 (Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap) with 44.49 q/ha yields and treatment T_6 (Light traps + NSE (5%)) with 41.52 q/ha yield. However, the latter two treatments T_7 and T_6 were also at par with treatment T_5 (Removal of infested shoots + NSE (5%) + Yellow sticky trap), T_4 (Removal of infested shoots + Light traps + Yellow sticky trap), T_2 (Light trap only) and T_3 (Neem seed extract (5%) only) alone which recorded 38.44, 37.87, 35.29 and 33.25 q/ha yield of okra fruits, respectively.

However, the above observations are in line with Parmar *et al.* (2013) [13] who revealed that the application of imidacloprid 70 WS + foliar spray of imidacloprid 17.8 SL resulted in highest yield of okra 57.40 q/ha over other treatments which is quite consistent with T_9 (Recommended insecticidal spray) which recorded 52.32 q/ha. Venkataravanappa *et al.* (2012) [17] reported treatment NSE (5%) yielded 31.16 q/ha of okra, whereas in present finding it was 33.25 q/ha which also gives the strong support to present findings.

Table 5: Average yield of okra fruits (q/ha)

Sr. No.	Treatment details	Mean	Yield (q/ha)
T_1	Removal of infested shoots only + Yellow sticky trap	2.88	19.45
T_2	Light trap only	5.26	35.29
T_3	Neem Seed Extract (5%) only	4.80	33.25
T_4	Removal of infested shoots + Light traps + Yellow sticky trap	5.57	37.87
T_5	Removal of infested shoots + NSE (5%) + Yellow sticky trap	5.68	38.44
T_6	Light traps + NSE (5%)	6.08	41.52
T_7	Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap	6.81	44.49
T_8	Control (Untreated)	2.31	17.38
T_9	Recommended insecticidal spray (Recommended)	7.70	52.23
	'F' test	Sig.	
	SE (M) ±	0.62	
	C. D. at 5%	1.85	

4. Conclusion

Non-pesticidal treatment T_7 (Removal of infested shoots + Light traps + NSE (5%) + Yellow sticky trap) successfully manages the population of sucking pests of okra. This findings can be explore as replacement for insecticidal treatment in organic farming. Also it helps in producing pesticide residue free okra fruits. Use of only Light trap was found to be less effective against aphids and whitefly as they were having less attraction towards the light.

5. 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. The author is also grateful to esteem chairman and members of advisory committee.

6. References

1. Adilakshmi A, Korat DM, Vaishnav PR. Bio-efficacy of some botanical insecticides against pests of okra. Karnataka Journal of Agricultural Sciences 2008;21(2):290-292.
2. Anonymus. Horticulture statistics at a glance https://www.agri.nic.in 2018.
3. Bhonde PM, Mohod VD, Thakare AY, Longare SG, Undirwade DB. Evaluation of sticky traps and

azadirachtin against sucking pests of okra. Trends in Biosciences 2017;10(11):2105-2107.
4. Chaitanya G, Kumar A, Nawle JS. Efficacy of selected insecticides and neem products against jassids (*Amarsca biguttula biguttula*)) of okra (*Abelmoschus esculentus* (L.) Moench). Journal of Pharmacognosy and Phytochemistry 2018;7(5):3259-3260.
5. Deepika D, Razak TA, Elanchezhiyan K, Manivannan MI. Evaluation of botanicals and an alkaloid on jassids and aphids of okra (*Abelmoschus esculentus* L. (Moench)). International Journal of Advances in Agricultural Science and Technology. 2018;5(7):30-34.
6. 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.
7. Gomez KA, Gomez AA. Statistical procedures for agricultural research. A Wiley Int. Sci. Publ. John Wiley and Sons. New York, Brisbane, Singapore 1984,139-240p.
8. Jadhav YT, Mane SR, Shinde DS. Effect of different newer pesticides on aphid population of summer okra. International Journal of Plant Protection. 2016;9(2):418-423.
9. Meenambigai C, Bhuvaneswari K, Kumar KM, Sangavi R. Pesticides usage pattern of okra, *Abelmoschus esculentus* (L.) Moench in Tamil Nadu. Journal of Entomology and Zoology Studies. 2017;5(6):1760-1765.
10. Mishra PN. Bio-efficacy of some newer insecticides against the pest complex of Okra. Bangladesh Horticulture 1991;17(1):1-4.
11. Naik RH, Devakumar N, Rao GE, Vijaya N, Khan HS, Subha S. Performance of botanical and fungal formulation for pest management in organic okra production system. J Bio-pest 2012;5:12-16.
12. Pareek BL, Sharma GR, Bhatnagar KN. Field evaluation and economics of insecticides against the major pests of okra. International Journal of Pest Management 1987;33(3):192-195.
13. 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.
14. Pawar MA, Patil CS, Guru PN. Evaluation of efficacy of neonicotinoids against *Aphis gossypii* Glover and *Amrasca biguttula biguttula* Ishida infesting okra. Journal of Pharmacognosy and Phytochemistry 2018;7(1):346-350.
15. Preetha G, Manoharan T, Kuttalam S, Stanley J. Foliar application of Imidacloprid 17.8 SL against bhendi aphid, *Aphis gossypii* Glover. Pest Management in Horticultural Ecosystems 2007;13(2):134-138.
16. Prem Kumar KN, Ashwani Kumar. Efficacy of selected insecticides against sucking insect pests (*Amrasca biguttula biguttula* (Ishida) and *Bemisia tabaci* (Gennadius)) of okra (*Abelmoschus esculentus* (L.) Moench). International Journal of Current Microbiology and Applied Science 2017;6(8):3256-3259.
17. Venkataravanappa V, Krishnareddy M, Lakshinimarayanreddy CN, Jlali S. Management of okra YVM disease through neem product and insecticides. Annals of Plant Protection Sciences 2012;19(2):487-488.