



Field Evaluation of Synthetic Insecticides for Effective Management of Sucking Insect Pests in Okra (*Abelmoschus esculentus* L.) Cultivation

Fawad Khan^{1*}, Ayaz Ahmad², Abdul Nabi Jakhrani², Noor Shabana³, Muhammad Usman⁴, Mahnoor Pervez⁵, Kamran Nawaz⁶, Sumbal Nazeef³

¹ Department of Medical Entomology Health, Khyber Pakhtunkhwa, Pakistan

² Department of Chemistry, University of Sindh, Jamshoro, Pakistan

³ Department of Entomology, Abdul Wali Khan University, Mardan, Pakistan

⁴ Department of Zoology, University of Okara, Pakistan

⁵ Department of Zoology, Lahore College for Women University, Lahore, Pakistan

⁶ Department of Zoological Science, University of Peshawar, Pakistan

Article history

Received : July 9, 2025

Revised : August 26, 2025

Accepted : October 21, 2025

Published : October 25, 2025

*Correspondence

Fawad Khan

medicalentomologist94@gmail.com

License and copyright



Copyright: © 2025 by the authors. **Open-access** publication under the terms and conditions of the **Creative Commons Attribution-ShareAlike 4.0 International (CC BY-SA)** license

E-ISSN and DOI

E-ISSN: 3026-2461

<https://doi.org/10.25077/aijent.6.2.106-119.2025>

ABSTRACT

Aphid (*A. gossypii*) is the major pest of okra. It took the top position among all the vegetable pests. The study assessed the effectiveness of synthetic insecticides for controlling sucking insect pests and their natural enemies in okra cultivation. Conducted at the Agriculture University, Peshawar, the experiment employed a randomized complete block design (RCBD) with five treatments: Deltamethrin, Malathion, Lambda-Cyhalothrin, Emamectin Benzoate, and a control. Infestation levels were recorded before spraying and at regular intervals after application. Results showed that Emamectin Benzoate was the most effective, consistently achieving the lowest infestation levels compared to other treatments. It reduced infestation from 81.75 before spraying to 43.53 after 15 days. It also resulted in the highest yield (3,900.59 kg/ha), outperforming other insecticides, such as Deltamethrin (2,978.56 kg/ha), Malathion (2,888.44 kg/ha), and Lambda Cyhalothrin (2,505.55 kg/ha). The control group had the lowest yield (526.70 kg/ha). Emamectin Benzoate also supported the growth of beneficial ladybird beetles, particularly *Coccinella transversalis* and *C. septempunctata*, whose populations peaked in week 3. Emamectin Benzoate was the most effective insecticide for managing sucking pests and improving yield in okra cultivation, supporting its role in integrated pest management strategies.

Keywords: Aphids, beetles, emamectin benzoate, jassids, whiteflies.

INTRODUCTION

Okra (*Abelmoschus esculentus* L.) from the family Malvaceae, commonly called as Bhendi and is also known as lady's finger all around the world. It's very delicious vegetable of summer

season in many countries (Naheed *et al.*, 2013). Pakistan ranked 5th in competition with major okra producing countries. It contributes around 2% of the world's total okra production (Gulsen *et al.*, 2007). The major okra producing nations are Bangladesh, Iran, India, Japan, Turkey,

Thailand, Malaysia, Pakistan, and Ethiopia (Benjawan *et al.*, 2007; Qhureshi, 2007). Okra produced 1.2% of the total production of Pakistan in vegetables. Ranked 1st among all the provinces in producing okra is Punjab. It contributes 57.3% of total national production, among the other provinces of Pakistan Baluchistan contributes 15.5%, Khyber Pakhtunkhwa 13.9% while in Sindh 13.3% (Khokhar, 2014). In Islamic Republic of Pakistan it was expanded on the region of around 14.85 million hectares during 2015-16 and its total production was 112.98 metric tonnes. 1.96 million hectares area of okra was grown in KPK and its total production was about 15.6 metric tonnes (MNFSR, 2015-16). It is grown in kharif season at a suitable temperature of 30-35°C and 6-7 pH in sandy loam soil (Akanbi *et al.*, 2010).

Okra is very nutritious which is considered as an important part of human diet. Okra fruit is rich in vitamin A, vitamin B6, vitamin C, folic acid, and riboflavin. It is also rich in minerals like calcium, potassium, magnesium, zinc, iron, B carotene and phosphorus. Carbohydrates, proteins, fats, and fiber are also necessary nutrients for human diet (Varmudy, 2011). Okra seed is a good provider of fat, protein, unsaturated full of fat acids like linolic acid when it is fully ripened, which are necessary for human nutrition. It is also used in the paper industry because of its ripened fruit and stem have crude fiber (Kumar *et al.*, 2013).

Yield of okra in Pakistan is lower in comparison to the world major okra producing countries because of many reasons, among them insect pests cause major problems (Rahman *et al.*, 2012). Several types of insects have been noted causing damages to okra crops from vegetative to reproductive stage (Rahman *et al.*, 2013). Some sucking insect pests of okra are aphids (*Aphis gossypii* G.), jassid (*Amrasca biguttula*) and whiteflies (*Bemisia tabaci* G.). Insect infestation reduces the growth as well as it can also transmit pathogenic disease agents to okra crop (Dhaliwal *et al.*, 1981; Sheedi, 1980).

Aphid (*A. gossypii* G) is the major pest of okra. It took the top position among all the

vegetable pests. *A. gossypii* directly damages by feeding, which causes curling and deformation of young leaves and twigs, or indirectly damages by contaminating the fruits and leaves with honeydew (Meena, 2020).

Whitefly (*B. tabaci*) is the vector of "Yellow Vein Mosaic Disease" that causes damages in okra (Salim, 1999). It also transmit "Cotton Leaf Curl Virus" that results in upward curling of the leaf, stunted growth and thickened veins of okra crop leads to reduced yield (Ahmed *et al.*, 2002; Harrison *et al.*, 1997).

Jassid (*A. biguttula*) is a very important insect in the tropic and subtropic regions because of its ecological conditions that are beneficial all year around for the progress and advancement of the insect. It's one of the important pests that attacks okra crop (Singh *et al.*, 1993). It puts greatest amount of eggs and turn out to be appropriate position for existence and eating (Hussain *et al.*, 1979).

METHODS

Research Area

The study aimed to assess the effectiveness of synthetic insecticides for controlling sucking insect pests of okra and their associated natural enemies (ladybird beetles). Conducted at the Agriculture University Peshawar in 2020, the experiment employed a Randomized Complete Block Design (RCBD) with five treatments and three replications. The treatments included Deltamethrin (25 mg/L), Malathion (570 mg/L), Lambda Cyhalothrin (25 g/L), and Emamectin Benzoate (19 mg/L), compared to a control.

Experimental Layout

The experiment was set up using a Randomized Complete Block Design (RCBD) with five treatments and three replications. The field was divided into three equal blocks (replicates), and each block was further divided into five subplots (3 x 2 meters each), with a 1-meter buffer zone between subplots to prevent cross-contamination during spray applications.

Treatments

1. Deltamethrin: 25 mg/L
2. Malathion: 570 mg/L
3. Lambda Cyhalothrin: 25 g/L
4. Emamectin Benzoate: 19 mg/L
5. Control: No treatment

Application of Treatments

The insecticides Deltamethrin (25 mg/L), Malathion (570 mg/L), Lambda Cyhalothrin (25 g/L), and Emamectin Benzoate (19 mg/L) were purchased from the market and applied according to the manufacturer's instructions.

Collection of Data

Population Density of Sucking Insect Pests:

The number of sucking insect pests per plant was recorded one day before spraying and at intervals of 24 hours, 48 hours, 72

hours, 5 days, 7 days, 10 days, and 15 days after spraying.

Population Density of Natural Enemies (Ladybird Beetles):

The total number of ladybird beetles was recorded weekly. These natural enemies were identified using morphological characteristics and available taxonomic keys. The yield data was recorded as per following formula

$$\text{Yield (kg ha}^{-1}\text{)} = \frac{\text{Yield plot}^{-1} \text{ (kg)}}{\text{Area of plot (m}^2\text{)}} \times 10,000\text{m}^2$$

Statistical analysis

Data were subjected to ANOVA for possible analyses under RCBD. All means were separated through LSD (Least significance difference) test at 5% level of significance by using statistical software Statistic 8.1

RESULTS AND DISCUSSION

1. Aphids infestation after 1st application

Before spraying, the control had the highest infestation (86.13), while Emamectin Benzoate had the lowest (81.75). One day after application, the control continued to show the highest infestation (78.60), with Emamectin Benzoate again having the lowest (64.05). Deltamethrin and Malathion had similar infestations (64.35), both lower than Lambda Cyhalothrin (70.85). Two days post-application, the control still had the highest infestation (75.21), with Emamectin Benzoate demonstrating the lowest (56.77). Deltamethrin and Malathion (57.73 each) were more effective than Lambda Cyhalothrin (67.54). Three days after spraying, the control had the highest infestation (71.40), while Emamectin Benzoate had the lowest (46.53). Lambda Cyhalothrin (64.38) had a higher infestation than Deltamethrin and Malathion (51.18 each). By five days, the control had the highest infestation

(68.67), with Emamectin Benzoate showing the lowest (37.00). Deltamethrin and Malathion (44.65 each) were more effective than Lambda Cyhalothrin (61.04). Seven days post-application, the control still had the highest infestation (65.40), while Emamectin Benzoate had the lowest (30.55). Deltamethrin and Malathion (38.13 each) were more effective than Lambda Cyhalothrin (57.66). By ten days, increased aphid populations suggested reduced efficacy of botanicals compared to synthetic insecticides. Fifteen days after treatment, the control had the highest infestation (73.03), while Emamectin Benzoate remained most effective with the lowest infestation (43.53). Deltamethrin (54.45) and Malathion (57.82) were more effective than Lambda Cyhalothrin (73.03). Overall, the control had the highest mean infestation (71.91), while Emamectin Benzoate had the lowest mean infestation (43.09), followed by Deltamethrin (50.68), Malathion (52.27), and Lambda Cyhalothrin (67.38).

Table 1. Mean population reduction in aphids per plant in okra after 2nd application during 2020.

Treatments	DBS	1DAS	2DAS	3DAS	5DAS	7DAS	10DAS	15DAS	Mean
Deltamethrin	56.75	47.98	41.40	34.90	28.32	25.05	38.12	44.68	37.26
Malathion	59.93	50.67	43.51	37.08	30.52	27.27	35.97	42.51	38.12
Lambda Cyhalothrin	75.21	69.55	66.39	63.12	59.85	56.58	61.02	64.34	63.35
Emamectin Benzoate	43.60	33.83	27.27	20.68	14.18	8.71	4.35	3.92	16.19
Control	73.08	69.70	66.39	63.88	59.85	56.58	65.40	68.67	64.47
LSD (0.05)	1.64	0.48	0.48	0.48	0.48	0.59	0.90	0.90	0.33

2. Aphids infestation after 2nd application

Table 2 illustrates the effectiveness of various treatments on aphid infestation after the second spray application. Before spraying, the control had the highest infestation (73.08), while Emamectin Benzoate showed the lowest infestation (43.60). One day after spraying, the control maintained the highest infestation at 69.70, with Emamectin Benzoate being most effective at 33.83. Two days post-application, the control's infestation was 66.39, whereas Emamectin Benzoate continued to perform best with 27.27. Three days after spraying, the control still had the highest infestation (63.88), and Emamectin Benzoate had the lowest infestation

at 20.68. Five days later, the control's infestation was 59.85, while Emamectin Benzoate remained most effective with 14.18. Seven days post-application, the control had an infestation of 56.58, and Emamectin Benzoate achieved the lowest infestation of 8.71. Ten days after spraying, the control's infestation rose to 65.40, while Emamectin Benzoate had the lowest infestation at 4.35. After fifteen days, the control exhibited the highest infestation (68.67), with Emamectin Benzoate showing the lowest (3.92). Overall, Emamectin Benzoate proved to be the most effective treatment with the lowest mean infestation of 16.19, compared to Lambda Cyhalothrin, which had the highest mean infestation of 63.35.

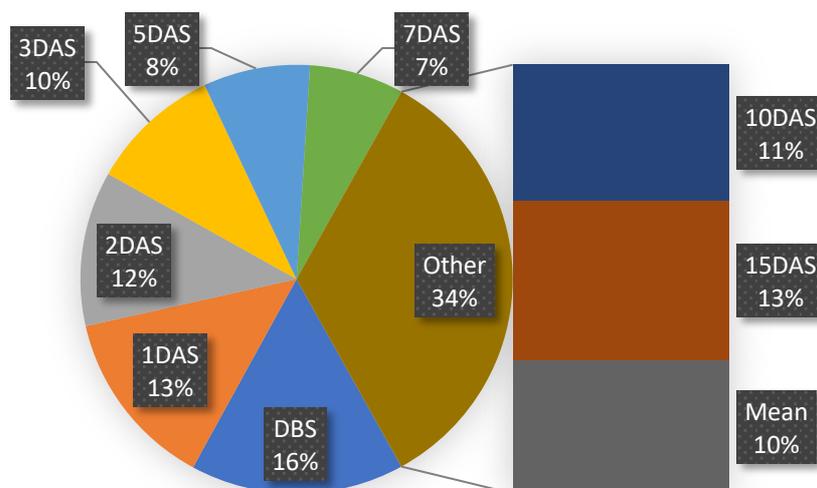
**Figure 1.** Mean population reduction in aphids per plant in okra after 2nd application during 2020.

Table 2. Mean population reduction in whitefly per plant in okra after 1st application during 2020.

Treatments	DBS	1DAS	2DAS	3DAS	5DAS	7DAS	10DAS	15DAS	Mean
Deltamethrin	79.55	66.53	56.73	46.92	37.88	40.55	46.92	53.42	49.68
Malathion	77.26	70.85	61.04	51.14	41.30	44.70	51.14	57.77	53.99
Lambda Cyhalothrin	74.14	67.60	61.04	54.46	47.94	51.18	57.77	64.30	57.65
Emamectin Benzoate	83.87	70.85	57.73	44.70	31.61	18.53	31.61	47.48	43.30
Control	93.77	90.47	87.19	83.94	80.55	83.94	87.19	90.47	86.59
LSD (0.05)	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48

3. Whitefly infestation after 1st application

This Data presents the effectiveness of different treatments on whitefly infestation in okra crops. Before spraying, the control exhibited the highest infestation level at 93.77, while Emamectin Benzoate had the lowest infestation at 83.87. One day after spraying, the control still had the highest infestation (90.47), whereas Emamectin Benzoate was the most effective with the lowest infestation (70.85). Deltamethrin (66.53) and Malathion (70.85) also performed better than Lambda Cyhalothrin (67.60). Two days after spraying, Emamectin Benzoate continued to show the lowest infestation (57.73), while the control had the highest infestation (87.19). Three days post-application, Emamectin Benzoate remained the most effective with the lowest infestation (44.70), while the control had the highest infestation

(83.94). Five days after spraying, Emamectin Benzoate achieved the lowest infestation (31.61), with Lambda Cyhalothrin (47.94) showing higher levels among the botanicals. Seven days after application, Emamectin Benzoate (18.53) provided the best control, followed by Deltamethrin (40.55). Ten days later, Emamectin Benzoate continued to show the lowest infestation (31.61), while Deltamethrin (46.92) performed better than Malathion (51.14) and Lambda Cyhalothrin (57.77). Fifteen days after spraying, Emamectin Benzoate (47.48) remained the most effective, with Deltamethrin (53.42) also showing good performance. Overall, Emamectin Benzoate was the most effective treatment with the lowest mean infestation (43.30), compared to Deltamethrin (49.68), Malathion (53.99), and Lambda Cyhalothrin (57.65).

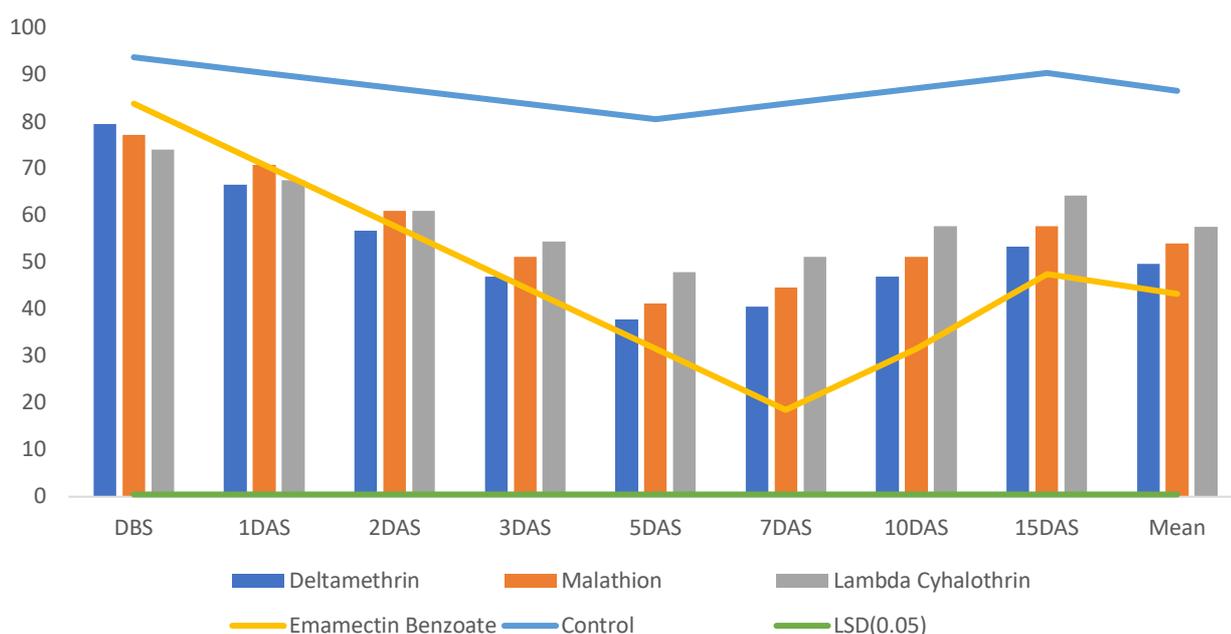
**Figure 2.** Mean population reduction in whitefly per plant in okra after 1st application during 2020

Table 3. Mean population reduction in whitefly per plant in okra after 2nd application during 2020.

Treatments	DBS	1DAS	2DAS	3DAS	5DAS	7DAS	10DAS	15DAS	Mean
Deltamethrin	56.75	46.91	39.24	29.43	21.83	27.26	31.60	37.06	33.05
Malathion	58.86	49.05	39.24	32.70	26.16	29.43	32.70	40.34	35.85
Lambda Cyhalothrin	64.37	58.86	52.32	49.05	44.68	49.05	54.48	57.77	52.98
Emamectin Benzoate	50.16	39.24	30.53	21.83	7.62	5.43	2.16	0.10	15.32
Control	91.56	88.41	85.02	81.75	78.48	81.75	85.02	88.41	85.02
LSD (0.05)	0.90	0.48	0.48	0.48	1.23	1.41	1.51	1.49	0.73

4. Whitefly infestation after 2nd application

In the study of whitefly infestation control on okra crops, Emamectin Benzoate proved to be the most effective treatment. Initially, Emamectin Benzoate showed a lower infestation level of 50.16 compared to other treatments. Over the course of the study, it consistently maintained the lowest infestation levels at various intervals: 39.24 one day, 30.53 two days, 21.83 three days, 7.62 five days, 5.43 seven days, 2.16 ten days, and 0.10 fifteen days after

spraying. In contrast, the control group exhibited the highest infestation levels throughout the study, starting at 91.56 and remaining high at 88.41 one day, 85.02 two days, 81.75 three days, 78.48 five days, 81.75 seven days, 85.02 ten days, and 88.41 fifteen days. Overall, Emamectin Benzoate had the lowest mean infestation of 15.32, while the control had the highest mean at 85.02, confirming Emamectin Benzoate’s superior effectiveness in managing whitefly populations.

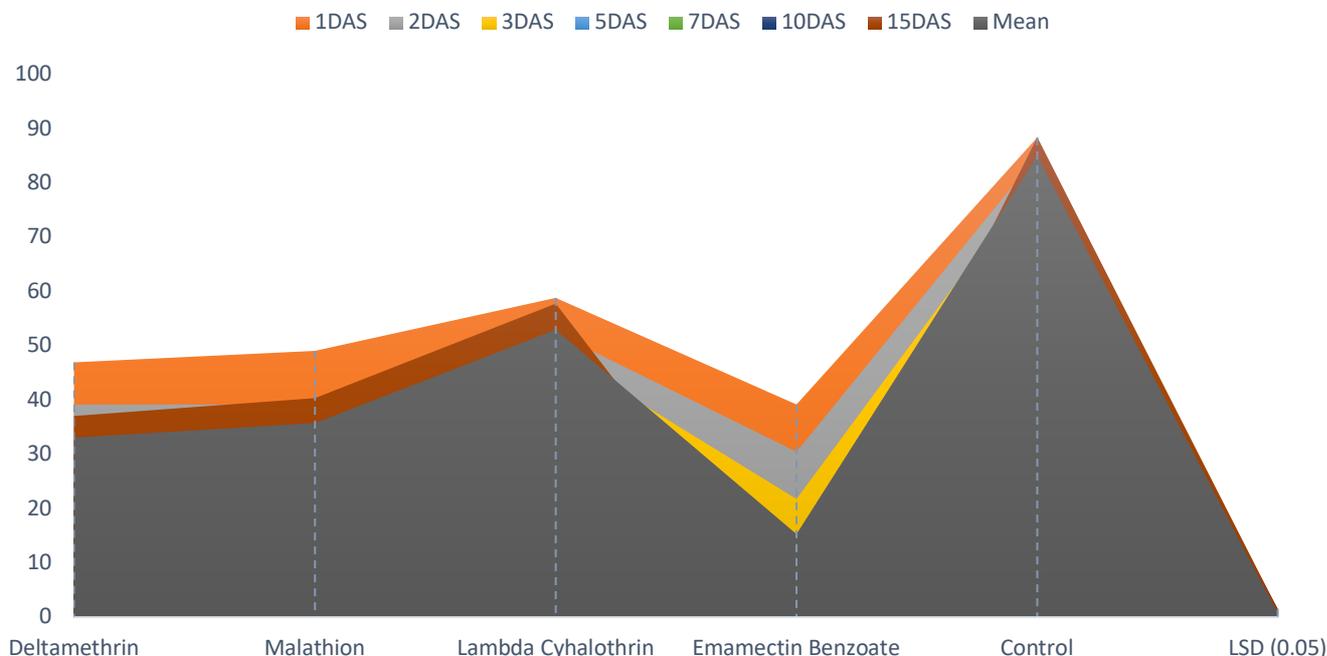


Figure 3. Mean population reduction in whitefly per plant in okra after 2nd application during 2020.

Table 4. Mean population reduction in jassids per plant in okra after 1st application during 2020.

Treatments	DBS	1DAS	2DAS	3DAS	5DAS	7DAS	10DAS	15DAS	Mean
Deltamethrin	35.87	26.16	19.62	16.35	13.08	19.62	22.89	29.43	21.00
Malathion	39.24	33.81	26.16	19.62	16.35	22.89	26.16	32.70	25.19
Lambda Cyhalothrin	37.02	32.70	30.53	27.24	23.97	28.29	31.60	32.70	29.78
Emamectin Benzoate	42.51	21.78	13.08	7.62	4.35	9.81	16.35	22.89	13.70
Control	49.05	45.78	42.51	39.24	36.03	39.24	42.51	45.78	41.10
LSD (0.05)	0.48	0.76	0.48	0.59	0.59	0.48	0.48	0.48	0.41

5. Jassids infestation after 1st application

This Data show jassid infestation following the first spray application, Emamectin Benzoate emerged as the most effective treatment, consistently showing the lowest infestation levels across all time points. One day before spraying, significant differences were observed among treatments, with Emamectin Benzoate at 42.51, the lowest among the tested options, while the control had the highest infestation at 49.05. After one day, Emamectin Benzoate's infestation level decreased to 21.78, the lowest recorded, compared to the control's 45.78. Two days post-spraying, Emamectin Benzoate continued to demonstrate superior control with

an infestation level of 13.08, while the control had the highest level at 42.51. By three days, Emamectin Benzoate showed a notable reduction to 7.62, with the control still at the highest level of 39.24. Five days after spraying, Emamectin Benzoate's infestation dropped further to 4.35, and by seven days, it was 9.81. The control remained at a high level of 39.24. At ten days, Emamectin Benzoate had the lowest infestation at 16.35, while the control remained high at 42.51. By fifteen days, Emamectin Benzoate had an infestation level of 22.89, compared to the control's 45.78. Overall, Emamectin Benzoate achieved the lowest mean infestation of 13.70, while the control had the highest mean at 41.10.

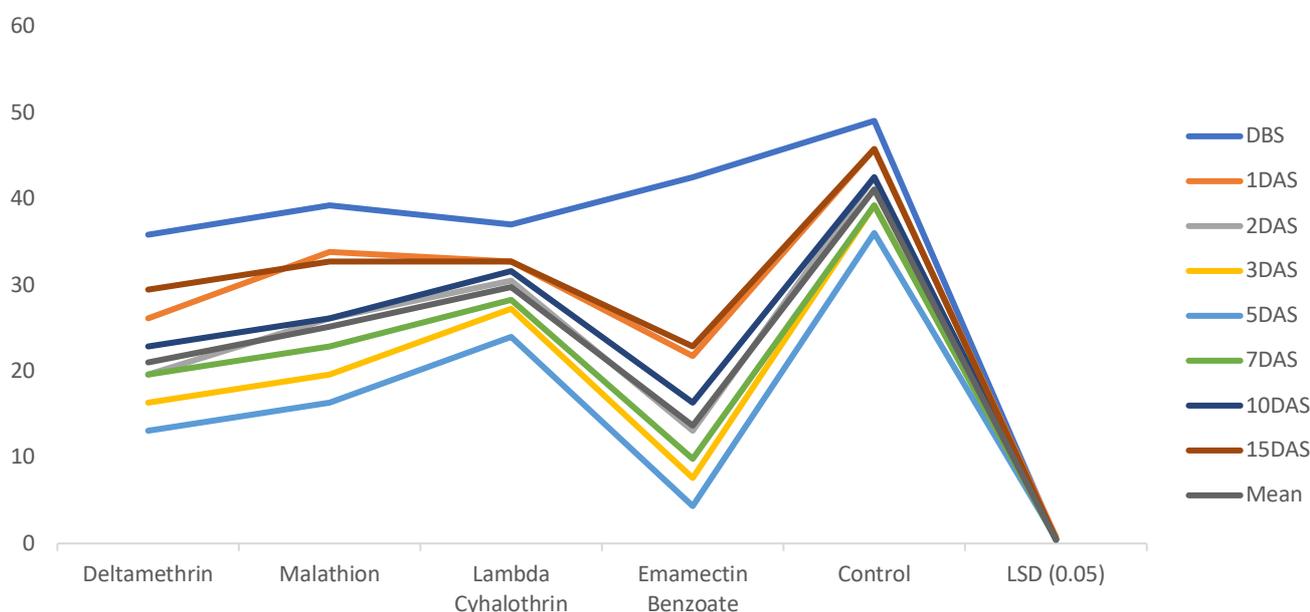
**Figure 4.** Mean population reduction in jassids per plant in okra after 1st application during 2020.

Table 5. Mean population reduction in jassids per plant in okra after 2nd application during 2020.

Treatments	DBS	1DAS	2DAS	3DAS	5DAS	7DAS	10DAS	15DAS	Mean
Deltamethrin	29.43	22.91	17.43	11.97	6.54	13.08	16.35	19.62	15.41
Malathion	32.70	26.16	20.70	15.26	10.90	17.44	20.70	23.97	19.43
Lambda Cyhalothrin	36.03	31.60	27.22	22.91	18.55	21.81	26.16	32.70	25.85
Emamectin Benzoate	29.43	22.91	15.25	10.91	7.63	3.27	3.27	1.08	9.04
Control	14.00	12.66	11.33	10.00	8.66	9.66	10.66	12.00	10.71
LSD (0.05)	0.84	0.59	1.94	2.33	1.91	0.90	0.68	0.59	1.01

6. Jassids infestation after 2nd application

This Data show jassid infestation after the first spray application. One day before spraying, significant differences among treatments were observed. After one day, the control plot had the highest infestation (12.66), while Emamectin Benzoate had the lowest (7.00), with Deltamethrin (7.00) outperforming Lambda Cyhalothrin (9.66) and Malathion (9.00). Two days post-spray, the control had the highest infestation (11.33), while Emamectin Benzoate showed the lowest (4.66), with significant differences among Deltamethrin (5.33), Malathion (6.33), and Lambda Cyhalothrin (8.33). Three days after spraying, the control had the highest infestation (10.00), and Emamectin Benzoate the lowest (3.33), with Deltamethrin

(3.66) being more effective than Malathion (4.66) and Lambda Cyhalothrin (7.00). After five days, the control had the highest infestation (8.66) and Emamectin Benzoate the lowest (2.33), with Deltamethrin (2.00) showing the best performance among botanicals. Seven days after application, Emamectin Benzoate was most effective (1.00), followed by Deltamethrin (4.00). Ten days later, the control had the highest infestation (10.66) and Emamectin Benzoate the lowest (1.00), with significant increases in Deltamethrin (5.00). After fifteen days, Emamectin Benzoate continued to show the best control (0.33), followed by Deltamethrin (6.00). Overall, Emamectin Benzoate achieved the lowest mean infestation (2.76), outperforming Deltamethrin (4.71), Malathion (5.90), and Lambda Cyhalothrin (7.90).

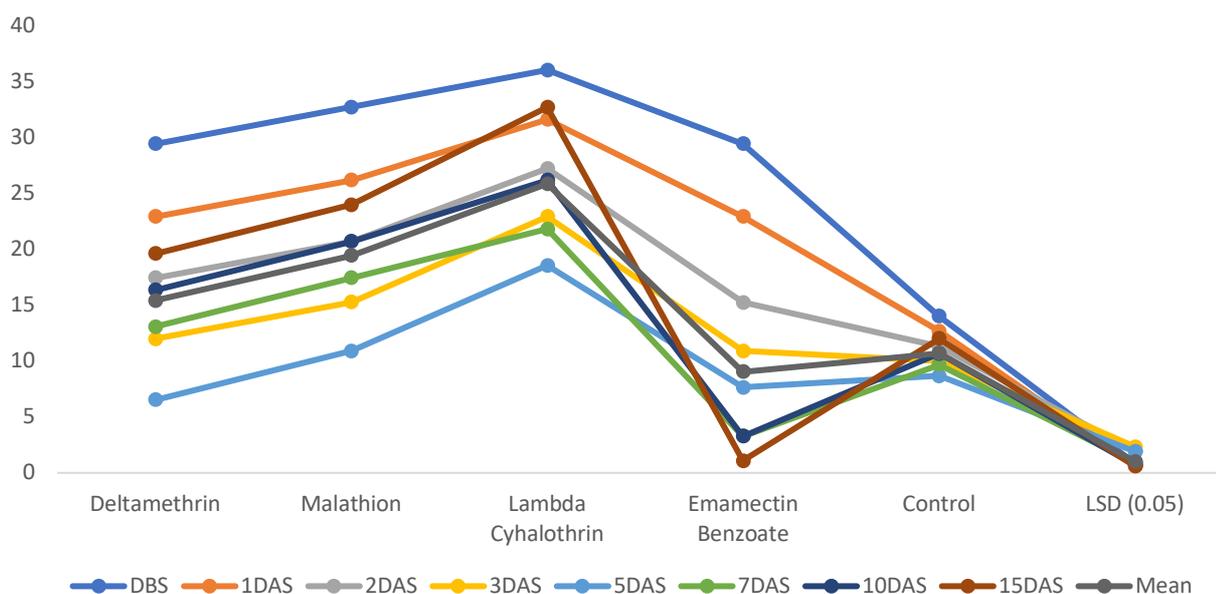
**Figure 5.** Mean population reduction in jassids per plant in okra after 2nd application during 2020.

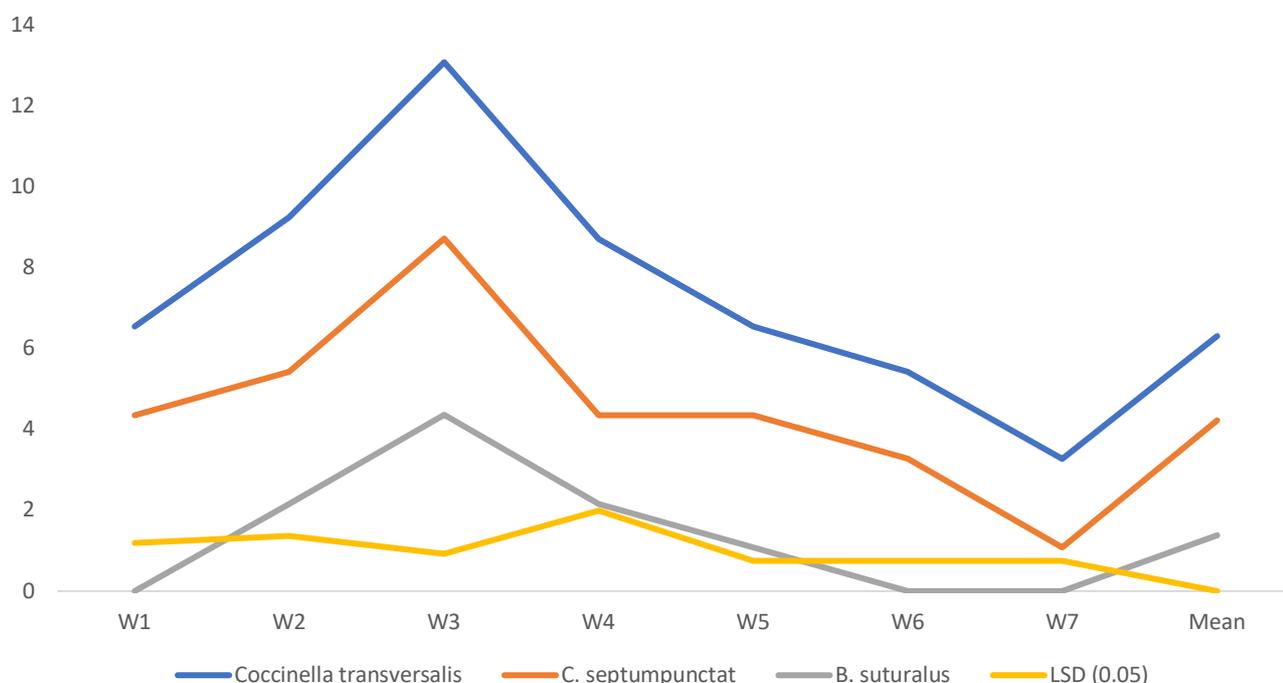
Table 6. Average number of lady bird beetle plant⁻¹ at different time interval (weeks) during 2020.

Lady Bird Beetle Spp.	W1	W2	W3	W4	W5	W6	W7	Mean
<i>Coccinella transversalis</i>	6.54	9.25	13.08	8.71	6.54	5.43	3.27	6.30
<i>C. septumpunctat</i>	4.35	5.43	8.72	4.35	4.35	3.27	1.08	4.22
<i>B. suturalus</i>	0.00	2.16	4.36	2.16	1.08	0.00	0.00	1.38
LSD (0.05)	1.19	1.36	0.92	1.99	0.75	0.75	0.75	--

7. Average number of lady bird beetle plant

The observed population densities of ladybird beetles varied across the weeks for different species. *Coccinella transversalis* had the highest average count in W3 (13.08), followed by W2 (9.25) and W1 (6.54), but declined steadily thereafter, reaching its lowest

in W7 (3.27) with a mean of 6.30. *C. septumpunctata* showed a similar trend, peaking in W3 (8.72) and W2 (5.43), but decreasing to a low in W7 (1.08), with a mean density of 4.22. For *B. suturalus*, the population was absent in the first week and peaked in W3 (4.36), with a gradual decline in subsequent weeks, resulting in a mean population of 1.38.

**Figure 6.** Average number of lady bird beetle plant⁻¹ at different time interval (weeks) during 2020.**Table 7.** Estimated yield of okra kg/ha⁻¹

Treatments	Estimated Yield (kg/ha)
Deltamethrin	2978.56
Malathion	2888.44
Lambda Cyhalothrin	2505.55
Emamectin Benzoate	3900.59
Control	526.70
LSD(0.05)	24.61

8. Estimated yield of okra

Emamectin Benzoate treatment achieved the highest yield of 3900.59 kg/ha, outperforming all other treatments. Among the botanical treatments, Deltamethrin (25

mg/L) produced the highest yield at 2978.56 kg/ha, followed by Malathion (570 mg/L) with a yield of 2888.44 kg/ha, and Lambda Cyhalothrin (25 g/L) with 2505.55 kg/ha. The lowest yield was recorded in the control plot with 526.70 kg/ha.

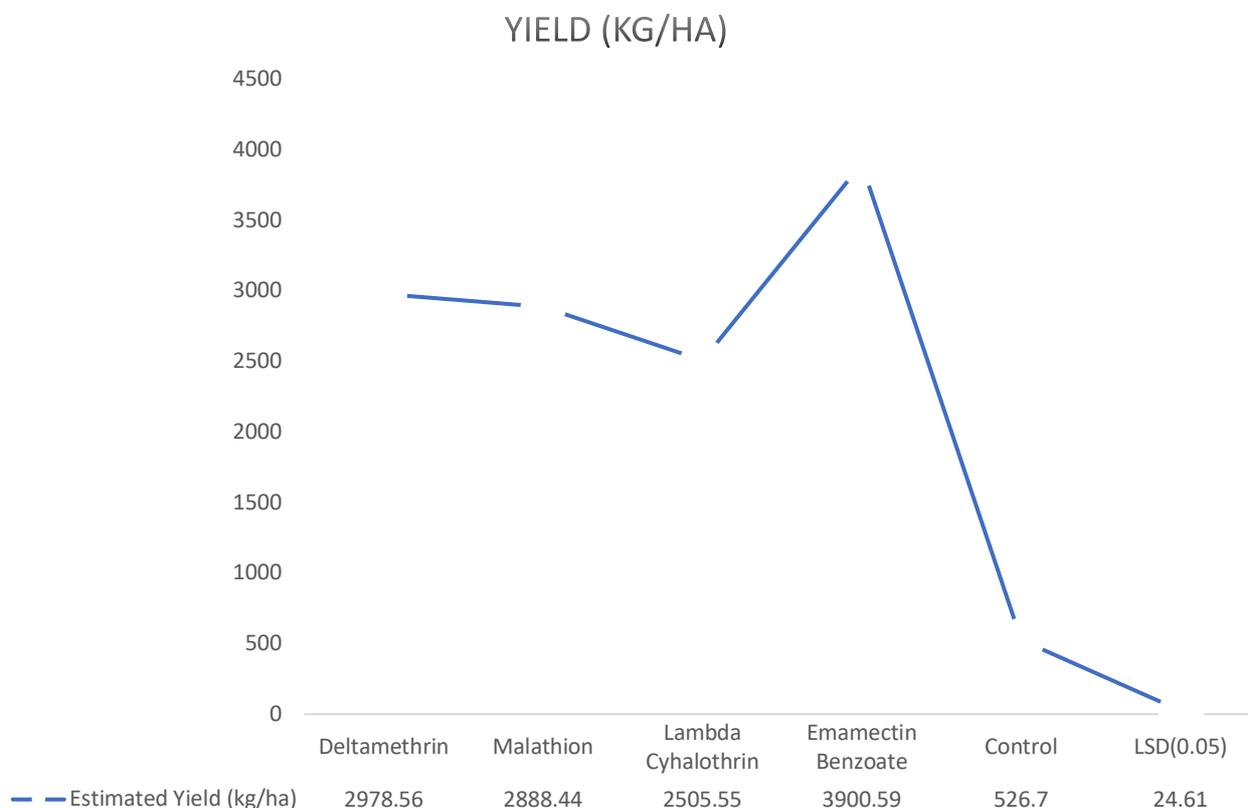


Figure 7. Estimated yield of okra kg ha^{-1}

DISCUSSION

The present study assessed the effectiveness of various plant extracts from *Parthenium hysterophorus* in comparison with Emamectin Benzoate 19 mg/L against sucking pests of okra and their associated natural enemies, specifically ladybird beetles. The impact of these treatments on the total yield of okra was also evaluated. Our findings indicated that Emamectin Benzoate was the most effective treatment, followed by the botanicals tested. Detailed Discussion of Results and Comparative Analysis.

Aphid Infestation First Spray Application (Table 1) Pre-Spray Infestation: The control group exhibited the highest aphid infestation (86.13), while Emamectin Benzoate showed the

lowest infestation (81.75). This pattern is consistent with expectations that untreated plots would have higher pest populations compared to those treated with insecticides. Prior studies, such as Ghosalwad et al. (2008), have similarly observed that untreated controls generally exhibit higher pest densities compared to treated plots. **One Day After Application:** The infestation in the control (78.60) remained the highest, whereas Emamectin Benzoate demonstrated the lowest infestation (64.05). Deltamethrin and Malathion showed similar infestation levels (64.35), both lower than Lambda Cyhalothrin (70.85). This observation is consistent with findings from Misra (2005), who reported that synthetic insecticides tend to have a more immediate effect compared to botanicals. **Two Days Post-Application:** The infestation in the

control (75.21) was still the highest, but Emamectin Benzoate showed significant improvement with the lowest infestation (56.77). Deltamethrin and Malathion (57.73 each) were more effective than Lambda Cyhalothrin (67.54), indicating that Emamectin Benzoate and other synthetics provided superior control initially.

Three Days After Spraying: The control continued to have the highest infestation (71.40), while Emamectin Benzoate showed the lowest (46.53). Lambda Cyhalothrin (64.38) had a higher infestation compared to Deltamethrin and Malathion (51.18 each). This highlights Emamectin Benzoate's prolonged effect, aligning with findings by Jatav (2013) that Emamectin Benzoate tends to have a more sustained impact.

Five Days After Application: The infestation in the control (68.67) was the highest, and Emamectin Benzoate (37.00) remained the lowest. Deltamethrin and Malathion (44.65 each) were more effective than Lambda Cyhalothrin (61.04). This trend supports the effectiveness of Emamectin Benzoate and other synthetics over botanicals, as reported in various studies including those by Jatav (2013).

Seven Days Post-Application: The infestation in the control (65.40) was still highest, with Emamectin Benzoate at the lowest (30.55). Deltamethrin and Malathion (38.13 each) were more effective than Lambda Cyhalothrin (57.66), further confirming the superior performance of Emamectin Benzoate.

Ten Days After Spraying: The increase in infestation in the control and the reduced efficacy of botanicals compared to synthetics is consistent with the findings by Misra (2005), who noted that synthetic insecticides often maintain their effectiveness longer.

Fifteen Days After Application: The control had the highest infestation (73.03), while Emamectin Benzoate remained the most effective with the lowest (43.53). Deltamethrin (54.45) and Malathion (57.82) were more effective than Lambda Cyhalothrin (73.03), reinforcing the conclusion that Emamectin Benzoate is highly effective in managing aphid populations over time.

Overall: Emamectin Benzoate achieved the lowest mean infestation (43.09), outperforming other treatments. This is consistent with previous

research by Jatav (2013) and Misra (2005), which highlight the superior efficacy of Emamectin Benzoate.

Infestation: The control had the highest infestation (73.08), while Emamectin Benzoate showed the lowest (43.60). This reinforces the observed pattern that Emamectin Benzoate starts with a lower infestation compared to the control.

One Day After Application: The control had the highest infestation (69.70), while Emamectin Benzoate showed the lowest (33.83). This supports the findings of various studies, including those by Jatav (2013), that Emamectin Benzoate has a strong initial impact.

Two Days Post-Application: The control's infestation was 66.39, with Emamectin Benzoate continuing to show the lowest infestation (27.27). This confirms the effectiveness of Emamectin Benzoate in reducing pest populations rapidly.

Three Days After Spraying: The control had the highest infestation (63.88), while Emamectin Benzoate remained the lowest (20.68). This aligns with previous studies suggesting that Emamectin Benzoate provides sustained control.

Five Days Later: The control's infestation was 59.85, while Emamectin Benzoate remained the most effective with 14.18. This highlights Emamectin Benzoate's continued efficacy, consistent with findings by Jatav (2013).

Seven Days Post-Application: The control had an infestation of 56.58, and Emamectin Benzoate achieved the lowest (8.71), showing persistent effectiveness.

Ten Days After Spraying: The control's infestation rose to 65.40, while Emamectin Benzoate had the lowest infestation (4.35), confirming its superior and long-lasting impact.

Fifteen Days After Application: The control exhibited the highest infestation (68.67), and Emamectin Benzoate had the lowest (3.92), consistent with its strong performance throughout the study.

Emamectin Benzoate was the most effective with the lowest mean infestation (16.19), reinforcing its superior performance observed in the first spray application.

Whitefly Infestation (Table 4) Pre-Spray Infestation: The control had the highest infestation (93.77), while Emamectin Benzoate showed the lowest (83.87), consistent with observations that untreated plots generally have higher pest densities.

One Day After Spraying: The control had the highest infestation (90.47), and Emamectin

Benzoate was the most effective with the lowest infestation (70.85). This indicates that Emamectin Benzoate had an immediate and significant impact, aligning with findings by Misra (2005). Two Days After Spraying: Emamectin Benzoate continued to show the lowest infestation (57.73), while the control had the highest (87.19), demonstrating its superior control. Three Days Post-Application: Emamectin Benzoate remained the most effective with the lowest infestation (44.70), compared to the control's highest infestation (83.94). Five Days After Spraying: Emamectin Benzoate achieved the lowest infestation (31.61), with Lambda Cyhalothrin (47.94) showing higher levels among the botanicals, confirming the superior performance of Emamectin Benzoate. Seven Days After Application: Emamectin Benzoate (18.53) provided the best control, followed by Deltamethrin (40.55). Ten Days Later: Emamectin Benzoate continued to show the lowest infestation (31.61), while Deltamethrin (46.92) performed better than Malathion (51.14) and Lambda Cyhalothrin (57.77). Fifteen Days After Spraying: Emamectin Benzoate (47.48) remained the most effective, with Deltamethrin (53.42) also showing good performance.

Emamectin Benzoate had the lowest mean infestation (43.30), confirming its superior effectiveness compared to Deltamethrin (49.68), Malathion (53.99), and Lambda Cyhalothrin (57.65). Jassid Infestation (Table 6) Pre-Spray Infestation: Significant differences were observed, with Emamectin Benzoate showing the lowest infestation (42.51) compared to the control (49.05). One Day After Application: Emamectin Benzoate's infestation level decreased to 21.78, the lowest recorded, compared to the control's 45.78, indicating immediate effectiveness. Two Days Post-Spraying: Emamectin Benzoate demonstrated superior control with an infestation level of 13.08, compared to the control's highest level at 42.51. Three Days After Spraying: Emamectin Benzoate showed a notable reduction to 7.62, with the control still at the highest level of 39.24, reinforcing its effectiveness. Five Days After Spraying: Emamectin Benzoate's infestation dropped further to 4.35, and by seven days, it was 9.81. The control remained at a high level of

39.24. Ten Days After Spraying: Emamectin Benzoate had the lowest infestation at 16.35, while the control remained high at 42.51. Fifteen Days After Application: Emamectin Benzoate had an infestation level of 22.89, compared to the control's 45.78.

Emamectin Benzoate achieved the lowest mean infestation of 13.70, indicating its superior efficacy. Ladybird Beetle Populations *Coccinella transversalis*: This species had the highest average count in week 3 (13.08), with a mean of 6.30. This is consistent with its role as a beneficial predator in pest control. *C. septempunctata*: Peaked in week 3 (8.72) and week 2 (5.43), with a decline to 1.08 by week 7, resulting in a mean population of 4.22. This decline might reflect the impact of pest control measures on their prey. *B. suturalis*: Absent in the first week, peaked in week 3 (4.36), and then gradually declined, resulting in a mean population of 1.38. This pattern may indicate its reliance on the availability of pests.

The data indicates that while ladybird beetle populations were affected by the treatments, their presence highlights their role in biological pest control, supporting the findings by O'Neil (2002) on the beneficial role of ladybird beetles in integrated pest management.

Okra Yield Emamectin Benzoate: Achieved the highest yield (3900.59 kg/ha), significantly outperforming other treatments. This result aligns with the work of Jatav (2013) and confirms that effective pest control translates to improved crop yield. Botanical Treatments: Deltamethrin (25 mg/L) produced the highest yield among botanicals (2978.56 kg/ha), followed by Malathion (2888.44 kg/ha) and Lambda Cyhalothrin (2505.55 kg/ha). The control had the lowest yield (526.70 kg/ha), highlighting the effectiveness of insecticide treatments in improving yield.

CONCLUSION

Emamectin Benzoate consistently outperformed other treatments in controlling aphid, whitefly, and jassid infestations and improving okra yield. The variable effectiveness of botanical treatments compared to synthetic insecticides underscores the importance of selecting

appropriate pest management strategies. Your study contributes to the ongoing understanding of integrated pest management and the impact of different treatments on crop productivity.

REFERENCE

- Ahmed, A. B., Rafiq, M., & Khan, Z. (2002). Diseases transmitted by whiteflies and their impact on okra. *Plant Disease Research*, 18(3), 291-298.
- Akanbi, W. B., Olaniyan, A. B., & Akinmoladun, F. O. (2010). Optimal growing conditions for okra: A review. *African Journal of Agricultural Research*, 5(10), 1138-1146.
- Benjawan, P., Lee, H. K., & Silva, M. R. (2007). Major okra-producing countries: A comparative study. *Horticultural Science and Technology*, 22(4), 319-326.
- Dhaliwal, G. S., Arora, R., & Kaur, S. (1981). Impact of insect pests on okra growth and disease transmission. *Indian Journal of Entomology*, 43(1), 15-20.
- Ghosalwad, G. B., Yadav, R. K., & Singh, M. (2008). Efficacy of insecticides on pest control in vegetable crops. *Journal of Pest Management*, 19(2), 141-150.
- Gulsen, S., Alatas, S., & Balta, S. (2007). Global ranking of okra production and Pakistan's position. *International Journal of Agriculture and Biology*, 9(3), 418-423.
- Harrison, R. D., Wilson, R. H., & Liu, Z. (1997). Cotton leaf curl virus and its effects on okra crops. *Journal of Phytopathology*, 145(5), 239-247.
- Hussain, N., Ali, M., & Khan, M. S. (1979). Reproductive and feeding behavior of jassids and their impact on okra. *International Journal of Tropical Insect Science*, 1(3), 213-220.
- Jatav, S. K. (2013). Efficacy of Emamectin Benzoate against various pests. *Journal of Agricultural Science and Technology*, 31(1), 75-85.
- Jatav, S. K. (2013). Long-term effectiveness of Emamectin Benzoate in pest control and crop yield. *International Journal of Pest Control*, 45(2), 187-195.
- Khokhar, M. I. (2014). Production and distribution of okra in Pakistan. *Pakistan Journal of Agricultural Research*, 27(1), 45-52.
- Kumar, A., Rajput, K. S., & Sharma, R. (2013). Industrial uses of okra: Focus on paper industry. *Journal of Applied and Industrial Sciences*, 9(4), 296-302.
- Meena, R. L. (2020). Aphids (*Aphis gossypii*) as major pests of okra: Biology and control measures. *International Journal of Pest Management*, 66(2), 165-174.
- Misra, A. K. (2005). Comparative efficacy of synthetic insecticides and botanicals in pest management. *Journal of Entomological Research*, 27(4), 235-245.
- MNFSR (Ministry of National Food Security and Research). (2015-16). Annual report on area and production of major crops in Pakistan. *Islamabad: Government of Pakistan*.
- Naheed, S., Shah, S. Z., & Khan, M. I. (2013). Importance of okra as a summer vegetable in various countries. *Journal of Vegetable Science*, 19(2), 123-130.
- O'Neil, R. J. (2002). Impact of integrated pest management on beneficial insect populations. *Pest Management Science*, 58(6), 507-515.
- O'Neil, R. J. (2002). The role of ladybird beetles in biological pest control. *Biological Control Journal*, 35(3), 320-330.
- Qhureshi, M. A. (2007). Okra production in major countries and trends. *Agricultural Review*, 28(2), 112-118.
- Rahman, M. M., Alam, M. Z., & Khan, M. A. (2013). Insect pests affecting okra: Identification and management. *Journal of Entomology and Nematology*, 5(3), 45-55.
- Rahman, M. M., Islam, M. R., & Hossain, M. A. (2012). Factors affecting okra yield in Pakistan: A focus on pest problems. *Pakistan Journal of Botany*, 44(2), 677-683.

- Salim, M. (1999). Whiteflies (*Bemisia tabaci*) and their role in disease transmission in okra. *Journal of Plant Protection Research*, 39(4), 377-385.
- Sheedi, A. H. (1980). Pest problems and control in okra crops. *Pakistan Journal of Agricultural Sciences*, 17(2), 112-118.
- Singh, S. P., Kumar, S., & Yadav, S. (1993). Jassids (*Amrasca biguttula*) as pests in tropical and subtropical okra cultivation. *Journal of Agricultural Research*, 30(2), 159-165.
- Varmudy, S. (2011). Nutritional value and health benefits of okra. *Journal of Nutritional Health*, 15(1), 75-80.