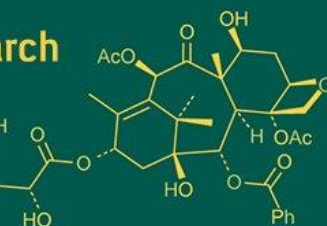
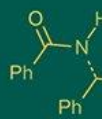


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Bio-efficacy of selected insecticides against *Aphis gossypii* Glover (Hemiptera: Aphididae) on okra and their impact on natural enemies.

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Abstract

Sucking pests including aphid, *Aphis gossypii* Glover cause considerable economic loss to okra cultivation in India. Conventional insecticides are routinely used for management of this pest. Despite the repeated application of conventional insecticides, farmers sometimes report inadequate control of this pest under field conditions. Hence, field experiments were conducted for two consecutive years (2025 and 2026) at Uttar Banga Krishi Viswavidyalaya to evaluate the field efficacy of selected insecticides for management of *Aphis gossypii* on okra. The experiment was laid out in a randomized block design with eight treatments viz., cyantraniliprole 10.26 OD, flonicamid 50 WG, spirotetramat 15.31 OD, tolfenpyrad 15 EC, broflanilide 20 SC, diafenthiuron 50 WP, azadirachtin 5%, and untreated control. Each treatment was replicated thrice. Tolfenpyrad 15 EC @ 150 g a.i. ha⁻¹ was found to be the most effective treatment followed by flonicamid 50 WG and broflanilide 20 SC. Next promising insecticides were cyantraniliprole 10.26 OD and spirotetramat 15.31 OD. Azadirachtin 5% neem extract concentrate appeared to be the least harmful to coccinellid predators followed by tolfenpyrad 15 EC and flonicamid 50 WG.

Keywords: *Aphis gossypii*, *Abelmoschus esculentus*, tolfenpyrad, flonicamid, coccinellid

Introduction

Okra, *Abelmoschus esculentus* (L.) Moench, also known as lady's finger, is a typical warm-season vegetable crop ^[1, 2], extensively grown in tropical and subtropical parts of Asia and Africa. Global production of okra is around 11.52 million tonnes from an area of 2.94 million hectares ^[3]. India is the largest okra producing country and accounts for more than 62% of okra produced in the world with an area of 0.54 million ha and an annual production of 7.15 million tonnes ^[3]. It is an important source of nutrients ^[4, 5, 6] and also contributes to the country's foreign exchange. Okra production is mainly confined to developing countries; therefore, its nutritional and nutraceutical properties can be useful in alleviating malnutrition ^[7].

The crop may get infested by about 72 insect pest species ^[8] from germination to harvesting, and pest incidence increases as crop maturity approaches ^[9]. A wide range of insect pests attack okra and result in significant reductions in yield ^[10]. Among these, *Aphis gossypii* (Glover) is an important sucking pest and feeds on plants from more than 50 different families. It predominates during the early growth stages of okra, sucking sap from the plants, weakening them, and resulting in reduced flowering and yield. Along with feeding, it produces excessive honeydew on leaves, which promotes the growth of sooty mold and reduces photosynthetic activity. Aphid infestation results in chlorosis of leaves, which then curl, become distorted, and dry up. Aphids also act as vectors for the transmission of viral diseases ^[11]. Among the available management practices, chemical insecticides are the primary tools used to combat insect pests due to their rapid knockdown effect, broad-spectrum activity, and easy availability. Chemical insecticides, particularly organophosphates, pyrethroids and neonicotinoids, have been central to achieving pest control. However, misuse or overapplication of these chemicals leads to several adverse consequences ^[12]. The extensive use of chemical insecticides, accompanied by improper application, has led to the development of insecticide resistance ^[13]. This pest has developed multi-fold resistance against various conventional insecticides ^[14, 15] leading to control failure

in the field sometimes. The aphids are difficult to control because of the high propagation rate and its ability to evolve resistance to many insecticide classes. Hence, it is essential to assess the performance of insecticides having novel mode of actions for effective management of this pest. As field level efficacy study of the present insecticides are lacking, this study endeavored to evaluate the bio-efficacy of selected insecticides against okra aphid and their effects on natural enemies. The findings of the present study will contribute in generating knowledge on potential alternatives for effective management of okra aphid in addition to effect on natural enemies in okra ecosystem.

Materials and Methods

Field experiments were conducted for two consecutive years (2025 and 2026) at Uttar Banga Krishi Viswavidyalaya to evaluate the field efficacy of selected insecticides for management of *Aphis gossypii* on okra. Insecticides representing different chemical classes were selected in order to assess their comparative effectiveness for management of aphid on okra. The experiment was laid out in Randomized Block Design (RBD) with eight treatments including control and each treatment was replicated thrice. Seven insecticides were obtained from the authorized vendors and used for this study: cyantraniliprole 10.26 OD @ 90g a.i/ha, flonicamid 50 WG @ 100 g a.i/ha, spirotetramat 15.31 OD @ 90 g a.i/ha, tolfenpyrad 15 EC @ 150 g a.i/ha, broflanilide 20 SC @ 25 g a.i/ha, diafenthiuron 50 WP @ 300 g a.i/ha and azadirachtin 5% neem extract concentrates @ 2ml/L. Okra seeds were sown manually at a spacing of 45 cm × 30 cm and at 5 cm depth. The crop (variety: Rohini) was cultivated following standard agronomic practices, excluding plant protection measures. Two sprayings were conducted during the early morning hours using a manually operated knapsack sprayer fitted with a hollow cone nozzle, maintaining a spray volume of 500 L/ha for each application. Observations on the aphid population were recorded on three leaves; each at top, middle and bottom of five randomly selected plants in each plot. The first observation was recorded one day prior to spraying as a pre-treatment count and subsequently at 3, 7, 10 and 15 days after each spraying as post-treatment count. Observation on the incidence of coccinellid predators were recorded from five randomly selected plants from each plot before insecticide application and subsequently at 3, 7, 10 and 15 days after each spray. The data, thus obtained, were analyzed using two-way ANOVA after making necessary transformation wherever required. The mean data were statistically analyzed and subjected to the analysis of variance as outlined by Panse and Sukhatme, ^[16].

Results

Efficacy of tested insecticides against *A. gossypii*

The efficacy of different insecticidal treatments against *A. gossypii* on okra obtained from the first year of study (2025) has been presented in table-1. The experimental results clearly indicated that one day before spraying there was no significant difference among the treatments in terms of population of *A. gossypii* indicating uniform distribution of *A. gossypii* population on okra. But after the application of insecticides, it was observed that all the insecticidal treatments were significantly superior over control. Tolfenpyrad 15 EC was found to be the best treatment in reducing the aphid population at 3 days after first

application. The lowest aphid population (10.13 per three leaves) was recorded from this treatment followed by flonicamid 50 WG (10.27/three leaves) and broflanilide 20EC (10.47/three leaves). These three treatments were statistically at par with each other. Tolfenpyrad 15 EC maintained its superiority over other treatments by recording the lowest aphid population at 7, 10 and 15 days after application and this treatment was at par with flonicamid 50 WG and broflanilide 20EC. It was also noticed that, irrespective of the treatments, the aphid population started increasing slightly from 15 days after application. After first application, tolfenpyrad 15 EC was found to be the best treatment in reducing the aphid population and it showed 79.93 percent reduction over control.

Three days after second application, tolfenpyrad 15 EC showed the lowest population of aphid (4.67/three leaves) followed by flonicamid 50 WG (4.73/3leaves) and broflanilide 20EC (4.87/3leaves) and these three treatments were at par with each other. At 7 days and 10 days after second spraying, tolfenpyrad 15 EC maintained its superiority over other treatments by recording the minimum aphid population. The efficacy of flonicamid 50 WG and broflanilide 20EC against okra aphid was at par with the tolfenpyrad 15 EC. Based on the percent reduction over control, tolfenpyrad 15 EC showed the highest reduction of aphid population (95.21%) followed by flonicamid 50 WG (94.71%) and broflanilide 20EC (94.54%) at 15 days after second application. Other treatments viz., spirotetramat 15.31 OD, cyantraniliprole 10.26 OD and diafenthiuron 50 WP resulted 89.57, 89.25 and 87.91 percent reduction over control, respectively. Azadirachtin 5% neem extract concentrates showed only 78.82 percent reduction over control. However, in untreated control significantly higher aphid population (40.27/three leaves) was observed at 15 days after second application.

The efficacy of different insecticidal treatments against *A. gossypii* on okra obtained from the second year of study (2026) has been presented in table-2. Similar trend of efficacy was also observed during the second season as that of first season. All the treatments were found to be significantly superior to control in reducing the aphid population. Tolfenpyrad 15 EC @ 150 g a.i/ha was found to be the most effective treatments in terms of reducing the aphid population at different days after first and second application followed by flonicamid 50 WG and broflanilide 20EC and these treatments were found statistically at par with each other. After second application, tolfenpyrad 15 EC resulted 93.36 per reduction over control. Next promising insecticide for management of okra aphid was spirotetramat 15.31 OD followed by cyantraniliprole 10.26 OD and diafenthiuron 50 WP. These three insecticides showed more than 86% reduction of aphid population over control.

The results from the pooled data after two years of study have been presented in table-3. Cumulative results (pooled) clearly indicated that although different treatments varied in their efficacy at different days of observation but all of them were significantly superior to untreated control. After two applications it was found that tolfenpyrad 15 EC @ 150 g a.i/ha consistently maintained its superiority over all other treatments at all the days of observations. None of the treatment was as effective as tolfenpyrad 15 EC which achieved the highest percent reduction of aphid population (95.20%) over control at 15 days after second application.

This treatment was statistically at par with flonicamid 50 WG and broflanilide 20EC resulting 94.70 and 94.54 percent reduction over control at 15 days after second application. Spirotetramat 15.31 OD, cyantraniliprole 10.26 OD and diafenthiuron 50 WP also proved effective resulting 89.57, 89.24 and 87.91 percent reduction over control at 15 days after second application.

Effect of tested insecticides against coccinellid predators in okra ecosystem

It was observed that the major natural enemies in the study area were coccinellid predators viz., *Coccinella septempunctata* L., *C. transversalis* Fabr. and *Cheilomenes sexmaculata* (Fabr.). Hence, efforts were made to study the effect of insecticides on these coccinellid predators only. The foliar application of all the insecticides showed an initial reduction in the population of natural enemies as compared to untreated control plots. However, the magnitude of reduction varied among different insecticides applied.

The effects of different treatments on coccinellid predators have been presented in table-4 and 5. The results indicated that all the experimental plots showed non-significant variation with respect to the coccinellid population before application. One day prior to application of insecticides, coccinellids population ranged from 7.67 to 9 per five plants during the first year of study. But post-treatment observations revealed that there was an initial decrease in coccinellids population at 3 and 7 days after each spraying and it was again started increasing from 10 days after spraying and continued to increase at 15 days after application. Hence, despite initial decrease in coccinellid population, subsequent gradual recovery was also observed at different treatments. The lowest mean coccinellids population (6.67 per 5 plants) was observed in the diafenthiuron 50 WP treated plots at 15 days after first spray but after second spray, cyantraniliprole 10.26 OD showed the minimum number of coccinellids population (6.50 per 5 plants). Among the insecticidal treatments, azadirachtin 5% treated plots showed the highest number of coccinellids population (8.08/5 plants) followed by tolfeprad 15 EC (7.67/5 plants) at 15 days after second applications during the first season. Untreated control plots recorded as high as 15.33 coccinellids per 5 plants during this period.

Similar trend of impact of different treatments on coccinellids also observed during the second season. Initial decrease in population was observed at 3 and 7 days after each application but the population started to increase gradually from 10 days after each application. The highest population of coccinellids was observed in azadirachtin 5% treated plots followed by tolfeprad 15 EC treated plots after each application during second season.

The cumulative effects on coccinellids after two years of study have been presented in table-6. Initial decline of the population was observed in different treatments but subsequent gradual recovery was also observed from 15 days after each application. After two rounds of application, it was observed that azadirachtin 5% neem extract @ 2 ml/L had the least impact on natural enemies and recorded the highest coccinellids population. Tolfeprad 15 EC and flonicamid 50 WG treated plots also showed less impact on coccinellids predator as compared to other treatments. Cyantraniliprole 10.26 OD and diafenthiuron 50 WP treated plots consistently recorded the lowest coccinellid

populations after each application indicating more harmful effect on coccinellid predator as compared to other treatments.

Discussion

The results of the present investigation revealed that two foliar applications of tolfeprad 15 EC was the most effective treatment for management of okra aphid. Present findings are in line with the findings of Bajpai *et al.*, 2013^[17] who reported that tolfeprad 15 EC @ 150 g a.i./ha resulted 90.3 to 100% reduction in aphid population at 3 and 7 days after spray. The higher efficacy of tolfeprad 15 EC against sucking pests of okra including *A. gossypii* was also reported by Suman *et al.*, 2021^[18]. Similarly, Kalyan *et al.* (2014)^[19] also reported that tolfeprad 15 EC @ 150 and 125 a.i./ha were found superior for management of aphid population in cotton. The findings of the present experiments are also in agreement with the findings of Mallick *et al.* (2016)^[20], who revealed that tolfeprad 15% EC @ 125 and 150 g a.i. ha⁻¹ were effective in managing *A. gossypii* in okra after two sprays, and it was less harmful to natural enemies. The efficacy of tolfeprad 15 EC against *A. gossypii* may be attributed to the unique mode of action of this insecticide. It acts as a mitochondrial complex I electron transport inhibitor (METI) which inhibit the cellular respiration in mitochondria causing death of the insect. It is a broad-spectrum pyrazole class insecticide and a miticide, with contact activity against several economically important insect pests of order hemiptera, thysanoptera, eriophid and tarsonemid mites (Anonymous, 1996)^[21]. Moreover, this novel insecticide has no reported cross resistance to other insecticides (Wimer *et al.*, 2015)^[22] and has waiting period of three days only in okra (Anonymous, 2026)^[23].

Flonicamid 50WG was also highly effective for management of okra aphid in the present experiments. The effectiveness of flonicamid 50WG was also reported by Rakesh *et al.*, 2024^[24] who revealed that flonicamid 50 WG was highly efficacious in managing all sucking pests, exhibiting the lowest incidence of leafhoppers, aphids and whiteflies and highest okra yield. This insecticide has emerged as the most economical choice, highlighting its potential as a primary solution for managing sucking pests in okra. Flonicamid belongs to pyridinecarboxamide class of chemistry and represents a member of the novel group of insecticides known as chordotonal organ nicotinamidase inhibitors. Flonicamid comes under IRAC group 29 and is the only insecticide in this class. It is a novel systemic insecticide with selective activity against hemipterous thysanopterous pests. Aphid can attach its proboscis to the leaf surface but salivation and sap feeding are strongly inhibited. Hence, death of the insect occurs due to starvation as it fails to penetrate its stylet into plant tissue (Morita *et al.*, 2007)^[25]. Moreover, there are no reported instances of cross-resistance between flonicamid and other conventional insecticides (Sun *et al.*, 2026; Rakesh *et al.*, 2024)^[26, 24]. However, this insecticide has waiting period of 10 days in okra (Anonymous, 2026)^[23]. The present experiment revealed that broflanilide 20 SC was also effective for management of okra aphid. Broflanilide is a novel meta-diamide insecticide, which has a distinct mode of action. It acts as a GABA-gated chloride channel allosteric modulators and belong to IRAC group 30. This insecticide has waiting period of one day only in okra (Anonymous,

2026)^[23] making it highly attractive for management of sucking pests in okra. Besides these three treatments, cyantraniliprole 10.26 OD and spirotetramat 15.31 OD also found effective for managing okra aphid. The higher efficacy of cyantraniliprole 10.26 OD against okra aphid was also reported by Patel and Rahaman, 2021^[27]. These two insecticides have waiting period of 3 days (Anonymous, 2026)^[23]. Cyantraniliprole 10.26 OD is also effective for management of aphid on other crop like chilli. Wasu *et al.*, 2025^[28] reported that cyantraniliprole 10.26 OD was the most promising treatment by recording the least population of aphid on chilli and the highest yield. Cyantraniliprole is the member of diamide class of insecticides which acts as a ryanodine receptors (RyRs) modulator. This activation triggers uncontrolled calcium release from the sarcoplasmic reticulum, resulting in sustained muscle contraction, paralysis, and ultimately death (Wu *et al.*, 2026)^[29]. But care should be taken before using this insecticide as there is an inherent risk of cross-resistance among diamide insecticides. Different chemical subclasses of diamides (e.g., anthranilic vs. phthalic diamides) or even compounds within

the same subclass (e.g., chlorantraniliprole and cyantraniliprole) can't be simply used in rotation for resistance management (Bolzan *et al.*, 2019; Zuo *et al.*, 2017)^[30, 31]. Similarly, high level of cross resistance between spirotetramat and alpha-cypermethrin (238-fold) and bifenthrin (37-fold) in *A. gossypii* was reported by Peng *et al.*, 2016^[32]. Moreover, both cyantraniliprole 10.26 OD and spirotetramat have waiting period of 3 days in okra (Anonymous, 2026)^[23].

Among the treatments, azadirachtin appeared to be the least harmful to coccinellid predators. Similar result was also reported by Dutta *et al.*, 2016^[33] from Bangladesh. After azadirachtin, tolfeprpyrad 15% EC treated plots showed the higher population coccinellid population. Mallick *et al.*, 2016^[20] also reported that tolfeprpyrad 15% EC @ 125 and 150 g a.i./ha might be recommended for okra and it is also safer to natural enemies. Similarly, Kodandaram, 2017^[34] reported that flonicamid 50WG did not show any phytotoxic symptoms and toxic effects to the natural enemies including spiders and rove beetles in okra.

Table 1: Effect of different insecticides for management of *Aphis gossypii* on okra during 2025 (1st season).

Treatments	Dosage g a.i ha ⁻¹	1 st application						2 nd application					
		Mean aphid population/3 leaves					% ROC	Mean aphid population/3 leaves					% ROC
		PTC	3 DAA	7 DAA	10 DAA	15 DAA		PTC	3 DAA	7 DAA	10 DAA	15 DAA	
Cyantraniliprole 10.26 OD	90	29.53	12.93 (3.66)	10.73 (3.35)	8.4 (2.98)	8.73 (3.04)	74.72	20.13	6.27 (2.60)	4.73 (2.29)	3.87 (2.09)	4.33 (2.20)	89.25
Flonicamid 50 WG	100	29.13	10.27 (3.28)	8.33 (2.97)	7.13 (2.76)	7.27 (2.79)	78.95	12.87	4.73 (2.29)	2.27 (1.66)	1.93 (1.56)	2.13 (1.62)	94.71
Spirotetramat 15.31 OD	90	29.13	12.87 (3.66)	10.53 (3.32)	8.33 (2.97)	8.67 (3.03)	74.89	18.53	6.13 (2.57)	4.67 (2.27)	3.73 (2.06)	4.2 (2.17)	89.57
Tolfeprpyrad 15 EC	150	28.93	10.13 (3.26)	8.27 (2.96)	6.67 (2.68)	6.93 (2.73)	79.93	11.53	4.67 (2.27)	2.2 (1.64)	1.87 (1.54)	1.93 (1.56)	95.21
Broflanilide 20 SC	25	28.87	10.47 (3.31)	8.53 (3.00)	7.27 (2.79)	7.33 (2.80)	78.77	12.93	4.87 (2.32)	2.33 (1.68)	2.00 (1.58)	2.2 (1.64)	94.54
Diafenthuron 50 WP	300	28.93	13.13 (3.69)	11.87 (3.52)	8.8 (3.05)	9.13 (3.10)	73.56	20.27	6.33 (2.61)	4.87 (2.32)	3.93 (2.10)	4.87 (2.32)	87.91
Azadirachtin 5% Neem Extract Concentrates	2 ml L ⁻¹	29.8	15.67 (4.02)	13.23 (3.71)	10.53 (3.32)	11.27 (3.43)	67.36	21.13	9.27 (3.13)	8.53 (3.00)	7.27 (2.79)	8.53 (3.00)	78.82
Untreated control	-	29.47	31.2 (5.63)	33.13 (5.80)	32.93 (5.78)	34.67 (5.93)	-	33.53	35.8 (6.02)	37.67 (6.18)	38.53 (6.25)	40.27 (6.39)	-
S.Em (±)	-	-	0.05	0.06	0.04	0.07	-	-	0.07	0.13	0.1	0.06	-
CD (5%)	-	NS	0.15	0.17	0.14	0.2	-	-	0.22	0.38	0.31	0.19	-

N.B: PTC: Pre-treatment count; DAA: Days after application; % ROC: percent reduction over control; Figures in parentheses are square root transformed values.

Table 2: Effect of different insecticides for management of *Aphis gossypii* on okra during 2026 (2nd season).

Treatments	Dosage g a.i ha ⁻¹	1 st application						2 nd application					
		Mean aphid population/3 leaves					% ROC	Mean aphid population/3 leaves					% ROC
		PTC	3 DAA	7 DAA	10 DAA	15 DAA		PTC	3 DAA	7 DAA	10 DAA	15 DAA	
Cyantraniliprole 10.26 OD	90	30.67	14.13 (3.82)	11.8 (3.51)	9.53 (3.17)	9.47 (3.16)	73.50	21.27	7.33 (2.80)	5.93 (2.54)	5.27 (2.40)	5.27 (2.40)	87.19
Flonicamid 50 WG	100	30.2	11.33 (3.44)	9.47 (3.16)	8.27 (2.96)	7.93 (2.90)	77.81	13.93	5.87 (2.52)	3.4 (1.97)	2.8 (1.82)	2.87 (1.84)	93.02
Spirotetramat 15.31 OD	90	30.13	13.93 (3.80)	11.67 (3.49)	9.47 (3.16)	9.3 (3.13)	73.97	19.53	7.27 (2.79)	5.73 (2.50)	4.93 (2.33)	5.13 (2.37)	87.53
Tolfeprpyrad 15 EC	150	30.2	11.27 (3.43)	9.33 (3.14)	7.73 (2.87)	7.8 (2.88)	78.17	12.73	5.73 (2.50)	3.33 (1.96)	2.73 (1.80)	2.73 (1.80)	93.36
Broflanilide 20 SC	25	29.93	11.53 (3.47)	9.67 (3.19)	8.33 (2.97)	8.13 (2.94)	77.25	14.13	5.93 (2.54)	3.53 (2.01)	3.13 (1.91)	3.2 (1.92)	92.22
Diafenthuron 50 WP	300	30.13	14.27 (3.84)	12.93 (3.66)	9.93 (3.23)	9.53 (3.17)	73.33	21.33	7.47 (2.82)	6.00 (2.55)	5.4 (2.43)	5.67 (2.48)	86.21
Azadirachtin 5% Neem Extract Concentrates	2 ml L ⁻¹	30.93	16.73 (4.15)	14.33 (3.85)	11.67 (3.49)	12.13 (3.55)	66.05	22.27	10.33 (3.29)	9.67 (3.19)	8.47 (2.99)	9.4 (3.15)	77.15
Untreated control	-	30.53	32.33 (5.73)	34.2 (5.89)	34.13 (5.88)	35.73 (6.02)	-	34.67	36.87 (6.11)	38.73 (6.26)	39.67 (6.34)	41.13 (6.45)	-
S.Em (±)	-	-	0.09	0.04	0.03	0.04	-	-	0.06	0.09	0.12	0.1	-
CD (5%)	-	NS	0.26	0.13	0.11	0.13	-	NS	0.19	0.26	0.35	0.32	-

N.B: PTC: Pre-treatment count; DAA: Days after application; % ROC: percent reduction over control; Figures in parentheses are square root transformed values.

Table 3: Effect of different insecticides for management of *Aphis gossypii* on okra (Pooled).

Treatments	Dosage g.a.i ha ⁻¹	1 st application						2 nd application					
		Mean aphid population/3 leaves					% ROC	Mean aphid population/3 leaves					% ROC
		PTC	3 DAA	7 DAA	10 DAA	15 DAA		PTC	3 DAA	7 DAA	10 DAA	15 DAA	
Cyantraniliprole 10.26 OD	90	30.10	13.53 (3.75)	11.27 (3.43)	8.97 (3.07)	9.10 (3.10)	74.15	20.7	6.80 (2.70)	5.33 (2.41)	5.90 (2.53)	4.33 (2.20)	89.24
Flonicamid 50 WG	100	29.67	10.80 (3.36)	8.90 (3.07)	7.70 (2.86)	7.60 (2.85)	78.41	13.4	5.30 (2.41)	2.83 (1.82)	2.37 (1.69)	2.13 (1.62)	94.70
Spirotetramat 15.31 OD	90	29.63	13.40 (3.73)	11.10 (3.40)	8.90 (3.06)	9.00 (3.08)	74.43	19.03	6.70 (2.68)	5.20 (2.38)	4.33 (2.19)	4.20 (2.16)	89.57
Tolfenpyrad 15 EC	150	29.57	10.70 (3.35)	8.80 (3.05)	7.20 (2.77)	7.37 (2.80)	79.07	12.13	5.37 (2.42)	2.77 (1.81)	2.30 (1.67)	1.93 (1.54)	95.20
Broflanilide 20 SC	25	29.40	11.00 (3.39)	9.10 (3.10)	7.80 (2.88)	7.73 (2.87)	78.03	13.53	5.40 (2.43)	2.93 (1.85)	2.57 (1.73)	2.20 (1.64)	94.54
Diafenthiuron 50 WP	300	29.53	13.70 (3.77)	12.07 (3.54)	9.37 (3.14)	9.33 (3.13)	73.48	20.8	6.90 (2.72)	5.43 (2.43)	4.67 (2.27)	4.87 (2.31)	87.91
Azadirachtin 5% Neem Extract Concentrates	2 ml L ⁻¹	30.37	16.20 (4.09)	13.78 (3.78)	11.10 (3.41)	11.70 (3.49)	66.76	21.7	9.80 (3.21)	9.10 (3.09)	7.87 (2.89)	8.53 (3.00)	78.81
Untreated control	-	30.00	31.77 (5.68)	33.67 (5.84)	33.53 (5.83)	35.20 (5.97)	-	34.1	36.33 (6.07)	38.20 (6.22)	39.10 (6.29)	40.27 (6.38)	-
S.Em (±)		-	0.06	0.03	0.03	0.05	-	-	0.05	0.07	0.09	0.06	-
CD (5%)		NS	0.18	0.09	0.11	0.14	-	-	0.14	0.21	0.28	0.19	-

N.B: PTC: Pre-treatment count; DAA: Days after application; % ROC: percent reduction over control; Figures in parentheses are square root transformed values.

Table 4: Effect of different insecticides on coccinellid predators in okra ecosystem during 2025 (1st season).

Treatments	Dosage g.a.i ha ⁻¹	1 st application						2 nd application					
		Mean coccinellid population/5 plants					Mean	Mean coccinellid population/5 plants					Mean
		PTC	3 DAA	7 DAA	10 DAA	15 DAA		PTC	3 DAA	7 DAA	10 DAA	15 DAA	
Cyantraniliprole 10.26 OD	90	8.33	6.67 (2.68)	6.33 (2.61)	7.00 (2.74)	7.67 (2.86)	6.92 (2.72)	8.00	5.67 (2.48)	5.67 (2.48)	7.00 (2.74)	7.67 (2.86)	6.50 (2.65)
Flonicamid 50 WG	100	8.00	6.67 (2.68)	6.67 (2.68)	7.33 (2.80)	7.67 (2.86)	7.08 (2.75)	8.67	6.33 (2.61)	6.00 (2.55)	7.33 (2.80)	8.33 (2.97)	7.00 (2.74)
Spirotetramat 15.31 OD	90	8.67	7.33 (2.80)	6.33 (2.61)	7.00 (2.74)	7.33 (2.80)	7.00 (2.74)	8.33	6.00 (2.55)	5.67 (2.48)	7.67 (2.86)	8.00 (2.92)	6.84 (2.71)
Tolfenpyrad 15 EC	150	8.67	7.67 (2.86)	7.00 (2.74)	7.33 (2.80)	7.67 (2.86)	7.42 (2.81)	9.00	6.67 (2.68)	7.33 (2.80)	8.00 (2.92)	8.67 (3.03)	7.67 (2.86)
Broflanilide 20 SC	25	7.67	7.00 (2.74)	6.33 (2.61)	6.67 (2.68)	7.33 (2.80)	6.83 (2.71)	8.67	6.33 (2.61)	6.00 (2.55)	7.67 (2.86)	8.33 (2.97)	7.08 (2.75)
Diafenthiuron 50 WP	300	7.67	7.00 (2.74)	6.00 (2.55)	6.67 (2.68)	7.00 (2.74)	6.67 (2.68)	8.33	5.67 (2.48)	5.33 (2.41)	7.33 (2.80)	8.00 (2.92)	6.58 (2.66)
Azadirachtin 5% Neem Extract Concentrates	2 ml L ⁻¹	8.67	8.33 (2.97)	7.67 (2.86)	7.67 (2.86)	8.00 (2.92)	7.92 (2.90)	9.67	7.33 (2.80)	7.00 (2.74)	8.67 (3.03)	9.33 (3.14)	8.08 (2.93)
Untreated control	-	9.00	10.67 (3.34)	11.33 (3.44)	11.67 (3.49)	13.33 (3.72)	11.75 (3.50)	12.67	13.00 (3.67)	14.67 (3.89)	15.00 (3.94)	15.33 (3.98)	14.50 (3.87)
S.Em (±)		-	0.07	0.09	0.15	0.16	0.06	-	0.08	0.14	0.18	0.11	0.06
CD (5%)		NS	0.21	0.28	0.45	0.48	0.19	-	0.25	0.43	0.54	0.35	0.20

N.B: PTC: Pre-treatment count; DAA: Days after application; % ROC: percent reduction over control; Figures in parentheses are square root transformed values.

Table 5: Effect of different insecticides on coccinellid predators in okra ecosystem during 2026 (2nd season).

Treatments	Dosage g.a.i ha ⁻¹	1 st application						2 nd application					
		Mean coccinellid population/5 plants					Mean	Mean coccinellid population/5 plants					Mean
		PTC	3 DAA	7 DAA	10 DAA	15 DAA		PTC	3 DAA	7 DAA	10 DAA	15 DAA	
Cyantraniliprole 10.26 OD	90	9.66	8.00 (2.92)	7.66 (2.86)	8.33 (2.97)	8.67 (3.03)	8.17 (2.94)	10.67	9.00 (3.08)	8.66 (3.03)	9.33 (3.14)	9.67 (3.19)	9.17 (3.11)
Flonicamid 50 WG	100	9.33	8.00 (2.92)	8.00 (2.92)	8.67 (3.03)	9.67 (3.19)	8.59 (3.01)	10.33	9.00 (3.08)	8.67 (3.03)	9.67 (3.19)	10.67 (3.34)	9.50 (3.16)
Spirotetramat 15.31 OD	90	10.33	8.66 (3.03)	7.67 (2.86)	8.33 (2.97)	8.67 (3.03)	8.33 (2.97)	11.33	9.67 (3.19)	8.67 (3.03)	9.33 (3.14)	9.67 (3.19)	9.34 (3.14)
Tolfenpyrad 15 EC	150	10.67	9 (3.08)	8.33 (2.97)	8.67 (3.03)	9.33 (3.14)	8.83 (3.05)	11.67	10.00 (3.24)	9.33 (3.14)	9.67 (3.19)	10.33 (3.29)	9.83 (3.21)
Broflanilide 20 SC	25	9.33	8.33 (2.97)	7.67 (2.86)	8 (2.92)	8.67 (3.03)	8.17 (2.94)	11.00	9.33 (3.14)	8.33 (2.97)	9.00 (3.08)	9.67 (3.19)	9.08 (3.10)
Diafenthiuron 50 WP	300	9.67	8.33 (2.97)	7.33 (2.80)	8.33 (2.97)	8.67 (3.03)	8.17 (2.94)	10.67	9.33 (3.14)	8.00 (2.92)	9.33 (3.14)	9.67 (3.19)	9.08 (3.10)
Azadirachtin 5% Neem Extract Concentrates	2 ml L ⁻¹	10.00	9.33 (3.14)	9 (3.08)	9.67 (3.19)	9.67 (3.19)	9.42 (3.15)	11.00	10.00 (3.24)	10.33 (3.29)	10.67 (3.34)	10.67 (3.34)	10.42 (3.30)
Untreated control	-	10.66	12 (3.54)	12.66 (3.63)	13 (3.67)	14.66 (3.89)	13.08 (3.69)	11.66	13.00 (3.67)	13.67 (3.76)	14.00 (3.81)	15.67 (4.02)	14.09 (3.82)
S.Em (±)		-	0.09	0.14	0.1	0.12	0.08	-	0.09	0.06	0.1	0.09	0.05
CD (5%)		-	0.28	0.42	0.31	0.35	0.24	-	0.28	0.17	0.31	0.29	0.16

N.B: PTC: Pre-treatment count; DAA: Days after application; % ROC: percent reduction over control; Figures in parentheses are square root transformed values.

Table 6: Effect of different insecticides on coccinellid predators in okra ecosystem (Pooled)

Treatments	Dosage g.a.i ha ⁻¹	1 st application						2 nd application					
		Mean coccinellid population/5 plants					Mean	Mean coccinellid population/5 plants					Mean
		PTC	3 DAA	7 DAA	10 DAA	15 DAA		PTC	3 DAA	7 DAA	10 DAA	15 DAA	
Cyantraniliprole 10.26 OD	90	9.00	7.33 (2.80)	7.00 (2.74)	7.67 (2.86)	8.17 (2.94)	7.54 (2.84)	9.34	7.33 (2.80)	7.17 (2.77)	8.17 (2.94)	8.67 (3.03)	7.83 (2.89)
Flonicamid 50 WG	100	8.67	7.33 (2.80)	7.33 (2.80)	8.00 (2.91)	8.67 (3.03)	7.83 (2.89)	9.50	7.67 (2.86)	7.33 (2.80)	8.50 (2.99)	9.50 (3.16)	8.25 (2.96)
Spirotetramat 15.31 OD	90	9.50	8.00 (2.91)	7.00 (2.73)	7.67 (2.86)	8.00 (2.90)	7.67 (2.85)	9.83	7.83 (2.89)	7.17 (2.76)	8.50 (3.00)	8.83 (3.05)	8.08 (2.93)
Tolfenpyrad 15 EC	150	9.67	8.33 (2.97)	7.67 (2.86)	8.00 (2.91)	8.50 (2.99)	8.13 (2.94)	10.34	8.33 (2.97)	8.33 (2.97)	8.83 (3.05)	9.50 (3.16)	8.75 (3.04)
Broflanilide 20 SC	25	8.50	7.67 (2.86)	7.00 (2.73)	7.33 (2.79)	8.00 (2.91)	7.50 (2.83)	9.84	7.83 (2.89)	7.17 (2.76)	8.33 (2.97)	9.00 (3.08)	8.08 (2.93)
Diafenthiuron 50 WP	300	8.67	7.67 (2.85)	6.67 (2.67)	7.50 (2.82)	7.83 (2.89)	7.42 (2.81)	9.50	7.50 (2.83)	6.67 (2.68)	8.33 (2.97)	8.83 (3.05)	7.83 (2.89)
Azadirachtin 5% Neem Extract Concentrates	2 ml L ⁻¹	9.34	8.83 (3.05)	8.33 (2.96)	8.67 (3.03)	8.83 (3.05)	8.67 (3.03)	10.34	8.67 (3.03)	8.67 (3.03)	9.67 (3.19)	10.00 (3.24)	9.25 (3.12)
Untreated control	-	9.83	11.33 (3.44)	12.00 (3.53)	12.33 (3.58)	14.00 (3.80)	12.42 (3.59)	12.17	13.00 (3.67)	14.17 (3.82)	14.50 (3.87)	15.50 (4.00)	14.29 (3.85)
S.Em (±)	-	-	0.06	0.08	0.09	0.12	0.06	-	0.06	0.08	0.11	0.05	0.04
CD (5%)	-	NS	0.18	0.26	0.27	0.36	0.17	-	0.17	0.24	0.32	0.16	0.12

N.B: PTC: Pre-treatment count; DAA: Days after application; % ROC: percent reduction over control; Figures in parentheses are square root transformed values.

Conclusion

Based on the findings of the present study, it can be concluded that tolfenpyrad 15 EC, flonicamid 50WG and broflanilide 20 SC were found to be effective for management of okra aphid. These insecticides may be the potential alternative for the management of *A. gossypii* on okra. Cyantraniliprole 10.26 OD and spirotetramat 15.31 OD were the next promising insecticides for managing okra aphid but cross-resistance incidence, if any, should be considered before application. These insecticides may be used in rotation for effective management of *A. gossypii* in okra.

Disclaimer (Artificial Intelligence)

Author(s) hereby declares that no generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during writing or editing of this manuscript.

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Competing Interests

Authors have declared that they have no known competing financial interests or non-financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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