

Laboratory Toxicity Bioassays to Evaluate the Efficacy of Potassium Salts of Fatty Acids 49 SL, A Biorational Pesticide Against *Aphis gossypii* (Glover) (Hemiptera: Aphididae) on Okra Plants

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ABSTRACT

Okra (*Abelmoschus esculentus* L. Moench), belongs to Malvaceae family, is a significant annual vegetable crop that is cultivated throughout the year in India. The cultivation of okra faces various challenges, particularly due to pest invasions. Aphids and leaf hoppers are examples of sucking pests can be particularly harmful, causing crop losses ranging from 23 to 54 per cent. The cotton aphid, *Aphis gossypii* Glover (Hemiptera: Aphididae), targets young okra plants, resulting in stunted growth, wilting, and in severe cases, the death of the plants, which leads to considerable economic losses. Different pests can be suppressed with alternative non-chemical pest management techniques, such as potassium salts of fatty acids or soap salts. Potassium salts of fatty acids have shown successful results in managing aphids, whiteflies, scales, and mealybugs, demonstrating high effectiveness against most soft-bodied insect pests. Several laboratory bioassays were conducted to assess the effectiveness of Potassium Salts of Fatty Acids 49 SL at various concentrations along with two Standard checks viz., Azadirachtin 05.00 w/w Min. Neem Extract Concentrates @ 0.5 ml/l and Imidacloprid 17.80 SL @ 0.25 ml/l against *Aphis gossypii*. Our results indicated that in leaf dip, Potassium Salts of Fatty Acids 49 SL @ 15 and 18.75ml/l resulted in 100 per cent mortality after 72 hrs of exposure which was on par with Standard checks-1 & 2. In Slide dip and Residual film, 100 per cent mortality was recorded at 24 HAT which was on par with Standard checks- 2.

Key words: *Abelmoschus esculentus* L., Aphid, Leaf dip, Residual film, Slide dip.

Introduction

In India, vegetables play a crucial role in the human diet. Among various vegetables, okra (*Abelmoschus esculentus* L. Moench), a significant annual crop from the Malvaceae family, is cultivated extensively throughout the year in India. As the leading global producer of okra, India cultivates 5.49 lakh hectares,

yielding 71.58 lakh tons annually, resulting in a productivity rate of 13.04 t/ha, which accounts for 60 per cent of the worldwide share (FAOSTAT, 2025). Nevertheless, okra farming encounters several obstacles, with pest infestations being a major issue (Bhatt *et al.*, 2018). A total of 72 insect species have been recognized as pests affecting okra crops, with the principal threats being the shoot and fruit borer

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(*Earias* spp.), aphids (*Aphis gossypii* Glover), leafhoppers (*Amrasca biguttula biguttula* Ishida), and whiteflies (*Bemisia tabaci gennadius*), particularly damaging in the southern states of India (Deevaraja *et al.*, 2020). Sucking pests like aphids and leafhoppers are especially harmful, causes yield losses ranging from 23 to 54 per cent in okra crops (Rai *et al.*, 2014). The cotton aphid, *Aphis gossypii* Glover (Hemiptera: Aphididae), is a significant piercing-sucking pest that affects various plants (Margaritopoulos *et al.*, 2006). *A. gossypii* infests immature okra plants, causing wilting, reduced growth, and in extreme cases, plant death. Additionally, honeydew produced by aphids promotes the growth of sooty mold and interferes with photosynthesis. During the reproductive phase, these pests damage flower buds, flowers, and fruits, leading to considerable economic losses (Kedar *et al.*, 2014).

Farmers in Tamilnadu rely on chemical insecticides to eradicate okra pests right away. Numerous insect pests are resurged to okra as a result of the extended use of synthetic pesticides. Different pests can be managed with alternatives to these chemical pesticides, such as potassium salts of fatty acids, also referred to as soap salts (Ciancio and Mukerji, 2010; Wafula *et al.*, 2017). Insecticides based on fatty acids are readily biodegradable and have little to no harmful environmental impacts since they occur naturally in both plants and animals (Dheeraj *et al.*, 2013). Fatty acid potassium salts are effective only when insects come into direct contact with them. They disrupt the cell membrane's permeability and remove the protective coating on the insect's surface, leading to dehydration (Mohamad *et al.*, 2013). Potassium salts of fatty acids have been effectively used to control aphids, whiteflies, scales, and mealybugs with high efficacy (Dheeraj *et al.*, 2013; Mohamad *et al.*, 2013). They are particularly effective against a wide range of soft-bodied insect pests.

Materials and Methods

Mass culturing of *Aphis gossypii* (Glover)

A. gossypii collected from infested Okra plants from farmers holding in C. Muttalur village (during first week of July 2024) were reared on okra [*Abelmoschus esculentus* L. (Var: Arka anamika)] plants. Fresh okra plants were added at monthly intervals to ensure the continuous supply of test aphids (Farang *et al.*, 2024 and Mahmoud *et al.*, 2023).

Leaf dip bioassay for *A.gossypii*

The leaf dip bioassay was conducted to evaluate the efficacy of potassium salts of fatty acids 49 SL against *A. gossypii* in the Toxicology Laboratory (Lat 11.387658°N and Long 79.723503°E), Department of Entomology, Faculty of Agriculture. Healthy okra leaves from the okra plants maintained in pots in pot culture yard of Department of Entomology, Faculty of Agriculture were collected and washed in tap water to avoid other insect contaminants later the leaves were cut into small leaf disks of 4cm diameter were dipped in each treatment for 15 sec, dried at room temperature for 30-40 min and placed adaxially in a petri dish (9 cm dia) containing the thin layer of moist moistened cotton pad on the bottom and covered with filter paper to prevent the okra leaf disk from drying and to maintain the turgidity. Each treatment was replicated three times. For each replication, 10 aphids (third instar nymphs) were released into leaf disks with a fine camel hair brush (size: 000) and then all bioassay plates incubated at 25± 0.5 °C and 65 ± 5% relative humidity. Observation on aphid mortality was recorded after 24, 48 and 72 hours after treatment (HAT). The experiment was conducted during the fourth week of July 2024 (Prasannakumar *et al.*, 2021; Kang-sheng *et al.*, 2022).

Slide dip bioassay

Slide dip bioassay was conducted to evaluate the efficacy of potassium salts of fatty acids 49 SL against *A. gossypii* at the Toxicology Laboratory (Lat 11.387658° N and Long 79.723503°E), Department of Entomology, Faculty of Agriculture. Ten adult aphids were placed dorsally side on the piece of double-sided adhesive tape (size: 2 Sq.cm) was affixed to the right side corner of the glass slides using a fine camel hair brush (size: 000). Treatments were replicated three times for each concentration of insecticide used. After 10 aphids were glued to each slide glass, it was dipped in the insecticide solution ensuring complete submergence of the insects with water as control for 5 sec. Excess fluid on both the glass slides and adhesive tape was wiped with absorbent paper. Slides were dried at room temperature for 15 min and then placed in a plastic tray under room temperature. The numbers of dead aphids were accessed after 24 hours after exposure to insecticides. The experiment was conducted during the second week of August 2024 (Shonga *et al.*, 2008; Ebenezer *et al.*, 1995).

Residual film bioassay

The residual film bioassay was conducted to evaluate the efficacy of potassium salts of fatty acids 49 SL against *A. gossypii* in the Toxicology Laboratory (Lat 11.387658°N and Long 79.723503°E), Department of Entomology, Faculty of Agriculture during the fourth week of August 2024. One ml of each insecticide solution was pipetting out and poured in each petri dish (9 cm dia) corresponding to the respective treatments were closed tightly using glass lids. Then, the closed petri dishes were swirled for 5 sec in both upright and inverted positions. Excessive solutions were drained off and allowed to dry at room temperature for an hour. Ten *A. gossypii* adults were transferred to each petri dish using a fine camel hair brush (size: 000) and placed in a controlled environment chamber. Each treatment was replicated three times and mortality was recorded at 24 HAT (Manjarika *et al.*, 2018).

Statistical Analysis

Mortality data were accessed using Abbott's formula (Abbott, 1925). Data were evaluated using analysis of variance (ANOVA) under a completely randomized design (CRD). The data were subjected to arc sine transformations before statistical analysis. The significant differences among means were determined by Duncan's Multiple Range Test (DMRT) (Duncan, 1951; Gomez and Gomez, 1984). Statistical analyses were performed using CCARI-ICAR WASP 2.0.

$$\text{Corrected mortality (\%)} = \frac{Po - Pc}{100 - Pc} \times 100$$

Where, Po is observed mortality in treatment and Pc is Observed mortality in the control.

Results and Discussion

Leaf dip bioassay

After 12 h of exposure, maximum mortality (90.00%) was observed in T₄ followed by T₃ (90.00%) followed by T₂ (46.67 %) and T₁ (33.33 %) followed by standard check-2 (20.00 %) and standard check-1 (13.33%) and no mortality of *A. gossypii* observed in control. After 24 h of exposure, T₃ & T₄ recorded 100 per cent mortality followed by T₂ (76.67 %) and T₁ (70.00 %) followed by standard check-2 (66.67 %) and standard check-1 (53.33%) and 3.33 per cent mortality of *A. gossypii* observed in control. After 48 h of exposure, T₃ & T₄ recorded 100 per cent mortality followed by T₂ (86.67 %) and T₁ (80.00 %) followed by standard check-2 (96.67 %), standard check-1 (90.00%) and 6.67 per cent mortality of *A. gossypii* observed in control (Table 1).

T₄ recorded the maximum mean per cent mortality (94.44) followed by T₃ (94.44), T₂ (70.00), T₁ and standard check-2 (61.11), followed by standard check-1 (52.22) and control (3.33). The order of efficacy was T₄ > T₃ > T₂ > T₁ > Standard check-2 > standard check-1 (Table 1).

Slide dip bioassay

After 24 h of exposure, 100 per cent mortality was observed in T₂, T₃, T₄ and standard check-2 followed by T₁ (96.67%), standard check-1 (93.33%) and Control (10.00%). The order of efficacy was T₂= T₃= T₄ =

Table 1. Leaf dip bioassay of MPede / Potassium Salts of Fatty Acids 49 SL against *Aphis gossypii*

Tr. No.	Treatments	Dose (ml/l)	*Mortality (%)			Mean
			12 HAT	24 HAT	48 HAT	
T ₁	MPede / Potassium Salts of Fatty Acids 49 SL	10	33.33(35.52) ^c	70.00(57.71) ^{bc}	80.00(63.93) ^c	61.11
T ₂	MPede / Potassium Salts of Fatty Acids 49 SL	12.5	46.67(43.07) ^b	76.67(61.93) ^b	86.67(68.85) ^c	70.00
T ₃	MPede / Potassium Salts of Fatty Acids 49 SL	15	83.33(66.15) ^a	100.00(89.72) ^a	100.00(89.72) ^a	94.44
T ₄	MPede / Potassium Salts of Fatty Acids 49 SL	18.75	90.00(71.56) ^a	100.00(89.72) ^a	100.00(89.72) ^a	96.67
T ₅	Azadirachtin 05.00 w/w Min. Neem Extract Concentrates	0.5	13.33(21.15) ^d	53.33(46.93) ^c	90.00(74.91) ^{bc}	52.22
T ₆	Imidacloprid 17.80 SL	0.25	20.00(26.07) ^d	66.67(54.78) ^{bc}	96.67(83.66) ^{ab}	61.11
T ₇	Control (Water)	-	0.00(0.28) ^e	3.33(6.34) ^d	6.67(12.38) ^d	3.33
	SE(d)	-	3.61	7.32	7.22	-
	CD (p=0.05)	-	7.32	13.03	14.46	-

HAT: Hours After Treatment; *Mean of four replications;

Values in parenthesis are arc sine transformed values;

In a column means followed by the same letter(s) are not significantly different (p=0.05) by DMRT.; Rankings are plotted in descending order.

standard check-2 > T₁>standard check-1.

Residual film bioassay

After 24 h of exposure, 100 per cent mortality was observed in T₃ and T₄ followed by T₂ and standard check-2 (96.67%) followed by T₁ and standard check-1 (90.00%) and Control (6.67%). The order of efficacy was T₃ = T₄>T₂= standard check-2 > T₁= standard check-1 (Table 3).

The findings from this study indicated that Potassium Salts of Fatty Acids 49 SL @ 15ml/l and Potassium Salts of Fatty Acids 49 SL @ 18.75 were effective in managing *A. gossypii* achieving 100 per cent mortality, comparable to the effects of standard checks 1 & 2 in leaf dip bioassay. Our results are in accordance with the findings of Mohamed *et al.* 2013 found that potassium salts of fatty acids at concen-

trations of 1 and 1.5 per cent in spray solutions significantly decreased populations of whiteflies and thrips. The efficacy of potassium salts of fatty acids in this study was found to rise as their concentration in the spray solution increased. As the concentration of potassium salts of fatty acids in the spray solution increased, so did their efficacy in this investigation. Our results are also consistent with the findings by Liu and Stansly (2000), which showed that higher concentrations of potassium salts led to increased mortality rates in whiteflies. These findings illustrate that potassium salts can be as effective as synthetic chemical pesticides in managing populations of *A. gossypii*, as noted by Dheeraj *et al.* (2013). The outcomes are in line with the research of Studies by Heidi and Cullen (2008), Ciancio and Mukerji (2010), Mohamad *et al.* (2013), and Dheeraj *et al.*

Table 2. Slide dip bioassay of MPede / Potassium Salts of Fatty Acids 49% SL against *Aphis gossypii*

Tr. No.	Treatments	Dose (ml/l)	*Adult Mortality (%) 24 HAT
T ₁	MPede / Potassium Salts of Fatty Acids 49 SL	10	96.67(83.66) ^{ab}
T ₂	MPede / Potassium Salts of Fatty Acids 49 SL	12.5	100.00(89.71) ^a
T ₃	MPede / Potassium Salts of Fatty Acids 49 SL	15	100.00(89.71) ^a
T ₄	MPede / Potassium Salts of Fatty Acids 49 SL	18.75	100.00(89.71) ^a
T ₅	Azadirachtin 05.00 w/w Min. Neem Extract Concentrates	0.5	93.33(77.61) ^b
T ₆	Imidacloprid 17.80 SL	0.25	100.00(89.71) ^a
T ₇	Control (Water)	-	10.00(18.44) ^c
	SE(d)	-	4.91
	CD (P=0.05)	-	9.81

HAT: Hours after Treatment; *Mean of four replications;

Values in parenthesis are arc sine transformed values;

In a column means followed by the same letter(s) are not significantly different (p=0.05) by DMRT.; Rankings are plotted in descending order.

Table 3. Residual film bioassay of MPede/Potassium Salts of Fatty Acids 49% SL against *Aphis gossypii*

Tr. No.	Treatments	Dose (ml/l)	*Adult Mortality (%) 24 HAT
T ₁	MPede / Potassium Salts of Fatty Acids 49 SL	10	90.00(74.91) ^{ab}
T ₂	MPede / Potassium Salts of Fatty Acids 49 SL	12.5	96.67(83.66) ^{ab}
T ₃	MPede / Potassium Salts of Fatty Acids 49 SL	15	100.00(89.71) ^a
T ₄	MPede / Potassium Salts of Fatty Acids 49 SL	18.75	100.00(89.71) ^a
T ₅	Azadirachtin 05.00 w/w Min. Neem Extract Concentrates	0.5	90.00(71.57) ^b
T ₆	Imidacloprid 17.80 SL	0.25	96.67(83.66) ^{ab}
T ₇	Control (Water)	-	6.67(12.39) ^c
	SE(d) -	7.48	
	CD (p=0.05)	-	14.96

HAT: Hours after Treatment; *Mean of four replications;

Values in parenthesis are arc sine transformed values;

In a column means followed by the same letter(s) are not significantly different (p=0.05) by DMRT.; Rankings are plotted in descending order.

(2013) that concentrated on aphids and other arthropod pests further complement the findings of Clinton *et al.* (2011), who addressed the management of thrips in onions.

In slide dip and residual film bioassay, Potassium Salts of Fatty Acids 49 SL @ 12.5 ml/l, 15 ml/l and 18.75 ml/l causes 100 per cent mortality after 24 hrs of exposure which was same effective as standard check 2. These are in accordance with the findings that Potassium salts of fatty acids are effective against the majority of soft-bodied insect pests, but only when they come into direct contact with the pest (Liu and Stansly, 2000). Aphids, whiteflies, scales, and mealy bugs have all been successfully managed by them (Mohamad *et al.*, 2013; Dheeraj *et al.*, 2013; Hollingsworth, 2005). Insects get desiccated when potassium salts of fatty acids break down the protective layer on their surface and permit penetration through the cell, disrupting the permeability of the cell membrane (Mohamad *et al.*, 2013; Dheeraj *et al.*, 2013; Ciancio and Mukerji, 2010). However, potassium salts of fatty acids act quickly, giving pests a rapid knockdown effect, and they breakdown quickly after application, leaving no residues on the crops, unlike synthetic chemical pesticides (Dheeraj *et al.*, 2013; Hollingsworth, 2005).

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Conflict of Interest - None

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