Effectiveness of Plant Oils for Bio-intensive Control of Uzi Fly Infestation in Mulberry Silkworm (*Bombyx mori*): A Comparative Study

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ABSTRACT

A study was carried out to assess the effect of plant oils against the uzi fly (*Exorista sorbillans* Weidemann) and the mulberry silkworm (*Bombyx mori* Louis), at three different concentrations: 0.2, 0.4, and 0.8 percent. Among the treatments, 0.8 % of neem (*Azadirachta indica*) oil recorded reduced number of eggs laid (fecundity) (40.33), egg hatchability (46,00 %), and maggot recovery (34.00 %), followed by karanj (*Pongamia pinnata*) oil (54.00, 52,67 and 50.00%, respectively) and was statistically superior to control (114.33, 93.00% and 92%) and *Nesolynx thymus* (107.67, 90.00 and 89.00%). Significantly higher maggot (larvae) mortality was observed with 0.8 per cent neem oil (65.33 %), followed by karanj oil (35.33 %) compared to castor oil (24.67 %), and control treatment (11.00%). Spraying plant oil from neem and karanj, also drastically reduced the pupation rate %, adult emergence%, adult longevity, and fecundity of the uzi fly.

Keywords: Plant oils, Uzi fly, Silkworm, Nesolynx thymus, Treatments.

1. INTRODUCTION

The production of successful mulberry silk faces numerous challenges, including yield-limiting factors such as pests and diseases. Among these, the uzi fly *Exorista sorbillans* Wiedemann, from the family Tachinidae, order Diptera is a particularly serious pest. It is a serious endo-larval parasitoid of both mulberry and non-mulberry silkworms[8,12]. Chemical control of this pest is impractical because of its detrimental effects on the growth and development of *B.mori* L. Previously, various methods have been proposed to control the uzi fly, including the eradication of infested silkworms and maggots[10], rearing under nylon net and fly proof wire mesh[13], spraying of uzicide, use of uzitrap and release of natural enemies[7]. However, despite the adoption of these control techniques by farmers, the prevalence of infestation has persisted. Utilizing of chemicals can help reduce the number of uzi flies, but because silkworms are sensitive to chemicals, doing so could result in their demise and a direct loss for the sericulture sector. Due to the recent tendency in pest management to replace synthetic chemicals with botanical substances that have reduced or no environmental hazards, it is thought that it is vital to evaluate novel botanicals for their ability to combat pests. The latest trend in Indian agriculture is bio-intensive integrated pest control, which is a crucial element of integrated management that would help to reduce the reliance on chemical pesticides and their negative effects on the environment.

Therefore, there is a critical need for alternative control techniques. In this regard, a strategy based on the use of plant oils for uzi fly control has been developed.

2. MATERIAL AND METHODS)

[2.1 Collection and artificial infestation of uzi fly

Uzi-infested mulberry larvae were collected from farmers, and fresh maggots were gathered as soon as they pierced out from their host through the cocoon shell and, maintained in a container with soil to allow the uzi fly maggot to pupate. The wire net of the cage was used to confine these adults and they were given honey solution[11,14]. These uzi pupae were kept in a container and covered with muslin cloth until adult uzi flies emerged. After the flies had mated, the silkworms after second moult were introduced into the cage and fed on mulberry leaves. The silkworms were previously treated before being placed in the rearing cage, and flies were permitted to infest them.

2.2 Preparation and application of treatments

Various plant oils viz., such as neem, castor, and karanj oils, were purchased from Ayurvedic stores. A Tween 20 emulsifier was added to five milli liter of each oil, and 95 mL of distilled water was added to bring the volume to 100 ml. This solution was maintained in a 5 percent stock solution. Serial dilutions were prepared from this stock solution using distilled water to obtain concentrations of 0.2, 0.4 and 0.8 percents. The 20 ml solution prepared was sprayed on batch of 50 silkworm larvae after bed cleaning from the third instar onwards in three replications. The plant oils were applied with a 200 ml sprayer at intervals of three days starting from the third instar of the silkworm.

2.3 Methods of plants oil application

3.1 Fecundity (Number of eggs laid per female)

A batch of 50 silkworm larvae were reared individually, replication wise, in an insect-rearing cage until the third instar, and then treated with 20 ml of plant oil solution and were transferred into the rearing cage where uzi flies were present and permitted for oviposition. The number of eggs deposited and hatched from each larva was then recorded.

2.3.1 Ovicidal effects

After oviposition, each batch was sprayed with 20 ml of plant oil and maintained separately in triplicate. Egg hatchability percentages and recovery were calculated.

2.3.2 Larvicidal effects

After the uzi fly eggs hatched plant oil was sprayed again on a batch of 50 silkworms at an interval of three days and maintained separately, replication-wise. Maggot mortality, pupation rate, adult emergence, adult longevity and fecundity were also recorded.

2.3.3 Effects of plant oils on silkworm larvae

Fifty batches of silkworms were sprayed with 20 ml of plant oil and introduced into a rearing cage where uzi flies were maintained in a container. The fifth-instar larval duration of Bombyx mori Louis was recorded and reported in days. Before spinning, mature silkworms were measured from each replication of a 50 batch of silkworms. The weight was measured using electronic balance, and the mean of three replication was recorded in grams. The number of larvae died due to effect of different treatments was recorded. Larval weight, duration and mortality were recorded.

3. RESULTS AND DISCUSSION

3.1 Fecundity

The capacity of uzi flies to lay eggs was significantly affected by the application of plant oils. The lowest quantities of eggs deposited at 0.2, 0.4, and 0.8 percent concentrations in neem oil were 77.33, 50.00, and 40.33 eggs, respectively. The concentration of castor oil (98.33, 84.00, and 63.00) and karanj oil (93.33, 72.33, and 54.00

eggs at 0.2, 0.4, and 0.8 percent concentrations, respectively). The trays that were individually covered with nylon nets had the fewest uzi fly eggs—0.00—deposited on them. *N. thymus* therapy was statistically equivalent to that of the untreated treatment (control). Following neem, karanj, and castor oil, as the treatments that produced the fewest eggs were trays that were individually covered with nylon nets. With an increase in plant oil content, the egg-laying capacity of uzi flies decreased dramatically (Table 1, Figure 1).

2.4 Egg hatchability

The least conducive oil to egg hatching at various concentrations was neem oil, followed by castor and karanj oils. Egg hatchability decreased as concentration increased. Neem oil had the lowest egg hatchability percentage of uzi fly eggs, 46.00% at 0.8 percent concentration; it was followed by castor and karanj oils, at 52.67 and 62.33 percent, respectively (Table 1).

2.5 Maggot recovery

Maggot recovery was inhibited as concentration of plant oils increased. Neem oil was superior, with a maggot recovery rate of 34.00% at 0.8 percent concentration, followed by karanj oil at 50.00%. The *N. thymus* was the least effective which was significantly similar than that of the control (Table 2, Figure 1).

2.6 Maggot mortality

The highest maggot mortality was reported for neem oil at 0.8 percent concentration (65.33%). Karanj oil increased maggot mortality by 35.33 percent at both 0.4 and 0.8 concentrations, placing it second in effectiveness. The minimum mortality was recorded in control and *N. thymus* with 11.00 and 18.00 % respectively (Table 2).

2.7 Pupation rate

Neem oil outperformed the other treatments, with pupal formation rates of 47.67, 27.33, and 30.33 percent, respectively, at concentrations of 0.2, 0.4, and 0.8 percent (Table 3). Karanj oil, with a pupation percentage of 40.33 at a concentration of 0.4 percent concentration. The statistical parity between the *N. thymus* and the control was 84.00 percent.

2.8 Adult emergence

The emergence of adult uzi flies was significantly suppressed by 14.0 percent in the treatment where *N. thymus* was used. Following neem oil treatment. the emergence of adult uzi flies was decreased as concentrations increased.

With respect to the treatments examined, a reduction in adult emergence was observed for 51.17, 46.61, and 43.95 percent of the treatments as the plant oil content increased (Table 3).

2.9 Adult longevity

The lowest adult longevity days of 6.67 and 6.00 days at 0.4 and 0.8 percent concentrations, respectively. Followed by 7.00 days was recorded in the treatment with *N. thymus*. Neem oil at 0.2 percent concentration was statistically at parity with control. Castor oil and karanj oil were statistically similar to the control, with longer adult longevity (Table 3).

2.10 Morphological deformities in pupa and adult

When different plant oils are sprayed on *E. sorbillans* maggots in their third instar, they cause morphological changes in both the pupa and the maggot. Both pupae and adults developed malformations after the maggot was exposed to plant oils. The mouth and anal areas of the treated resultants were darkened, and it was discovered that the treated maggots did not pupate and created maggot-pupal intervals. The treated materials gave rise to pupae with a disproportionate pupal body and a darker pupal body. The treated pupae either had an aberrant appearance or the pupae did not develop into healthy adults. The treated adult creatures had malformed appendages and wings. The effect of different plant oils revealed morphogenic defects in the pupae and adults of the uzi fly. The pupae were abnormally long or shortened in length and width. Darkened color and mostly inability to emerge into adults. Abnormalities in adults include failure to emerge from the pupal case and incomplete wing development (fig. 2,3).

2.11 Effects of oil on mulberry silkworm larvae

Spraying of neem oil (0.8 percent concentration) recorded 7.92 days larval duration which was statistically at par with the control. The larval duration was prolonged to 9.39 and 9.78 days was recorded when sprayed with karanj oil and castor oil (0.8% concentration). However, in castor oil larval days prolonged to 10.40 and 9.78 days at 0.2 and 0.8 percent concentrations (Table 4).

2.11.1 Mature larval weight

Ten mature silkworm larvae were recorded for each replicate. The maximum larval weight was recorded in neem oil (4.21 g) at 0.4 percent concentration, and the minimum was recorded in karanj oil (1.83 g) at 0.2 percent concentration, which were significantly different from that of the untreated control. Among the concentrations tested, at 0.4 percent concentration, the maximum larval weights were 4.21, 2.50 and 2.95 gram sprayed by neem oil, castor oil and karanj oil, respectively.

2.11.2 Larval mortality

The Lower larval mortality was recorded in neem oil 9.53 % at 0.4 percent concentration, which was statistically at par the control (9.90 percent). Among the treatments tested, karanj oil showed the highest larval mortality (13.09 %) at the 0.4 percent concentration (Table 4).

3. DICUSSION

The primary emphasis of this study was how plant oils affect uzi flies and mulberry silkworms in comparison to physical barriers, biocontrol agents, and untreated controls. Some plant compounds function as ovipositional deterrents, causing significantly less oviposition in silkworm larvae. All plant oils outperformed each other in terms of lowering the number of eggs deposited on silkworm larvae. The larvae treated with 0.8 percent neem oil and uzi fly laid the fewest eggs, followed by those treated with karanj oil. The tray that was individually covered with nylon net outperformed all other treatments with 00.00 uzi fly eggs on the larval body[3]. It was also reported that the neem oil 1% exhibited a statistically significant repellent or oviposition deterrent effect on *Drosophila Suzukii* Matsumura adults compared with their control[1,19]. Neem oil 1% was able to reduce the mean number of larvae per test fruit from 38.8 for the control group to 27.9 for the 1% treatment.

Neem oil reduced the egg hatchability. This reduction may be due to the presence of biochemicals in neem oil that interfere with embryonic development[17]. The topical application of different concentrations of neem oil on silkworm larvae after oviposition of the uzi fly reduced the hatching of uzi fly egg[4]. The fecundity of the house fly, *Musca domestica* was completely inhibited by the Neem extract[6].

The maggot recovered from the larvae sprayed with plant oils significantly decreased. The results revealed that neem oil was superior in reducing the maggot recovery with increasing concentration. Plant oils were given to uzi maggots exogenously, which drastically decreased the pupation percentage compared to controls. All the plant oils showed a reduction in pupation percentage in comparison to *Nesolynx thymus* and the control. Murugesh (2012) reported that the number of pupae formed was reduced by using different botanicals, and the pupation rate was lowest in the lot treated[14]. The highest mortality was recorded with different percent concentrations of neem oil. The highest larval mortality percentage was recorded in EC formulations (dip method) followed by powder formulation (topical spray) and dust formulation (contact method) of neem oil in the maggots of the uzi fly, *Blepharipa zebina*[18].

A drastic decrease in adult emergence was recorded in the lot treated with the bio-control agent, *Nesolynx thymus* and significantly differed from the other treatments. The neem oil from the plant oils showed highly reduced adult emergence. It was reported that the 57.33% of the farmers indicated that the extent of suppression of uzi fly due to the use of *Nesolynx thymus* in the demonstrations, 21.33% of the respondents were of the opinion that the uzi fly incident was brought down above 50% by the use of bio-control agents[9].

The shorter adult longevity days was recorded at 0.4 and 0.8 percent concentrations to 6.67 and 6.00 days, respectively and followed by the *Nesolynx thymus* with 7.00 days adult longevity. Castor oil and karanj oil extended adult longevity. A similar observation was reported, that the developmental rate of *Podius nigrispinus* decreased with increasing neem oil concentrations[20]. Longevity of stink bug predator, *Podisus nigrispinus* adult was from 16.5 and 15.7 days at 0.5 and 50% neem concentrations.

The effects of different plant oils revealed morphogenic defects in the pupae and adults of the uzi fly. The pupae were abnormally long or shortened in length and width. Darkened color and mostly inability to emerge into adults. Abnormalities in adults include failure to emerge from the pupal case, and incomplete wing development. This may be due to the presence of high juvenile hormone levels in maggot or chemical compounds in the neem oil preventing normal pupation and emergence of adults, similar finding was observed by Chinnamma[5].

Larval duration was not considerably altered by spraying plants with the neem oil solution during the fifth instar. However, castor and karanj oil extended larval days with the increasing concentrations. It was reported that the batch of plain white cocooned eri silkworms nourished with leaves devoid of botanicals recorded lowest larval duration (21.04 days) followed by 3 ml/lit neem oil treated worms (21.64 days), whereas in the brick red cocoon eri silkworm strain, the batch of worms treated with 3 ml/lit neem oil recorded lowest larval duration (20.21days) followed by untreated control (20.45 days)[16]. The eri silkworms nourished with 5 ml/lit karanj oil recorded the longest larval duration (22.38 and 21.2 days in plain white and brick red strains respectively). The silkworm weight when sprayed with neem oil was at parity with the control, whereas in castor oil treated silkworm weight was reduced, which may be due to the antifeedant effect of the plant oil[16]. The plant oil application revealed that the silkworm larval mortality was lowest in neem oil and was statistically at par with that of the control. The highest larval mortality was recorded in karanj oil with increasing concentration. This could be correlated with the findings, reported that the bioassay of three pesticides on bivoltine silkworm showed that mortality of silkworm was very low in case of the neem oil followed by pongamia oil after 15days of spray[2]. Murugesh and Bhaskar reported that *Pongamia glabra* recorded statistically higher percentage of larval mortality (11.98%) than distilled water control (11.63%)[15].

Table 1. The effects of different treatments on fecundity and hatchability of eggs of *Exorista sorbillans*.

Treatments	Number of eggs laid by *Exorista sorbillans*			Treatments	Hatchability of *Exorista sorbillans* eggs (%)		
	0.2%	0.4%	0.8%		0.2%	0.4%	0.8%
T1: Neem oil	77.33^{c} (8.85)	50.00^{d} (7.14)	40.33^{d} (6.43)	T1: Neem oil	66.33^{d} (0.73)	40.67^{d} (0.42)	46.00^{d} (0.48)
T2: Castor oil	98.33^{b} (9.97)	84.00^{b} (9.22)	63.00^{b} (8.00)	T2: Castor oil	87.67^{b} (1.07)	66.00^{b} (0.72)	62.33^{b} (0.67)
T3: Karanj oil	93.33^{b} (9.71)	72.33^{c} (8.56)	54.00^{c} (7.42)	T3: Karanj oil	74.67^{c} (0.84)	53.33^{c} (0.56)	52.67^{c} (0.55)
T4: Nylon net	0.00^{d} (1.00)	0.00^{e} (1.00)	0.00^{e} (1.00)	T4: Nylon net	0.00^{e} (0.01)	0.00^{e} (0.01)	0.00^{e} (0.01)
T5: *Nesolynx thymus*	107.67^{a} (10.42)	107.67^{a} (10.42)	107.67^{a} (10.42)	T5: *Nesolynx thymus*	90.00^{ab} (1.12)	90.00^{a} (1.12)	90.00^{a} (1.12)
T0: Control	114.33^{a} (10.74)	114.33^{a} (10.74)	114.33^{a} (10.74)	T0: Control	93.00^{a} (1.20)	93.00^{a} (1.20)	93.00^{a} (1.20)
Mean	81.83	71.38	63.22	Mean	68.61	57.16	57.33
SE(d)±	0.155	0.104	0.116	SE(d)±	0.043	0.037	0.037
$C.D._{(p=0.05)}$	0.343	0.228	0.257	$C.D._{(p=0.05)}$	0.095	0.081	0.080

*Data based on mean of three replications
*50 numbers of larvae per replication
*Figures in parentheses are angular transformed value

Table 2. The effects of different treatments on maggot recovery and hatchability of eggs of *Exorista sorbillans*.

Treatments	Maggot recovery of *Exorista sorbillans* (%)			Treatments	Maggot mortality of *Exorista sorbillans* (%)		
	0.2%	0.4%	0.8%		0.2%	0.4%	0.8%
T1: Neem oil	52.67^{c} (0.56)	32.00^{d} (0.33)	34.00^{d} (0.35)	T1: Neem oil	47.67^{a} (0.50)	59.33^{a} (0.64)	65.33^{a} (0.71)
T2: Castor oil	79.00^{b} (0.91)	66.00^{b} (0.72)	66.67^{b} (0.73)	T2: Castor oil	22.00^{c} (0.22)	25.00^{c} (0.25)	24.67^{c} (0.25)
T3: Karanj oil	74.00^{b} (0.83)	53.00^{c} (0.53)	50.00^{c} (0.52)	T3: Karanj oil	30.67^{b} (0.31)	35.33^{b} (0.36)	35.33^{b} (0.36)
T4: Nylon net	0.00^{d} (0.01)	0.00^{e} (0.01)	0.00^{e} (0.01)	T4: Nylon net	0.00^{e} (0.01)	0.00^{f} (0.01)	0.00^{f} (0.01)

T5: *Nesolynx thymus*	89.00^{a} (1.10)	89.00^{a} (1.10)	89.00^{a} (1.10)	T5: *Nesolynx thymus*	18.00^{c} (0.18)	18.00^{d} (0.18)	18.00^{d} (0.18
T0: Control	92.00^{a} (1.17)	92.00^{a} (1.17)	92.00^{a} (1.17)	T0: Control	11.00^{d} (0.11)	11.00^{e} (0.11)	11.00^{e} (0.11)
Mean	64.45	55.33	55.27	Mean	21.56	24.78	25.72
SE(d)±	0.037	0.032	0.040	SE(d)±	0.018	0.020	0.022
C.D.$_{(p=0.05)}$	0.081	0.070	0.087	C.D.$_{(p=0.05)}$	0.039	0.043	0.049

*Data based on mean of three replications
*50 numbers of larvae per replication
*Figures in parentheses are angular transformed value

Table 3. The effects of different treatments on pupation percentage, adult emergence and adult longevity of *Exorista sorbillans*.

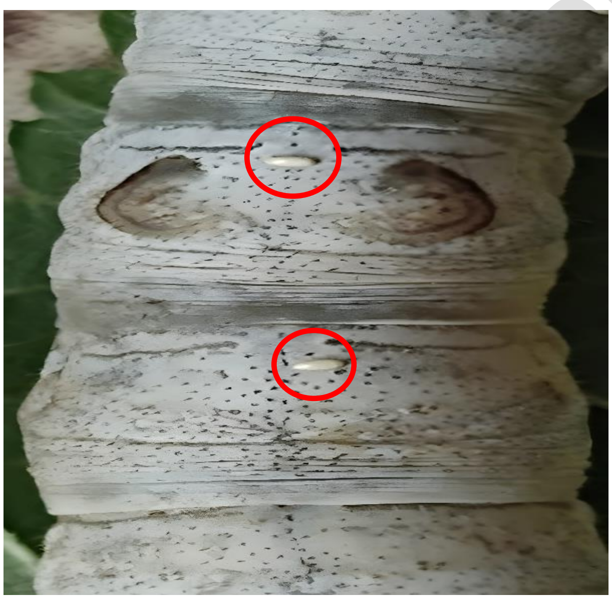
Treatments	Pupation (%) of *Exorista sorbillans*			Treatments	Adult emergence of *Exorista Sorbillans* (%)			Treatments	Adult longevity of *Exorista sorbillans* (days)		
	0.2%	**0.4%**	**0.8%**		**0.2%**	**0.4%**	**0.8%**		**0.2%**	**0.4%**	**0.8%**
T1: Neem oil	47.67^{e} (0.50)	27.33^{e} (0.28)	30.33^{d} (0.31)	T1: Neem oil	54.33^{c} (0.58)	41.67^{d} (0.43)	41.00^{d} (0.42)	T1: Neem oil	10.33^{b} (3.35)	6.67^{c} (2.77)	6.00^{b} (2.64)
T2: Castor oil	76.00^{c} (0.86)	60.00^{c} (0.64)	58.67^{b} (0.63)	T2: Castor oil	81.00^{a} (0.94)	72.00^{b} (0.80)	66.00^{b} (0.73)	T2: Castor oil	11.00^{a} (3.46)	11.67^{a} (3.56)	11.33^{a} (3.51)
T3: Karanj oil	62.00^{d} (0.67)	40.33^{d} (0.42)	42.00^{c} (0.43)	T3: Karanj oil	71.67^{b} (0.80)	66.00^{c} (0.72)	56.67^{c} (0.60)	T3: Karanj oil	12.00^{a} (3.60)	9.33^{b} (3.21)	11.00^{a} (3.46)
T4: Nylon net	0.00^{f} (0.01)	0.00^{f} (0.01)	0.00^{e} (0.01)	T4: Nylon net	0.00^{e} (0.01)	0.00^{f} (0.01)	0.00^{f} (0.01)	T4: Nylon net	0.00^{d} (1.00)	0.00^{e} (1.00)	0.00^{d} (1.00)
T5: *Nesolynx thymus*	84.00^{b} (1.00)	84.00^{b} (1.00)	84.00^{a} (1.00)	T5: *Nesolynx thymus*	14.00^{d} (0.14)	14.00^{e} (0.14)	14.00^{e} (0.14)	T5: *Nesolynx thymus*	7.00^{c} (2.83)	7.00^{d} (2.83)	7.00^{c} (2.83)
T0: Control	88.00^{a} (1.08)	88.00^{a} (1.08)	88.00^{a} (1.08)	T0: Control	86.00^{a} (1.04)	86.00^{a} (1.04)	86.00^{a} (1.04)	T0: Control	10.00^{b} (3.31)	10.00^{ab} (3.31)	10.00^{a} (3.31)
Mean	59.61	49.94	50.5	Mean	51.17	46.61	43.95	Mean	8.39	7.45	7.56
SE(d)±	0.025	0.051	0.036	SE(d)±	0.029	0.024	0.056	SE(d)±	0.206	0.154	0.159
C.D.$_{(p=0.05)}$	0.055	0.016	0.080	C.D.$_{(p=0.05)}$	0.064	0.052	0.122	C.D.$_{(p=0.05)}$	0.454	0.340	0.349

*Data based on mean of three replications
*50 numbers of larvae per replication
*Figures in parentheses are angular transformed value

Table 4. Effects of Plant oils on silkworm, *Bombyx mori*

Treatments	Larval duration of *Bombyx mori* (days) (fifth instar)			Treatments	Larval weight of *Bombyx mori* (g)			Treatments	Larval mortality of *Bombyx mori* (%)		
	0.2%	**0.4%**	**0.8%**		**0.2%**	**0.4%**	**0.8%**		**0.2%**	**0.4%**	**0.8%**
T1: Neem oil	7.52 (15.91)	8.04 (16.47)	7.92 (16.30)	T1: Neem oil	2.69 (0.43)	4.21 (0.62)	3.40 (0.53)	T1: Neem oil	10.02 (18.44)	9.53 (19.00)	10.62 (17.98)
T2: Castor oil	10.40 (18.80)	8.26 (16.71)	9.78 (17.94)	T2: Castor oil	1.95 (0.29)	2.50 (0.34)	1.97 (0.29)	T2: Castor oil	11.67 (19.96)	12.25 (20.26)	12.01 (20.48)
T3:Karanj oil	9.63 (18.06)	8.06 (16.49)	9.39 (17.59)	T3:Karanj oil	1.83 (0.26)	2.95 (0.470	2.16 (0.33)	T3: Karanj oil	12.00 (20.26)	13.09 (20.51)	12.28 (21.19)
T0: Control	7.90 (16.32)	7.90 (16.32)	7.90 (16.32)	T0: Control	2.96 (0.46)	2.96 (0.46)	2.96 (0.46)	T0: Control	9.90 (18.33)	9.90 (18.33)	9.90 (18.33)
Mean	8.86	8.06	8.75	Mean	2.36	3.16	2.62	Mean	10.67	11.19	11.20
S.E(d) ±	0.611	0.044	0.576	S.E(d) ±	0.261	0.310	0.291	S.E(d)±	0.230	0.352	0.379
C.D$_{(p=0.05)}$	1.431	0.103	1.349	C.D$_{(p=0.05)}$	0.863	1.025	0.963	C.D$_{(p=0.05)}$	0.540	0.824	0.888

*Data based on mean of three replications
*50 numbers of larvae per replication
*Figures in parentheses are angular transformed value



(a)

(b)

(c)

(d)

Figure 1. **The figure shows (a) Uzi fly eggs on silkworm larvae, (b) Uzi maggot piercing out from mulberry silkworm, (c) Uzi maggots and (d) Heavy infestation of uzi maggot**

(a)

(b)

(c)

(d)

Figure 2. The effects of plant oils on pupa of *Exorista sorbilans* (a) malformed pupa due to neem oil, (b) effect of castor oil, (c) comparison of normal and malformed cocoon and (d) malformed pupa due to karanj oil.

Figure 3. The effects of plant oils on moth of *Exorista sorbilans* (a) half emerged uzi fly, (b) both wings deformed, (c)one wing deformed and (d) whole deformed body.

4. CONCLUSION

The impact of plant oils on uzi flies and mulberry silkworms compared to barriers, biocontrol agents, and controls. Neem oil and karanj oil significantly reduced oviposition in silkworm larvae. Neem oil, especially at 0.8%, was most effective against uzi fly eggs. Neem oil at 1% also acted as a repellent for *Drosophila Suzukii* Matsumura adults. It hindered egg hatchability and interfered with embryonic development.

Plant oils, particularly neem oil, decreased maggot recovery and pupation percentages in uzi maggots. Neem oil formulations led to high larval mortality rates. Bio-control agent *Nesolynx thymus* decreased adult emergence. Plant oils caused morphogenic defects in uzi fly pupae and adults, affecting pupation and emergence. However, they did not notably alter larval duration.

Neem oil, particularly at 0.8% concentration, exhibited the most significant impact on the uzi fly, affecting various developmental stages and resulting in morphological deformities. Furthermore, the study revealed the effects of plant oils on mulberry silkworm larvae, indicating variations in larval duration, weight, and mortality across different concentrations of neem, castor, and karanj oils. Overall, the findings suggest the potential of plant oils, particularly neem oil, as an effective bio-intensive treatment for controlling the uzi fly and safeguarding mulberry silkworms.

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COMPETING INTERESTS

THE AUTHORS DECLARE NO CONFLICT OF INTEREST.

AUTHORS’ CONTRIBUTIONS

“ ‘Author 1*’ designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. ‘Author 2’ , Author 3’ and ‘Author 5’ managed the analyses of the study. ‘Author 4’ managed the literature searches…… All authors read and approved the final manuscript.”

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare 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 manuscripts.

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