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Evaluation of some botanical and synthetic insecticides against Mustard Saw Fly (Athalia proxima Klug) fed on Okra (*Abelmoschus esculentum*)

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ABSTRACT

Three botanical pesticides *Azadirachta indica* leaves extract, *Acacia catechu* leaf and bark extract, *Carica papaya* seed extract and three chemical pesticides Indocarb 15 SC, 0.006%,@30a.i./ha,200ml/g/ha, Fipronil 5EC0.005%,25-50gai/ha,500ml/g/ha and Endosulfan 35 EC,0.05-0.07%,250-500a.i. /ha700-1004ml/g/h were tested against 2ndand4thinstar larvae of the *Athalia proxima* in the field of okra under both laboratory and field conditions. In square dip experiment, a highly significant difference was recorded amongst the different treatments for mean mortality of *A.proxima*. The maximum mean mortality was obtained at AcBE10% >NLE10%> NLE 2.5% >NSE 2.5%. The order was found to be descending. Repellency test through square dip experiments showed that the significant difference was recorded amongst the different treatments for mean mortality of larvae. During larval immersion method, AcBE10% was proved to be the most significant followed by AcLE10%> NLE10%>NSE 2.5%. The effect of feeding on larvae in square dip method found highly significant at 9DAT(Days After Treatment) with Endosulphan, Indoxcarb,Fipronil, CpLE10%and NLE2.5% followed to 6DAT maximum loss was recorded by Endoslphan>Indoxcarb>CpLE10%>NLE2.5-5% and 3DAT CpLE(2.5-10%) showed maximum weight loss followed to Endosulfan, NLE 2.5% Results on weight loss in larvae through Larval immersion method showed that the larval weight decreased initially on feeding at 9 DAT CpLE2.5%>Indoxcarb>AcBE10%>AcBE2.5%. At 6DAT, AcBE10% showed maximum weight loss while 3DAT maximum loss was recorded by NLE10%>AcBE10% >AcLE10% >Indoxcarb>Endosulphan. The field spray schedule showed the significant results with the spray of CpLE 2.5% > Endosulphan> NLE 2.5%-5.0% with Ist spray. IInd spray schedule NLE 2.5%, NSE 2.5% and NLE 5.0% were recorded as significant. IIIrd spray schedule Indoxcarb, Fipronil, Endosulphan were found most significant followed by AcLE 10.0% NLE 2.5-10% and NSE 2.5-10% AcLE 2.5-5.0%.

Keywords: *Athalia proxima*, Mustard sawfly, Neem leaf extract, Acacia bark extract, Carica seed extract, Repellent.

I. INTRODUCTION

Today the rapid increase in population and demand for food materials has initiated the large use of insecticides and pesticides. These toxic chemical insecticides and pesticides are resulting in harmful effects and biomagnifications which is continuously polluting fertile lands and acquiring infertility. No doubt they provide results in eradication of insects, pests, and diseases but are also killing beneficial organism the soil and affects soil fertility. The conventional farming practices based on chemical methods broadly kill arthropods, resulting in the malfunctioning of the food chain and food web.

Bio-control is the best method to cope with the losses done by the chemicals. In these method insects, pests and pathogens are removed using biological methods without harming the environment and another organism. Biocontrol is based on natural predation rather than introduced chemicals. The use of bio-insecticides and pesticides also comes under this category. Today due to awareness about the harmful effects of the chemical insecticides and pesticides, most of the farmers are diverting towards the organic farming. In our local area many such plants, waste matter, etc. are available from which these bio-insecticides and pesticides can be prepared by using natural means only. Conventional pesticides are synthetic materials that directly kill or inactivate the pest. Being single chemical entity, chemical pesticides have resulted in increased resistance to pests.

Biological Pesticides are pesticides derived from natural materials as animals, plants, bacteria, and certain minerals. Biopesticides are less toxic and also reduce the pollution problems caused by conventional pesticides. The use of bio-insecticides and bio-pesticides also fall under this category only. Organic agriculture is a unique production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity, and this is accomplished by using on-farm agronomic, biological and mechanical methods in exclusion of all synthetic off-farm inputs. Organic farming produces somewhat lower yields but sustains better yields during drought years, allowing it to reap higher yields in some cases. Studies thus far have shown that organic farming requires less water, uses few and always natural pesticides, prevents soil erosion, leaches dramatically fewer nitrates, and has been shown to have improved nutrient qualities including as much as double the flavonoids, an important antioxidant. “Bio pesticides include naturally occurring substances that control pests (biochemical pesticides), microorganisms that control pests (microbial pesticides), and pesticidal substances produced by plants containing added genetic material (plant-incorporated protectants) or Pips. Agriculture has had to face the destructive activities of numerous pests like fungi, weeds, and insects from time immemorial, leading to a radical decrease in yields. With the advent of chemical pesticides, this crisis was resolved to a great extent. But the over-dependence on chemical pesticides and eventual uninhibited use of them has necessitated for alternatives mainly for environmental concerns. Degraded soils and groundwater pollution have resulted in nutritionally imbalanced and unproductive lands. Violative pesticide residues also sometimes raise food safety concerns among domestic consumers and pose trade impediments for export crops. Therefore, an eco-friendly alternative is the need of the hour. Bio pesticides or biological pesticides based on plant extracts specific to a target pest offer an ecologically sound and efficient solution to pest problems. They pose less threat to the environment and human health. The potential benefits of agriculture and public health programmes through the use of bio pesticides are considerable. The interest in biopesticides is based on the advantages associated with such products which are: (i) inherently less harmful and less environmental load,(ii) designed to affect only one specific pest or, in some cases, a few target organisms, (iii) often effective in very small quantities and decompose quickly, thereby resulting in lower exposures and mostly avoiding the pollution problems and (iv) when used as a component of Integrated Pest Management (IPM) programs, biopesticides can contribute significantly.

Mustard sawfly, *Athalia lugens proxima* Klug (Hymenoptera: Tenthredinidae) has become a severe pest of mustard and radish in several regions of India, including the north-east of India. It is a pest of cold weather and is active from October to March. The female fly lays the eggs singly on the young leaves, close to the margin. Under favorable conditions, hatching takes place in 5-7 days, and the larval stage lasts about 13-15 days. There are six larval instars, and the pupation takes place in the soil. The whole life – cycle is completed in about 30-39 days. The larvae alone are destructive and feed on the margin of the leaf towards the center. The grown-up larvae make holes, preferably on young leaves, and skeletonize them. Sometimes they also feed on the epidermis of the tender shoots, flowers, and fruits (Chowdhury 2009). The severity of infestation varies according to the season, and in severe cases major attack at the seedling stage, the crop may even need resowing.

II. METHODS AND MATERIAL

Extraction of plant materials

(A) Azadirachta indica: The shade dried leaves of different neem plants were ground in an electrical grinder to make a fine powder. For extraction, 10gm powder of each plant leaves was weighed for extraction through petroleum ether (40-600C), and then another sample of 10 gm each was taken for obtaining alcoholic extracts with the help of soxhlet apparatus. The extraction was completed within 4 hours. The extracts obtained in the reservoir of the Soxhlet apparatus evaporated on a water bath till they remained about 15 ml and then transferred to pre-weighed 50 ml beakers, through filtration from a thick layer of anhydrous sodium sulphate made on silica gel on glass wool plugged funnels. The extracts were again dried over a water bath to obtain a semi-solid extractive of each plant. The extractives were used to make the stock solution. One percent stock solutions of all the fractions in methanol were prepared from the residues obtained at each stage of the purification process, and the fractions were tested at different concentrations.

(B) Acacia catechu: One kg of the dried leaves and bark Acacia catechu was taken in an aluminum pot to which ten liters of water was added so that the chips wholly immersed under water. It was boiled over an open fire for four hours and allowed to stand for 24 hours so that more catechu might diffuse into the water. The extract was decanted off in a pot and was filtered through a fine muslin cloth to remove wood chips and other suspended materials. The filtrate was evaporated and the residue obtained was air dried and weighed (180g). The yield of catechu was 18%. Isolated catechu (150g) was taken in a five-liter stainless steel beaker containing one liter distilled water. It was boiled with constant stirring for complete dissolution and filtered through a filter paper. Then it was evaporated to 500 ml and allowed to stand for 24 hours. The obtained precipitate was filtered using a filter paper. The aqueous filtrate was rejected. The residue was dissolved in ethanol and filtered. The ethanolic solution was evaporated to dryness, and the residue was dissolved in hot water (500 ml). It was allowed to stand for 24 hours. The precipitate was filtered and dried in air (m.p. 95-6ºC, yield 37.5g, 25%).

(C) Carica papaya: papaya fruit was obtained from the market. Seeds were shade-dried for a minimum of 15 days. Powdered seeds (1 kg) were extracted with chloroform (3.0 L), under reflux, for four h; the extract was cooled to room temperature and filtered. The solvent was removed under reduced pressure by the rotatory evaporator, and the extract was dried in a vacuum oven at room temperature for 12 h (yield, 7.2% by weight). Fatty acid methyl esters were prepared according to the AOAC-IUPAC Method 969.33 [18]. Chloroform extract (90 mg) and 1 N solution of NaOH in methanol (4 mL) were placed in a round-bottomed flask, and the mixture was heated to boiling point with stirring for 15 min. Next,BF3-MeOH (5 mL, 15% w/w) were added and heating continued for 5 min. Iso-octane (2 mL) was added; the mixture was stirred for 5 min, more and extracted with hexane (2 mL). The organic phase was dried over anhydrous Na2SO4. The fatty acid methyl esters were analyzed on an Agilent Technologies 6890N GC equipped with an HP-5MS column (30 m in length;25 mm internal diameter; 0.25 μm film thickness) equipped with an Agilent EM 5973 detector, at 150 °C. The carrier gas was helium, at a flow rate of 1 mL/min; the split ratio was

(D) 2:1. The column temperature was initially 60 °C (for 3 min) and was gradually increased to 170 °C, at 3 °C/min; this temperature was held for 1 min. Next, the temperature was raised to 330 °C, at a rate of 10 °C/min; this temperature was held for 10 min. The injector temperature was 330 °C and one μL of organic phase were injected by duplicate.

Insects

The larvae used for the study were collected from the host plants of different vegetables in the fields and brought to the lab, under laboratory conditions. The culture of A.proxima was maintained in the laboratory on a semi-synthetic diet as suggested by Nagarkatti and Prakash (1974) with some modifications at a temperature of 27± 1oC and relative humidity 60 ± 1 percent. They were reared on artificial diet in small round plastic vials (3.5x2.0Cm) till pupation under laboratory conditions. Studies were carried out using I-VI instar larvae of A. proxima against the leaf extract of A.indica.The percentage mortality was calculated after a period of 24h. Second and fourth-stage larvae were used in various experiments, and they were starved for 12 hrs before all experiments.

Bio efficacy evaluation

The various botanical and synthetic preparations used in laboratory and field are listed inTable1 (Figure1).

The host plants okra (Abelmoschus esculentum) used for the spraying tests in the laboratory and field were 3 to 5 weeks old and with 7-8 branches. Under laboratory conditions, the tests were carried out in Petri dishes (8.5cmdiameter).

In Square Dip Experiment, the design was CRD with three replications. The medium sized test leaves were collected from unsprayed fields. A total of 30 equal sized squares was dipped into each treatment for 20 seconds as shown in Table1 and then airdried for 60 minutes. The weight of each larva was recorded before treatment application using sensitive balance. The treated leaves were placed into the Petri dishes on moistened filter paper (one larva per Petri dish) with the adaxial surface uppermost.

A.proxima larvae were then placed onto the leaf disc, and then a cover was put onto the dish. For control treatments, the leaves were dipped in water only.

In larval immersion experiment, the larvae were immersed into the respective treatments for 20 seconds and then transferred to the paper padded tray to remove excessive liquid from the body of the larvae. The purpose of this experiment is to evaluate the contact effect of pesticides on insects. The design of this experiment is CRD with three replications. Like in the square dip experiment, a total of 30 larvae were tested in each treatment. Third instar larvae were weighed before treatment application.

The experiments were conducted in the laboratory at a temperature of 25±1°C light regime of 14h light 10h dark and relative humidity of 65 ± 1 %. Mortality was assessed every 24 h,48 h, and 72 h in all the experiments.

The fourth experiment under field conditions, the plants of Abelmoschus esculentum were grown 3-5weeks before conducting the experiments in plots. The planting distances were 70 cm x30cm on plots that measured 4.2mx4.0m. When the plants attained about 7-8branches, the solutions of various treatments were applied with a trigger sprayer, mistingtorun-off level. Water was used as a control. The spray equipment was drained and triple rinsed after each treatment to avoid any contamination. Second and third instars of A.proxima were placed on each plant, and ten plants were used in each treatment (30 larvae per treatment), and observations were recorded before and after 4 hrs,8hrs,24hrs, and 32hrs from the time of spray. In the experimental field trial, three replications for each treatment were performed.

Statistical analysis

For statistical analysis of the efficacy of insecticides to A.proxima mortality due to the different insecticides were analyzed using the Tukey 's Studentized Range (HSD) Test.

III. RESULTS AND DISCUSSION

Toxicity of insecticides to A.proxima

Our results show significant differences in the mortality recorded from the different treatments under laboratory and field conditions. Our results indicated that Acacia bark extract, Neem leaf and seed extracts applied in different concentration for repellency test, mean weight (mg) percentage and weight losses in Athalia proxima through square dip and larval immersion method in laboratory trials with their effects on different field treatment were found similar to finding conducted by Chopra et al.,(1949).

The lowest mean mortality was recorded by NLE 10% and control water treatment. Significantly higher mortality was detected in all the treatments compared with the untreated control as shown in table 2(figure 2) and table3(figure3) The effect of feeding on larvae found highly significant at 72 hrs after treatment with AcLE 10% followed to 48hrs after treatment in AcBE. Neem Leaf Extract (10% and 5%) was found effective at 72hrs treatment while other treatments found insignificant in comparison to control by square dip method. Results on weight loss at 3 DAT, CpLE(2.5-10%) showed maximum weight loss followed by Endosulphan. At 6 DAT maximum loss was recorded by Endosulphan followed to Indoxcarb, CpLE 10%, NLE 2.5%. At 9DAT Endosulphan, Indoxcarb, Fipronil and CpLE 10%and NLE 2.5% were found more significant in square dip method. Results on weight loss through Larval immersion method showed that initial maximum weight loss recorded in AcLE 10% followed to NSE10% and least in AcLE10% while other treatment found insignificant. The field spray schedule showed the significant results with the spray of CpLE 2.5%, and Endosulphan followed by NLE 2.5-5.0%with Ist spray schedule was recorded. IInd spray schedule NLE 2.5%, NSE 2.5% and NLE 5.0% were recorded as significant. IIIrd spray schedule Indoxcarb, Fipronil, Endosulphan were found most significant followed by AcLE10% NLE 2.5%-10%.

Singh et al., (1993) used Azadirachta indica to control mustard sawfly (Athalia proxima Kiug) under field experiment with a concentration of 0.5,1.0, and 1.5%.

Agarwal and Saroj (2003) reported maximum larval mortality (47.5%) of Athalia proxima in 2.0% concentration followed by 30, 22.5,15 and 6.25% mortality with the treatment of 1.0, 0.5,0.25, and 0.125% concentration of neem oil for causing larval mortality, pupal inhibition , inhibition of adult emergence , larval antifeedant and larval repellent effect. Srivastava and Singh (2003) used neem leaf powder @75 kg/ha at the time of sowing in furrows, reduced the pupation of mustard sawfly and increased the grain yield 5.2%. Chandel (2011) revealed that the plant extract of Alpinia galanga caused maximum mortality (80.8%) larval mortality of A.proxima followed by 67.9% in C. longa, 66.3% in A.melegueta and 62.1% in Z. officinale and compared to 6.6% in control. The plant extract of Alpinia galanga differed significantly from remaining plant extracts except for C.longa. The concentration of 2.0% was superior to 1.0 and 0.5%. It was also observed that the difference in the percentage kill of larvae between concentrations 1.0% and 2.0% was higher than the difference in mortality between 0.5% and 1.0% in all the three periods It was also seen that 2..0% induced 83.5% larval mortality within 6hrs of exposure but in another 18hrs larval mortality increased only by 7.58%.

Table 1: Repellency test - Mean number of Athalia proxima larvae died in square dip method and Larval Immersion method

S.N.	Botanicals Treatment	Square Dip Method Mean ± SE	Larval Immersion method Mean ± SE
01	NLE 2.5%	4.333 ±0.333 i	4.000 ± 0.333i
02	NLE 5.0 %	4.666 ± 0.333g	3.000 ±0.333g
03	NLE 10.0 %	7.333 ±0.333 i	7.000±0.333 i
04	NSE 2.5%	3.000 ± 0.333efg	3.333±0.333efg
05	NSE 5.0 %	4.666± 0.333 de	3.666±0.333de
06	NSE 10.0 %	6.666± 0.333 b	5.666±0.33b
07	AcLE 2.5%	4.666 ±0.333 ij	3.000 ±0.333ij
08	AcLE 5.0 %	4.000 ±0.333i	4.000±0.333 i
09	AcLE 10.0 %	6.333±0.333 ij	5.000±0.333ij
10	AcSE 2.5%	4.666 ±0.333h	2.333 ± 0.000h
11	AcSE 5.0 %	5.333 ±0.333 def	3.333± 0.333def
12	AcSE 10.0 %	7.666 ±0.333 cd	7.333±0.000cd
13	CpLE 2.5%	3.000 ±0.333 i	0.666± 0.577i
14	CpLE 5.0 %	3.666 ±0.333ij	4.000± 0.333ij
15	CpLE 10.0 %	4.666± 0.333j	5.000 ±0.333j
16	Indoxacarb .006%	4.666 ±0.577bc	6.000± 0.333 bc
17	Fipronil .005%	4.333 ±0.000cd	4.000 ± 0.577cd
18	Endosulphane .05-07%	5.000 ±0.333 fg	5.000 ±0.333fg
19	Control	0.000 ± 0.33a	00.000 ±0.000a

Mean followed by the same letter within the column are not significantly different from each other at $P < 0.05$, Tukey 's Studentized Range (HSD) Test. NLE = Neem Leaf

Extract,; AcLE = Acacia leaf Extract; CpLE =Carica Papaya Leaf Extract

Table2 : Effect of Feeding larvae - Mean number of Athalia proxima damaged square within 24, 48, 72 hours after treatment application in Square dip method

S. No.	Treatments HAT	Mean of artificial square Damaged Mean ± SE
1	**NLE 2.5%**	
	24HAT	0.667±0.333opqr
	48HAT	1.667±0.333mno
	72HAT	2.333±0.333klmn
2	**NLE 5.0 %**	
	24HAT	2.667±0.333jklm
	48HAT	3.667±0.333ghij
	72HAT	5.000±0.000cef
3	**NLE 10%**	
	24HAT	3.667±0.333ghij
	48HAT	6.000±0.577bc
	72HAT	6.667±0.333b
4	**NSE 2.5%**	
	24HAT	0.333±0.333pr
	48HAT	1.333±0.3330nop
	72HAT	2.000±0.000lmn
5	**NSE 5.0 %**	
	24HAT	0.333±0.330pr
	48HAT	2.333±0.333klmn
	72HAT	4.000±0.000fghi
6	**NSE 10.0%**	
	24HAT	3.333±0.333hijk
	48HAT	4.667±0.333fg
	72HAT	1.667±0.333bc
7	**ACLE 2.5%**	
	24HAT	1.333±0.882nop
	48HAT	2.000±0.000lmn
	72HAT	2.333±0.333klmn
8	**ACLE 5.0 %**	
	24HAT	1.667±0.667mno
	48HAT	1.667±0.333mno
	72HAT	2.000±0.577lmn
9	**ACLE 10.0%**	
	24HAT	6.000±0.000mno
	48HAT	2.333±0.333klmn
	72HAT	3.000±0.577ijkl
10	**ACSE 2.5%**	
	24HAT	2.333±0.333klmn
	48HAT	3.333±0.333hijk
	72HAT	4.000±0.000fghi

11	**ACSE 5.0 %**	
	24HAT	2.667±0.333jklm
	48HAT	3.667±0.333ghij
	72HAT	5.667±0.333bcde
12	**ACSE 10.0%**	
	24HAT	4.000±0.000fghi
	48HAT	6.333±0.333b
	72HAT	8.000±0.000a
13	**CPLE 2.5%**	
	24HAT	0.333±0.333pr
	48HAT	1.333±0.333nop
	72HAT	2.000±0.000lmn
14	**CPLE 5.0 %**	
	24HAT	1.333±0.333nop
	48HAT	2.000±0.000lmn
	72HAT	3.000±0.000ijkl
15	**CPLE 10.0%**	
	24HAT	2.000±0.000lmn
	48HAT	4.667±0.333klmn
	72HAT	3.333±0.333fg
16	**Indoxacarb**	
	24HAT	3.333±0.333hijk
	48HAT	4.333±0.333fgh
	72HAT	4.667±0.333fg
17	**Fipronil**	
	24HAT	2.667±0.333jklm
	48HAT	2.333±0.333hijk
	72HAT	4.333±0.333fgh
18	**Endosulphane**	
	24HAT	3.000±0.000ijkl
	48HAT	4.333±0.333fgh
	72HAT	6.333±0.333b
19	**Control**	
	24HAT	0.000±0.000r
	48HAT	0.000±0.000r
	72HAT	0.000±0.000r

Table 3: Effect of feeding larvae (Athalia proxima) by number of squares consumed by 3, 6, 9 DAT

	Botanicals	Weight of Diet consumed in (gms) within 3,6,9 DAT (days after treatment)			
S.No.	Treatments DAT	I Replication	II Replication	III Replication	Mean Diet square consumed
1	NLE 2.5%				
	3 DAT	0.254	0.254	0.260	0.256±0.002
	6DAT	0.402	1.422	0.404	0.743±0.340
	9DAT	2.933	2.922	2.944	2.933±0.006
2	NLE 5.0 %				
	3 DAT	0.284	0.283	0.242	0.270± 0.014
	6DAT	0.300	0.300	0.325	0.308 ± 0.008
	9DAT	0.822	0.833	0.844	0.833 ± 0.006
3	NLE 10%				
	3 DAT	0.604	0.613	0.622	0.613 ± 0.005
	6DAT	0.723	0.722	0.724	0.723 ± 0.001
	9DAT	0.916	2.221	2.221	1.786 ± 0.434
4	NSE 2.5%				
	3 DAT	0.422	0.421	0.423	0.422 ± 0.001
	6DAT	0.615	0.646	0.631	0.631 ± 0.009
	9DAT	0.921	0.932	0.991	0.948 ± 0.002
5	NSE 5.0 %				
	3DAT	0.586	0.555	0.568	0.570 ± 0.009
	6DAT	0.798	0.789	0.780	0.789 ±0.005
	9DAT	0.814	0.873	0.832	0.840 ± 0.017
6	NSE 10.0%				
	3 DAT	0.718	0.716	0.714	0.716 ± 0.001
	6DAT	0.815	0.816	0.818	0.816 ± 0.001
	9DAT	0.936	0.930	0.938	0.915 ±0.002
7	AcLE 2.5%				
	3 DAT	0.113	0.112	0.111	0.112 ± 0.001
	6 DAT	0.124	0.113	0.111	0.116 ± 0.004
	9DAT	0.220	0.221	0.220	0.220 ±0.000

8	AcLE 5.0 %				
	3DAT	0.721	0.712	0.711	0.715 ± 0.003
	6DAT	0.913	0.923	0.921	0.919 ± 0.003
	9DAT	1.150	1.148	1.150	1.149 ±0.007
9	AcLE 10.0%				
	3 DAT	0.925	0.928	0.944	0.932 ± 0.006
	6DAT	1.100	1.200	1.250	1.183 ± 0.044
	9DAT	1.225	1.500	1.502	1.409. ±0.092
10	AcBE 2.5%				
	3 DAT	0.900	0.925	0.955	0.927 ± 0.016
	6DAT	1.250	1.260	1.260	1.257 ±0.003
	9DAT	1.787	1.788	1.888	1.821 ±0.034
11	AcBE 5.0 %				
	3 DAT	1.544	1.545	1.555	1.548 ± 0.004
	6DAT	1.654	1.700	1.685	1.680 ±0.014
	9DAT	1.989	1.978	1.992	1.986 ± 0.004
12	AcBE 10.0%				
	3 DAT	1.897	1.900	1.855	1.884 ± 0.015
	6DAT	1.952	1.945	1.998	1.965 ± 0.017
	9DAT	2.224	2.1222	2.214	2.187 ± 0.032
13	CPLE 2.5%				
	3 DAT	0.512	0.511	0.510	0.511 ± 0.001
	6DAT	0.604	0.612	0.618	0.611 ±0.004
	9DAT	0.800	0.810	0.805	0.805 ±0.003
14	CPLE 5.0 %				
	3 DAT	0.611	0.612	0.613	0.612 ± 0.001
	6DAT	0.710	0.725	0.722	0.719 ± 0.005
	9DAT	0.822	0.824	0.829	0.825 ±0.002
15	CPLE 10.0%				
	3 DAT	0.722	0.720	0.723	0.722 ± 0.001
	6DAT	0.829	0.824	0.822	0.825 ± 0.002
	9DAT	0.922	0.921	0.919	0.921 ±0.001
16	Indoxacarb				
	3 DAT	0.624	0.623	06.22	0.525 ± 0.002
	6DAT	0.730	0.710	0.715	0.718 ± 0.006
	9DAT	0.810	0.820	0.830	0.820 ± 0.006
17	Fipronil				
	3 DAT	0.220	0.225	0.230	0.225 ± 0.003
	6DAT	0.528	0.524	0.523	2.489 ± 1.865
	9DAT	0.625	0.626	0.624	0.625 ± 0.001
18	Endosulphan				
	3 DAT	0.594	0.521	0.522	0.546 ± 0.024
	6DAT	0.584	0.590	0.592	0.589 ± 0.002
	9DAT	0.685	0.675	0.670	0.677 ± 0.004
19	Control				
	3 DAT	0.00	0.00	0.00	0.000 ± 0.000
	6DAT	0.00	0.00	0.00	0.000 ± 0.000
	9DAT	0.00	0.00	0.00	0.000 ± 0.000

Mean followed by the same letter within the column are not significantly different from each other at P < 0.05, Tukey 's Studentized Range (HSD) Test. NLE = Neem Leaf Extract,; AcLE = Acacia leaf Extract; CpLE =Carica Papaya leaf Extract

Table 4 (a): *M*ean weight Loss (mg) in Larvae of *Athalia proxima* after treatment by Square Dip Method (3 DAT)

S. No.	Treatment in percentage	Initial Mean weight	Wt.loss	Mean weight 3days	Wt.loss
1	NLE 2.5%	1.000± 0.000de	5.333	8.000± 0.00e	5.667
2	NLE 5.0 %	0.667 ± 0.333 de	5.666	5.667±0.333gh	8
3	NLE 10.0 %	0.333± 0.333 de	6	4.667±0.333i	9
4	NSE 2.5%	0.333 ±0.333 de	6	7.000±0.000f	6.667
5	NSE 5.0 %	0.333 ±0.333 de	6	6.333±0.333fg	7.334
6	NSE 10.0 %	0.000 ±0.000 e	6.333	5.333±0.333hi	8.334
7	AcLE 2.5%	1.000±0.000 de	5.333	5.000± 0.00hi	8.667
8	AcLE 5.0 %	0.333 ±0.333 de	6	3.333±0.333jk	10.334
9	AcLE 10.0 %	0.000 ±0.000 e	6.333	2.667±0.333kl	11
10	AcBE 2.5%	1.333 ±0.333 cd	5	3.667±0.333j	10
11	AcBE 5.0 %	0.667 ±0.333 de	5.666	3.000±0.577jkl	10.667
12	AcBE 10.0 %	0.000 ±0.000e	6.333	2.333±0.333l	11.334
13	CpLE 2.5%	0.667 ±0.333 de	5.666	10.000±0.00b	3.667
14	CpLE 5.0 %	1.000 ±0.57 de	5.333	08.333±0.333de	5.337
15	CpLE 10.0 %	1.000 ±0.577de	5.333	9.000±0.577cd	4.667
16	Indoxacarb	3.667 ±0.333b	2.666	10.000±0.00b	3.667
17	Fipronil	3.333 ±0.333b	3	8.333±0.333de	5.334
18	Endosulphane	2.000 ±0.000 c	4.333	9.667±0.333bc	4
19	Control	6.333 ±0.333a	0	13.667±0.333a	0

Mean followed by the same letter within the column are not significantly different from each other at P < 0.05, Tukey 's Studentized Range (HSD) Test. NLE = Neem Leaf Extract,; AcLE = Acacia leaf Extract; CpLE =Carica Papaya leaf Extract

Table 4 (b): Mean weight Loss (mg) in Larvae of *Athalia proxima* after treatment by Square Dip Method (6, 9 DAT)

S. No.	Treatment in percentage	Mean weight 6 Days	Wt.loss	Mean weight 9 days	Wt.loss
1	NLE 2.5%	4.000±0.000e	7	2.000±0.000def	4.333
2	NLE 5.0 %	3.333±0.333ef	7.667	0.667±0.333fg	5.666
3	NLE 10.0 %	1.000±0.577hi	10	0.333±0.333g	6
4	NSE 2.5%	2.333±0.333fg	8.667	0.333±0.333g	6
5	NSE 5.0 %	1.333±0.333ghi	9.667	0.667±0.333fg	5.666
6	NSE 10.0 %	1.333±0.667ghi	9.667	0.000±0.000g	6.333
7	AcLE 2.5%	2.000±0.577gh	9	0.667±0.333fg	5.666
8	AcLE 5.0 %	1.333±0.333ghi	9.667	0.333±0.333g	6
9	AcLE 10.0 %	0.667±0.333i	10.333	0.000±0.000g	6.333
10	AcBE 2.5%	2.333±0.333fg	8.667	1.333±0.333efg	5
11	AcBE 5.0 %	1.667±0.333ghi	9.333	0.667±0.333fg	5.666
12	AcBE 10.0 %	1.333±0.333ghi	9.667	0.333±0.333g	6

13	CpLE 2.5%	2.000±0.000gh	9	1.000±0.000fg	5.333
14	CpLE 5.0 %	0.667±0.333i	10.333	0.333±0.333g	6
15	CpLE 10.0 %	5.667±0.333d	5.333	2.667±0.333cde	3.666
16	Indoxacarb	8.000±0.000c	3	4.000±0.577bc	2.333
17	Fipronil	6.000±0.000d	5	3.333±0.667bcd	3
18	Endosulphane	9.333±0.333b	1.667	4.667±1.333b	1.666
19	Control	11.000±0.577a	0	6.333±0.333a	0

Mean followed by the same letter within the column are not significantly different from each other at P < 0.05, Tukey 's Studentized Range (HSD) Test. NLE = Neem Leaf Extract,; AcLE = Acacia leaf Extract; CpLE =Carica Papaya Leaf Extract

Table 5 (a): *M*ean weight Loss (mg) in Larvae of *Athalia proxima* after treatment by Square Dip Method (3 DAT)

S. No.	Treatment in percentage	Initial Mean weight	Wt.loss	Mean weight 3days	Wt.loss
1	NLE 2.5%	1.000± 0.000de	5.333	8.000± 0.00e	5.667
2	NLE 5.0 %	0.667 ± 0.333 de	5.666	5.667±0.333gh	8
3	NLE 10.0 %	0.333± 0.333 de	6	4.667±0.333i	9
4	NSE 2.5%	0.333 ±0.333 de	6	7.000±0.000f	6.667
5	NSE 5.0 %	0.333 ±0.333 de	6	6.333±0.333fg	7.334
6	NSE 10.0 %	0.000 ±0.000 e	6.333	5.333±0.333hi	8.334
7	AcLE 2.5%	1.000±0.000 de	5.333	5.000± 0.00hi	8.667
8	AcLE 5.0 %	0.333 ±0.333 de	6	3.333±0.333jk	10.334
9	AcLE 10.0 %	0.000 ±0.000 e	6.333	2.667±0.333kl	11
10	AcBE 2.5%	1.333 ±0.333 cd	5	3.667±0.333j	10
11	AcBE 5.0 %	0.667 ±0.333 de	5.666	3.000±0.577jkl	10.667
12	AcBE 10.0 %	0.000 ±0.000e	6.333	2.333±0.333l	11.334
13	CpLE 2.5%	0.667 ±0.333 de	5.666	10.000±0.00b	3.667
14	CpLE 5.0 %	1.000 ±0.57 de	5.333	08.333±0.333de	5.337
15	CpLE 10.0 %	1.000 ±0.577de	5.333	9.000±0.577cd	4.667
16	Indoxacarb	3.667 ±0.333b	2.666	10.000±0.00b	3.667
17	Fipronil	3.333 ±0.333b	3	8.333±0.333de	5.334
18	Endosulphane	2.000 ±0.000 c	4.333	9.667±0.333bc	4
19	Control	6.333 ±0.333a	0	13.667±0.333a	0

Mean followed by the same letter within the column are not significantly different from each other at P < 0.05, Tukey 's Studentized Range (HSD) Test. NLE = Neem Leaf Extract,; AcLE = Acacia leaf Extract; CpLE =Carica Papaya Leaf Extract

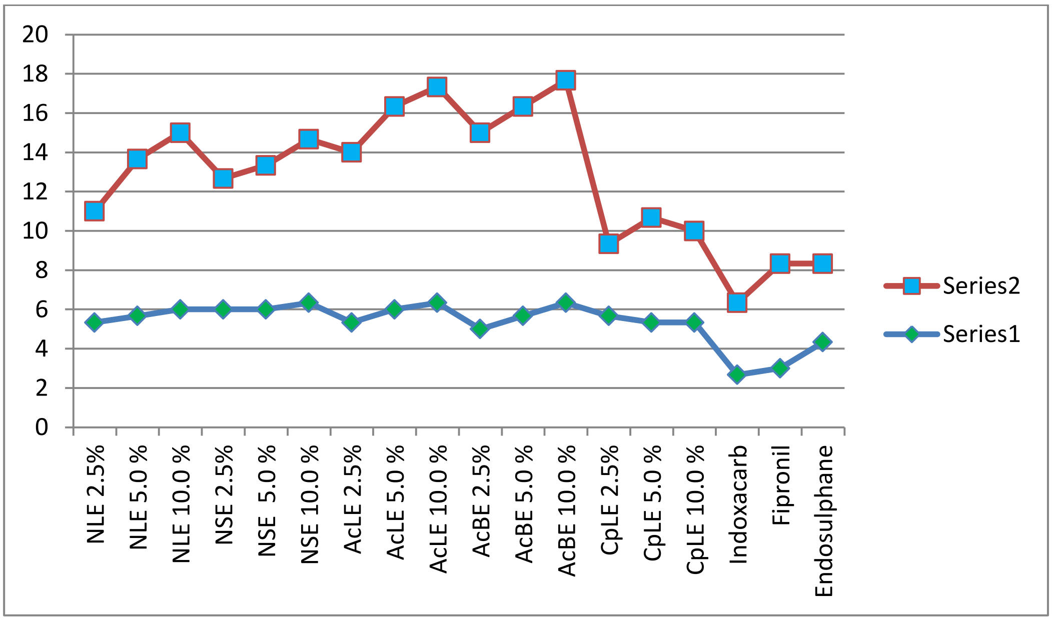
Table 5(b): Mean weight Loss (mg) in Larvae of *Athalia proxima* after treatment by Square Dip Method (6, 9 DAT)

S. No.	Treatment in percentage	Mean weight 6 Days	Wt.loss	Mean weight 9 days	Wt.loss
1	NLE 2.5%	4.000±0.000e	7	2.000±0.000def	4.333
2	NLE 5.0 %	3.333±0.333ef	7.667	0.667±0.333fg	5.666
3	NLE 10.0 %	1.000±0.577hi	10	0.333±0.333g	6
4	NSE 2.5%	2.333±0.333fg	8.667	0.333±0.333g	6
5	NSE 5.0 %	1.333±0.333ghi	9.667	0.667±0.333fg	5.666
6	NSE 10.0 %	1.333±0.667ghi	9.667	0.000±0.000g	6.333
7	AcLE 2.5%	2.000±0.577gh	9	0.667±0.333fg	5.666
8	AcLE 5.0 %	1.333±0.333ghi	9.667	0.333±0.333g	6
9	AcLE 10.0 %	0.667±0.333i	10.333	0.000±0.000g	6.333
10	AcBE 2.5%	2.333±0.333fg	8.667	1.333±0.333efg	5

11	AcBE 5.0 %	1.667±0.333ghi	9.333	0.667±0.333fg	5.666
12	AcBE 10.0 %	1.333±0.333ghi	9.667	0.333±0.333g	6
13	CpLE 2.5%	2.000±0.000gh	9	1.000±0.000fg	5.333
14	CpLE 5.0 %	0.667±0.333i	10.333	0.333±0.333g	6
15	CpLE 10.0 %	5.667±0.333d	5.333	2.667±0.333cde	3.666
16	Indoxacarb	8.000±0.000c	3	4.000±0.577bc	2.333
17	Fipronil	6.000±0.000d	5	3.333±0.667bcd	3
18	Endosulphane	9.333±0.333b	1.667	4.667±1.333b	1.666
19	Control	11.000±0.577a	0	6.333±0.333a	0

Mean followed by the same letter within the column are not significantly different from each other at P < 0.05, Tukey 's Studentized Range (HSD) Test. NLE = Neem Leaf Extract,; AcLE = Acacia leaf Extract; CpLE =Carica Papaya Leaf Extract

Histogram 5(a): Graph showing *M*ean weight Loss (mg) in Larvae of *Athalia proxima* after treatment by Square Dip Method (3 DAT)



Histogram 5(b): Graph showing *Mean* weight Loss (mg) in Larvae of *Athalia proxima* after treatment by Square Dip Method (6, 9 DAT)

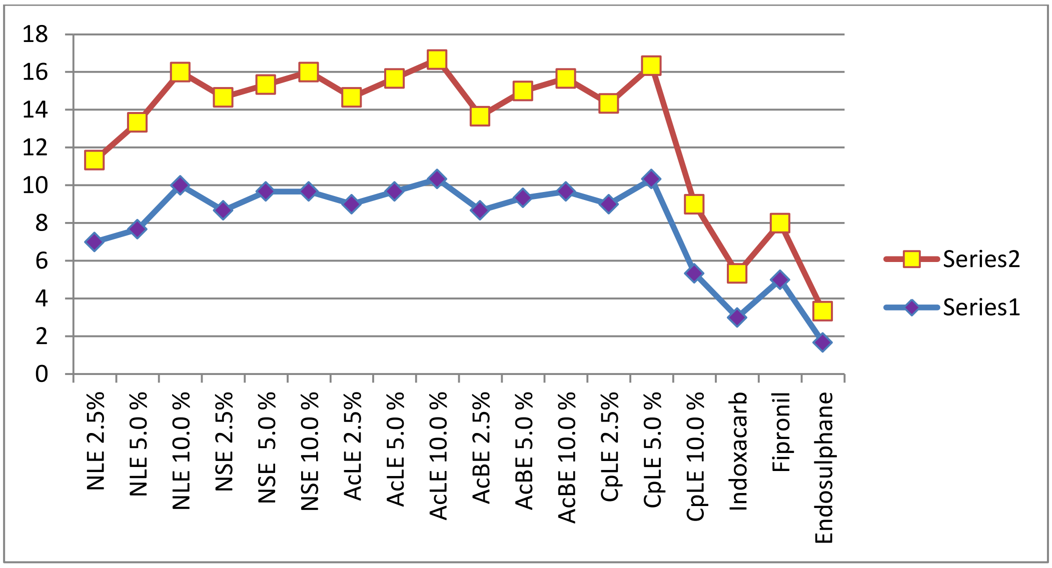


Table 6 (a): *Athalia proxima* larvae, mean weight (mg) at 3 DAT, in larval Immersion Method

S. No.	Treatment in percentage	Initial Mean weight	Weight Loss	Mean weight 3days	Weight Loss
1	NLE 2.5%	4.333±0.333cde	-4.333	4.000±0.000d	-4
2	NLE 5.0 %	4.667±0.333cde	-4.667	3.000±0.577ef	-3
3	NLE 10.0 %	7.333±a0.333ab	-7.333	7.000±0.577a	-7
4	NSE 2.5%	3.000±0.000f	-3	3.333±0.333de	-3.333
5	NSE 5.0 %	4.667±0.333cde	-4.667	3.667±0.333de	-3.667
6	NSE 10.0 %	6.667±0.333ab	-6.667	5.667±0.333bc	-5.667
7	AcLE 2.5%	4.667±0.333cde	-4.667	3.000±0.000ef	-3
8	AcLE 5.0 %	4.000±0.577def	-4	4.000±0.000d	-4
9	AcLE 10.0 %	6.333±0.333b	-6.333	5.000±0.000c	-5
10	ACE 2.5%	4.667±0.333cde	-4.667	2.333±0.333f	-2.333
11	AcBE 5.0 %	5.333±0.333c	-5.333	4.000±0.577d	-4
12	AcBE 10.0 %	7.667±0.333a	-7.667	7.333±0.333a	-7.333
13	CpLE 2.5%	3.000±0.000f	-3	0.667±0.333g	-0.667
14	CpLE 5.0 %	3.667±0.333ef	-3.667	4.000±0.000d	-4
15	CpLE 10.0 %	4.667±0.333cde	-4.667	5.000±0.000c	-5
16	Indoxacarb	4.667±0.333cde	-4.667	6.000±0.000b	-6
17	Fipronil	4.333±0.333cde	-4.333	4.000±0.000d	-4
18	Endosulphane	5.000±0.577cd	-5	5.000±0.000c	-5
19	Control	0.000±0.000g	0	0.000±0.000g	0

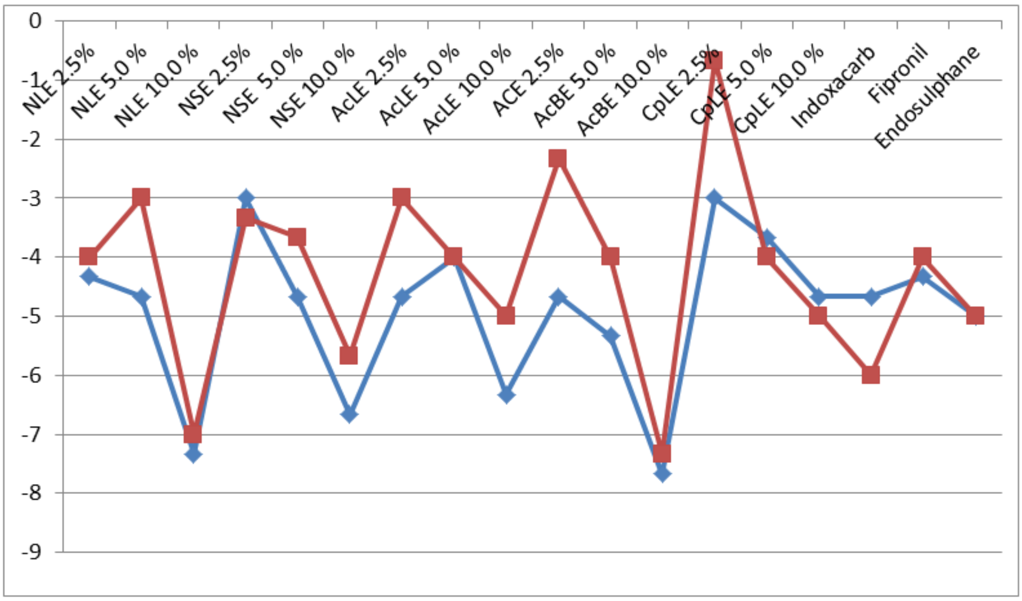
Mean followed by the same letter within the column are not significantly different from each other at P < 0.05, Tukey 's Studentized Range (HSD) Test. NLE = Neem Leaf Extract,; AcLE = Acacia leaf Extract; CpLE =Carica Papaya Leaf Extract

Table 6(b): *Athalia proxima* larvae, mean weight (mg) at 6, 9 DAT in larval Immersion Method

S.No.	Treatment in percentage	Mean Weight 6 days	Weight Loss	Mean weight 9 days	Weight Loss
1	NLE 2.5%	6.033±0.033e	1.217	8.0830.083abcd	-0.166
2	NLE 5.0 %	6.133±0.073de	1.117	8.417±0.083def	-0.5
3	NLE 10.0 %	6.233±0.145de	1.017	8.667±0.083efg	-0.75
4	NSE 2.5%	6.133±0.033de	1.117	8.250±0.144fg	-0.333
5	NSE 5.0 %	6.200±0.029de	1.05	8.333±0.083gh	-0.416
6	NSE 10.0 %	6.483±0.159d	0.767	8.417±0.167i	-0.5
7	AcLE 2.5%	6.033±0.033e	1.217	7.250±0.250hi	0.667
8	AcLE 5.0 %	5.967±0.117e	1.283	7.417±0.083efg	0.5
9	AcLE 10.0 %	6.233±0.017de	1.017	6.417±0.083i	1.5
10	AcBE 2.5%	5.033±0.033f	2.217	8.417±0.083j	-0.5
11	AcBE 5.0 %	5.300±0.100f	1.95	6.083±0.083k	1.834
12	AcBE 10.0 %	4.067±0.067g	3.183	5.417±0.083l	2.5
13	CpLE 2.5%	7.000±0.000bc	0.25	4.250±0.144ab	3.667
14	CpLE 5.0 %	6.500±0.382d	0.75	8.417±0.083bcd	-0.5
15	CpLE 10.0 %	6.150±0.076de	1.1	7.083±0.083cde	0.834
16	Indoxacarb	8.083±0.083bc	-0.833	6.833±0.083abcd	1.084
17	Fipronil	7.333± 0.083b	-0.083	8.333±0.220abc	-0.416
18	Endosulphane	6.917±0.083c	0.333	8.583±0.083ef	-0.666
19	Control	7.250±0.144a	0	7.917±0.083a	0

Mean followed by the same letter within the column are not significantly different from each other at P < 0.05, Tukey 's Studentized Range (HSD) Test. NLE = Neem Leaf Extract,; AcLE = Acacia leaf Extract; CpLE =Carica Papaya Leaf Extract

Histogram 6(a): Graph showing *Athalia proxima* larvae, mean weight (mg) at 3 DAT, in larval Immersion Method



Histogram 6(b): Graph showing *Athalia proxima* larvae, mean weight (mg) at 6,9 DAT in larval Immersion Method

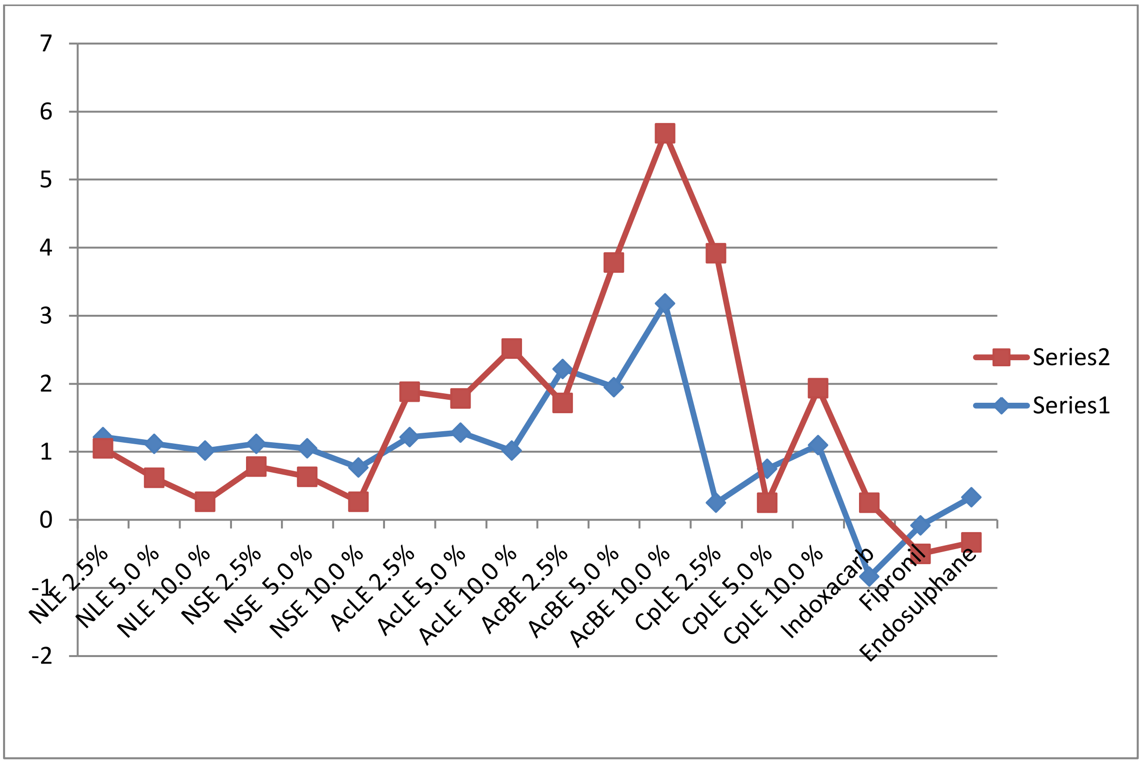


Table 6(c): *Athalia proxima* larvae - Mean weight (mg) at 3, 6, 9 DAT in larval Immersion Method

S. No.	Treatment in percentage	I	II	III	Initial Mean weight	% Weight Loss	I	II	III	Mean weight 3days	% Weight Loss
1	NLE 2.5%	8.00	8.00	8.00	4.333±0.333 cde	-4.333	14.00	14.25	14.25	4.000±0.000 d	-4
2	NLE 5.0 %	8.75	8.50	8.75	4.667±0.333 cde	-4.667	14.00	13.75	13.00	3.000±0.577 ef	-3
3	NLE 10.0 %	8.25	8.25	8.25	7.333±a0.333ab	-7.333	12.00	12.00	12.00	7.000±0.577 a	-7
4	NSE 2.5%	7.75	7.00	7.25	3.000±0.000f	-3	9.25	9.25	9.00	3.333±0.333 de	-3.333
5	NSE 5.0 %	7.75	7.75	8.00	4.667±0.333 cde	-4.667	8.75	8.75	8.75	3.667±0.333 de	-3.667
6	NSE 10.0 %	8.00	7.75	7.80	6.667±0.333 ab	-6.667	7.00	7.00	7.00	5.667±0.333 bc	-5.667
7	AcLE 2.5%	7.00	7.25	7.75	4.667±0.333 cde	-4.667	15.00	15.00	15.00	3.000±0.000 ef	-3
8	AcLE 5.0 %	8.25	8.50	8.50	4.000±0.577 def	-4	12.00	12.25	12.75	4.000±0.000 d	-4
9	AcLE 10.0 %	10.75	10.00	10.00	6.333±0.333 b	-6.333	10.00	10.00	10.00	5.000±0.000 c	-5
10	ACE 2.5%	5.00	5.75	5.25	4.667±0.333 cde	-4.667	11.00	11.25	11.25	2.333±0.333 f	-2.333
11	AcBE 5.0 %	7.00	4.25	4.25	5.333±0.333 c	-5.333	9.50	9.50	9.00	4.000±0.577 d	-4
12	AcBE 10.0 %	3.00	3.00	3.25	7.667±0.333 a	-7.667	7.00	7.75	7.25	7.333±0.333 a	-7.333
13	CpLE 2.5%	8.00	8.75	8.50	3.000±0.000f	-3	16.25	16.25	16.25	0.667±0.333 g	-0.667
14	CpLE 5.0 %	7.25	7.50	7.50	3.667±0.333 ef	-3.667	10.00	10.00	10.25	4.000±0.000 d	-4
15	CpLE 10.0 %	8.00	6.00	6.25	4.667±0.333 cde	-4.667	12.00	12.00	12.00	5.000±0.000 c	-5
16	Indoxacarb	12.75	12.75	12.75	4.667±0.333 cde	-4.667	17.00	16.75	16.75	6.000±0.000 b	-6
17	Fipronil	13.	13.25	13.50	4.333±0.333	-4.333	18.25	18.00	18.25	4.000±0.000	-4

		00			cde					d	
18	Endosulphane	12.00	12.00	12.00	5.000±0.577 cd	-5	22.00	22.00	22.25	5.000±0.000 c	-5
19	Control	15.00	15.25	15.25	0.000±0.000 g	0	25.00	24.75	24.75	0.000±0.000 g	0

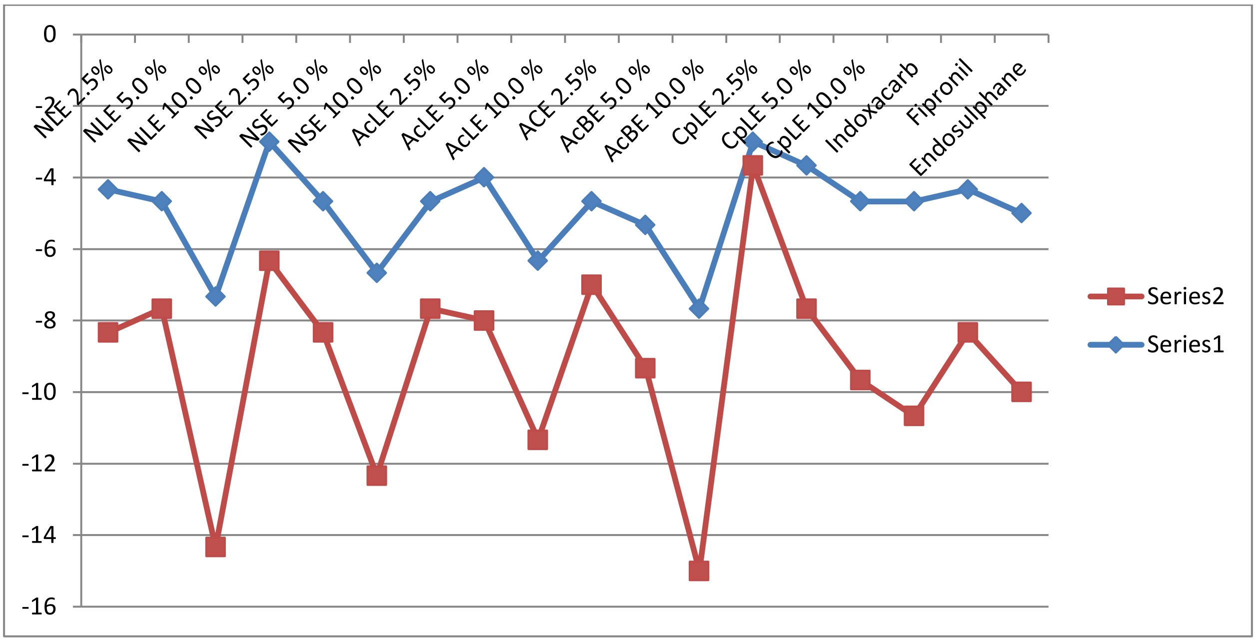
Mean followed by the same letter within the column are not significantly different from each other at P < 0.05, Tukey 's Studentized Range (HSD) Test. NLE = Neem Leaf Extract,; AcLE = Acacia leaf Extract; CpLE =Carica Papaya Leaf Extract

Table 6(d): *Athalia proxima* larvae - Mean weight (mg) at 3,6,9 DAT in Square Dip Method

S. No.	Treatment in percentage	I	II	III	Mean Weight 6 days	W.L	I	II	III	Mean weight 9 days	W.L
1	NLE 2.5%	25.25	25.00	25.00	6.033±0.033e	1.217	32.25	32.00	32.00	8.083±0.083abcd	-0.166
2	NLE 5.0 %	22.00	22.00	22.00	6.133±0.073de	1.117	29.00	29.00	29.00	8.417±0.083def	-0.5
3	NLE 10.0 %	20.00	20.00	20.00	6.233±0.145de	1.017	29.00	29.00	28.50	8.667±0.083efg	-0.75
4	NSE 2.5%	22.00	22.00	22.00	6.133±0.033de	1.117	31.75	31.00	31.00	8.250±0.144fg	-0.333
5	NSE 5.0 %	18.00	18.00	18.25	6.200±0.029de	1.05	20.00	28.00	28.25	8.333±0.083gh	-0.416
6	NSE 10.0 %	18.00	18.00	18.25	6.483±0.159d	0.767	25.00	25.00	25.25	8.417±0.167i	-0.5
7	AcLE 2.5%	16.00	16.00	16.25	6.033±0.033e	1.217	28.00	28.25	28.50	7.250±0.250hi	0.667
8	AcLE 5.0 %	15.00	15.00	15.00	5.967±0.117e	1.283	26.00	26.00	26.00	7.417±0.083efg	0.5
9	AcLE 10.0 %	13.75	13.75	13.75	6.233±0.017de	1.017	25.75	25.25	15.25	6.417±0.083i	1.5
10	AcBE 2.5%	12.00	12.25	12.25	5.033±0.033f	2.217	15.25	15.50	15.25	8.417±0.083j	-0.5
11	AcBE 5.0 %	11.00	11.00	11.50	5.300±0.100f	1.95	13.00	13.25	13.25	6.083±0.083k	1.834
12	AcBE 10.0 %	8.00	8.25	8.50	4.067±0.067g	3.183	11.00	11.00	11.25	5.417±0.083l	2.5
13	CpLE 2.5%	25.00	25.25	25.25	7.000±0.000bc	0.25	32.00	32.50	32.45	4.250±0.144ab	3.667
14	CpLE 5.0 %	20.00	22.75	20.25	6.500±0.382d	0.75	30.00	30.75	30.75	8.417±0.083bcd	-0.5
15	CpLE 10.0 %	18.00	18.25	18.25	6.150±0.076de	1.1	29.25	29.75	29.75	7.083±0.083cde	0.834
16	Indoxacarb	19.00	22.00	22.25	8.083±0.083bc	-.833	30.00	30.25	30.25	6.833±0.083abcd	1.084
17	Fipronil	22.00	22.00	22.25	7.333± 0.083b	-.083	28.00	28.25	28.25	8.333±0.220abc	-0.416
18	Endosulphane	25.00	22.00	22.00	6.917±0.083c	0.333	32.00	32.00	32.75	8.583±0.083ef	-0.666
19	Control	30.00	30.75	30.25	7.250±0.144a	0	35.25	35.00	35.25	7.917±0.083a	0

Mean followed by the same letter within the column are not significantly different from each other at P < 0.05, Tukey 's Studentized Range (HSD) Test. NLE = Neem Leaf Extract,; AcLE = Acacia leaf Extract; CpLE =Carica Papaya Leaf Extract

Histogram 6(c): Graph showing *Athalia proxima* larvae - Mean weight (mg) at 3,6,9 DAT in larval Immersion Method



Histogram 6(d): Graph showing *Athalia proxima* larvae - Mean weight (mg) at 3,6,9 DAT in Square Dip Method

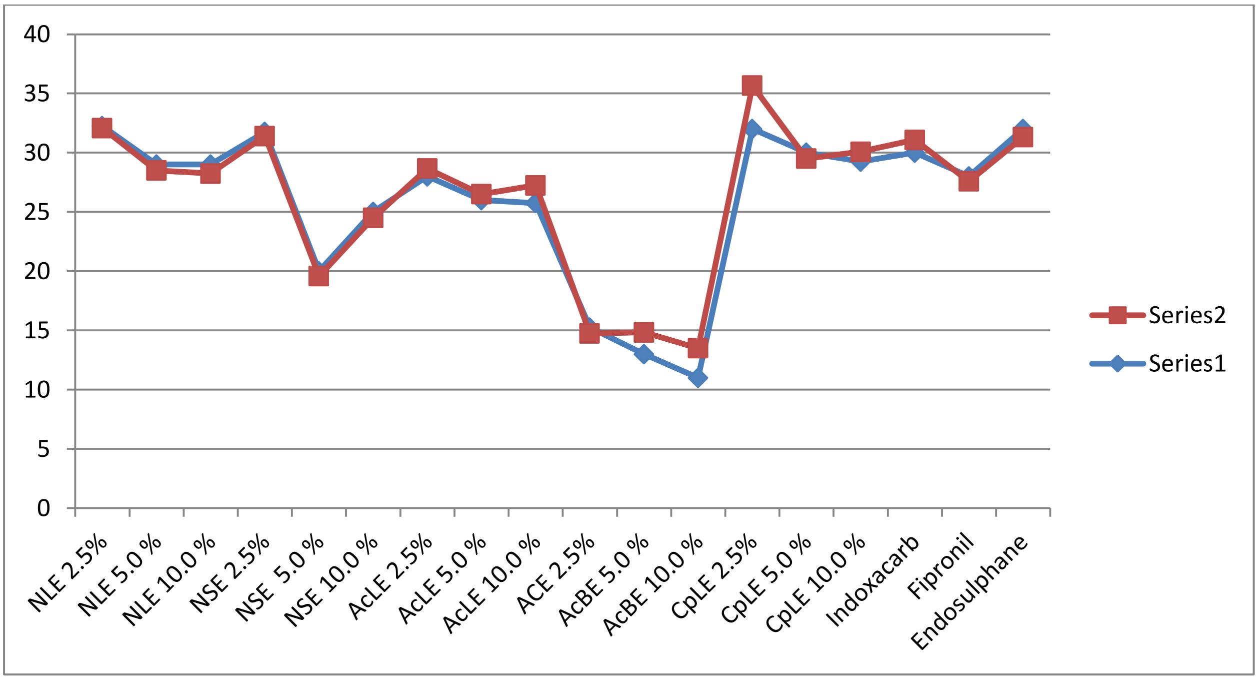
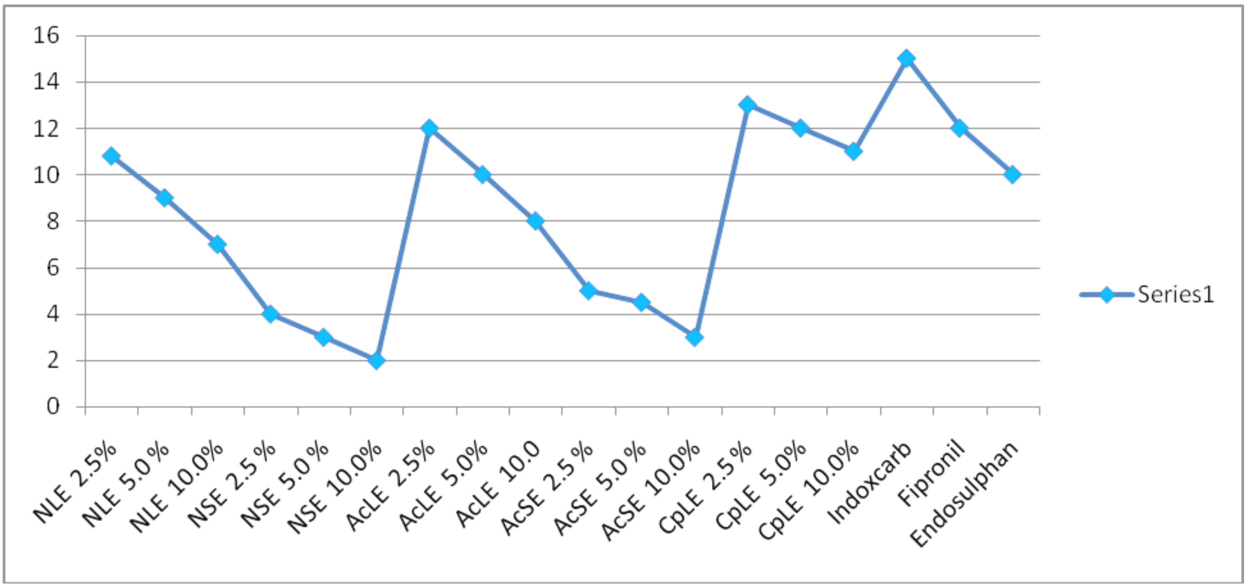


Table 7: Effect of different Botanicals on (*Athalia proxima*)

		Number of larvae/ ten plants			
		1st spray/ larvae died		II nd Spray	III rd Spray
S. No.	Treatments	Mean	Mean	Mean	Fruit damage (%)
01	NLE 2.5%	24.420±0.221abcd	39.333±0.220b	8.000±0.000efg	10.80
02	NLE 5.0 %	23.083±0.083def	38.083±0.083cde	8.667±0.083e	09.00
03	NLE 10.0%	22.500±0.144efg	37.500±0.144ef	8.250±0.000ef	07.00
04	NSE 2.5 %	22.000±0.000fg	39.250±0.000b	7.333±0.220gh	04.00
05	NSE 5.0 %	21.167±0.083gh	38.167±0.083cd	7.833±0.083efg	03.00
06	NSE 10.0%	19.417±0.220i	36.833±0.083g	7.850±0.076efg	02.00
07	AcLE 2.5%	20.583±0.300hi	36.083±0.083hi	7.333±0.220gh	12.00
08	AcLE 5.0%	22.417±1.805efg	35.000±0.000jk	8.417±0.083e	10.00
09	AcLE 10.0	19.417±0.167i	34.583±0.220k	9.917±0.083d	08.00
10	AcSE 2.5 %	10.750±0.000j	20.417±0.083l	5.333± 0.22i	05.00
11	AcSE 5.0 %	08.167±0.08k	16.167±0.083m	5.167±0.917i	04.50
12	AcSE 10.0%	06.750±0.000l	12.250±0.250n	3.083±0.083j	03.00
13	CpLE 2.5 %	25.167±0.083ab	38.417±0.083c	8.417±0.220e	13.00
14	CpLE 5.0%	24.083±0.083bcd	36.500±0.250gh	7.417±0.083fgh	12.00
15	CpLE 10.0%	23.583±0.167cde	35.500±0.250ij	6.750±0.629h	11.00
16	Indoxcarb	24.167±0.083abcd	37.583±0.300def	12.750±0.000bc	15.00
17	Fipronil	24.667±0.083abc	36.750±0.250g	13.250±0.144b	12.00
18	Endosulphan	22.667±0.333ef	37.083±0.083fg	12.000±0.000c	10.00
19	Control	25.583±0.300a	41.000±0.577a	15.167±0.083a	30.00

Mean followed by the same letter within the column are not significantly different from each other at P < 0.05, Tukey 's Studentized Range (HSD) Test. NLE = Neem Leaf Extract,; AcLE = Acacia leaf Extract; CpLE =Carica Papaya Leaf Extract

Histogram 7: Graph showing Effect of different Botanicals on (*Athalia proxima*)



IV. CONCLUSION

A chemical pesticide is used to protect crops and to kill pests. Use of synthetic pesticides causes some unfortunate consequences like environmental pollution, pest resistance and toxicity to other non-target organisms. To ally the fear of the hazardous effect of chemical residues to human and animal health, several studies were conducted to determine the most effective control methods without using insecticides.

The results of our study indicate that the plant products could be the best alternatives for the sustainable management of A.proxima on okra with less impact on the naturally occurring predatory arthropods.Few botanicals have been reported as effective managers of insect-pests and commercialized. Much knowledge and experience of using these are treasured in farmer's traditional knowledge. Derived from the Neem tree (Azadirachta indica), this contains several chemicals, including 'Azadirachtin,' which affects the reproductive and digestive process of some important pests. Recent research carried out in India and abroad has led to the development of effective formulations of Neem, which are being commercially produced. As Neem is non-toxic to birds and mammals and is non-carcinogenic, its demand is likely to increase.

It is widely recognized that we face a major challenge continuing to increase agricultural productivity to keep pace with a population racing toward 9 billion within the next few decades. Agricultural practices developed and honed in the 20th century, from the development of synthetic nitrogen fertilizers by Fritz Haber in the early nineteenth century (Smil 2004) to the invention of synthetic pesticides in the decades following, (Casida & Ousted 1998, Knight et al. 1997) have significantly improved crop productivity which has helped cope with an ever-increasing global population to date. While crop production has undoubtedly benefited, technological improvements have unfortunately also led to unexpected consequences for non-target organisms, soil and water quality. The development of synthetic pesticides has additionally resulted in challenges related to pest resistance which further complicates the drive towards improving yields.Growers struggle against a variety of pests during the crop season. Plant pathogens, for example, are responsible for dramatic yield losses. The Crop Life Foundation's 2005 study reviewed and endorsed by 38 commodity groups (including the National Cotton Council and United Soybean Board) says if left untreated, yields of most fruit and vegetable crops would plunge 50 to 95 percent (Gianissi 2005). Weeds and insect damage contribute to substantial impact on crop losses. In early agricultural practices, fungicides such as sulfur and copper were used to cope with plant diseases. These products have been used for centuries and are still heavily relied upon today. However, a step change in approach was experienced with the discovery of the single-site mode of action fungicides, often with systemic properties. These highly potent molecules provided exceptional disease control with much lower use rates.

Unfortunately, the ever-evolving pathogen population has been able to adapt to these new chemical classes quickly because of their particular modes of action. It is found that more recently developed chemical fungicides also correlate with more rapid reports of resistance in the field (adapted from Thind, 2011). One of the most significant challenges to agriculture today is the scarcity of new active ingredients with new modes of action unrelated to previously introduced chemistries. Since the use of agrochemicals with single site modes of action became widespread in the last fifty years, this has become of greater and greater concern.In recent years, interest in the use of biopesticides in conventional agricultural practices, both by growers and the agrichemical companies, has grown (Reiter 2011). Biopesticides are appealing for some reasons. According to the EPA, biopesticides are usually less toxic than conventional pesticides, generally affect only the target pest and closely related organisms, often are effective in tiny quantities and decompose quickly, and can greatly decrease the use of conventional pesticides while crop yields remain high. Growers and agrichemical companies also see biopesticides as potentially important tools in their efforts to stave off the development of pesticide resistance. Biopesticides are often complex in their activities and modes of action, offering new tools in the quest to develop programs that can manage resistance.For example, products based on the Bacillus Subtilis strain QST 713, including Serenade ASO® fungicide, Serenade Max® fungicide, and Serenade Soil® fungicide have been demonstrated to have several modes of activity. These include complex secondary metabolite profiles responsible for both anti-fungal and anti-bacterial activity. Detailed studies of the biophysical interaction of the lipopeptide class of compounds produced by this strain have shown complex membrane interactions (Patel et al. 2011).

These require somewhat higher application rates (as high as 1% active ingredient) and may require frequent reapplication when used out-of-doors. It is known that these extracts contain Azadirachtin in Neem, Catechin in Acacia catechu and Palmitic acid in Carica papaya.The management efficacy of these compounds in comparison to the chemical pesticides was also remarkable and cost-effective. Neem pesticides do not leave any residue on the crop. They also work as a systemic pesticide; absorbed into the plant, transported to all the tissues and are ingested by plant-feeding insects. Azadirachtin is considered nontoxic to mammals, fish and pollinators have low mammalian toxicity with LD50 of>5000 mg/kg for a rat. It is classified by Environment Protection Agency (EPA) as class IV. It is felt that none of the synthetic pesticides developed so far has the excellent virtues of Neem in pest management Thus, opens the opportunity for their commercialization on a large scale without any adverse effects on crop and soil.

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