



Toxicities of Desert Dates and Moringa Seeds Essential Oils on *Helicoverpa armigera* Hub (Lepidoptera: Pyralidae) Larvae under Laboratory conditions

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Abstract

Production of tomato, *Solanum lycopersicum* worldwide is being threatened by *Helicoverpa armigera* Hub., and farmers rely heavily on the use of costly hazardous synthetic insecticides for its management. The prime concern in increasing production of tomato is the obstacles posed by *H. armigera* and lack of sufficient understanding of available environmentally friendly control materials which are essential for the development of reliable integrated pest management strategies. The present study was conducted with the objectives of determining the toxicities of desert dates and moringa seed essential oils (EO) on the larvae of *H. armigera*. The two (2) EOs were obtained by distillation and evaporation techniques. Toxicity studies were conducted at the Entomology laboratory of the Department of Crop Protection, Bayero University Kano. Fruits and leaves of tomato plant were sprayed with different concentrations of 2%, 4% and 6% of the essential oil extracted from the plant and acetone was used as control, cypermethrin (synthetic insecticide) was used as a standard check. The treated plants parts were allowed to dry for 15 to 20 minutes under laboratory condition. Ten 3rd instar larvae of *H. armigera* were introduced into the container covered with muslin cloth and allowed to feed. Observation on larval mortality was made at 24, 48 and 72h post introduction. EOs composition was analysed using GC-MS for qualitative and quantitative determination of the biomolecules present. Results of the toxicity of the essential oils show both oils caused mortality of the larvae. The GC-MS analysis shows 1-Methylpentyl cyclopropane (Monoterpene) as the dominant compound in both essential oils. Two percent (2%) EO of balanites is recommended for application on both the fruits and leaves of the tomato plant to control *H. armigera*.

Keywords: *Helicoverpa armigera*, *Solanum lycopersicum*, Essential Oil, Cypermethrin, Moringa.

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INTRODUCTION

Helicoverpa armigera Hub. is a highly polyphagous pest infesting many plant species in the world. In Nigeria it affects numerous plant species that are critical to

food security. It causes greater damages to tomato, maize, beans, sorghum and millet. The threshold level is 13 larvae per tomato plant. On tomato plant the larvae initially feeds on vegetative parts and subsequently move to the fruits where it bores into the fruits making holes and contaminating same with frass thus, making it unfit for human consumption. The holes also serve as entry points for secondary opportunist infectious plant pathogens (Kumar *et al.*, 2017), thereby creating an infection complex.

The most widely used control measures against *H. armigera* in Nigeria and world over in general are synthetic insecticides which are associated with harmful effect to humans, non-target organism, important pest natural enemies, and the environment (Mailafiya *et al.*, 2014). These necessitate exploration of other methods which are ecofriendly such as the use of botanical pesticides which are considered to be medically safe (Elumalai *et al.*, 2013). Many plant derivatives are highly toxic to several insect pest species. Kumar (2012) reported that Plant extracts have appropriate active substances that synthesize metabolites with various mechanism of action, there by exhibiting diverse biological efficacy on insect pest species such as retardation in growth, oviposition deterrence, feeding inhibition, reduction in fecundity and fertility, and lethal toxicities.

Potential of several plant-based source of pesticides were identified, examine, and highlighted by several authors in Nigeria (Okute, 2012). Okute (2012) reported that the leaf, bark, seed, root and fruits of several plant species in Nigeria contains bio-active pesticidal agents. These plants include *Azadirachta indica*, *Cannabis sativa*, *Eucalyptus globules*, *Gmelina arborea*, *Balanites aegyptiaca*, *Khaya senegalensis*, *Nicotiana tabacum*, and *Prosopis africa*. Similarly, the report of a survey of crop seed

protection with botanicals carried out in Nigeria by Anjori (2008) indicated neem plant as source of pesticides that is relatively cheap and easily available. It possesses a complex mixture of active ingredients which function differently on various part of the insect life cycles that make it difficult for pest to develop resistance. Despite identifying the bio-active action of some botanicals on insect in Nigeria, there is a scanty work on management of *H. armigera* using botanicals, particularly those from balanite and Moringa seed oils in Nigeria.

MATERIALS AND METHODS

Experimental Site

The experiment was conducted at the Entomology Laboratory of the Department of Crop Protection, Faculty of Agriculture, Bayero University Kano, which is located on latitude; 11.97⁰N, longitude; 8⁰.43⁰E.

Collection of *H. armigera* larvae

Late instar larvae of *Helicoverpa armigera* were collected from pesticide-free tomato farm in the study area. The larvae were transported to Entomology Laboratory of the Department of Crop Protection, Bayero University Kano in transparent plastic box measuring 25 x 20 cm and 8 cm deep line with tissue paper and covered with muslin cloth.

Rearing of *H. armigera* Larvae

Larvae of *H. armigera* were reared in groups of 10 individuals in transparent plastic cup measuring of 8.5cm in diameter at the top, 6cm in diameter at the bottom and 5cm in depth line with tissue paper and covered with muslin cloth. The larvae were fed with young tomato leaves, twig and immature tomato fruits. These food materials were changed and replaced with fresh ones every 2 days. The larvae were allowed to pupate in same containers. After emergence, 50 adults were transferred to a cage measuring 45x45cm for

mass breeding to obtain homogenous and sufficient population for the experiment. Cotton wool soaked in 10% honey solution was provided as food. Tissue paper or muslin cloth were spread and hanged. Also, a small fresh branch of tomato plant carrying young leaves and flowers were dipped in a bottle containing water to keep it turgid was provided to the adult insect inside the cage as an oviposition site. These branches were renewed daily to attract the moths for egg laying.

Tissue paper, muslin cloth or small fresh branch of tomato plant carrying young leaves and flowers containing eggs were removed and replaced with new ones. The eggs on tissue paper, muslin cloth small fresh branch of tomato plant carrying young leaves and flowers were kept moist in transparent plastic box of 25x25cm and 8cm deep with perforated lid till they hatch. Neonates of *H. armigera* (1st instar larvae) were collected with camel hair brush and introduced onto young leaves and young fruits of tomato in a transparent plastic cup of 8.5cm in diameter at the top, 6cm in diameter at the bottom and 5cm in depth lined with moist filter papers. Feeding and changing of food materials was continued up to the stage needed for the termination of experiment (3rd instar larvae).

Collection of Pesticidal Plant Materials

Seeds of desert date (*Balanites aegyptiaca* Del) and Moringa (*Moringa oleifera*) were purchased from Kurmi market in Kano. The epicarp (outer cover) and mesocarp (pulp) of Desert date, and Moringa were removed and ground in to powder using comec (CM 290) micro grinder.

Extraction of the plants seed essential oils by hydro-distillation method

Fresh seed of Desert Date and Moringa were washed in tap water and allowed to dry, ground using Comec Laboratory grinder (CM

290) and placed separately into 2L round bottom flasks and distilled water was added into the round bottom flasks until all the plant materials are completely immersed. The flasks were then heated in a Clevenger-type apparatus heater and the mixture was boiled for 3 hours to evaporate the components in the plant materials. The vapours were condensed by the cold water circulating in the condenser. The condensed mixture of essential oils and water were collected in a separating funnel and re-extracted with pentane. The organic pentane layer was collected and anhydrous sodium sulphate was added to remove traces of water. After about 20 minutes the material was filtered to remove anhydrous sodium sulphate and the solvent was removed using a rotary evaporator. The essential oils obtained were stored in a refrigerator at 4 °C to avoid degradation of components until used.

Toxicological bioassay of the two Essential oils on *H. armigera* larvea

Fruits, and leaves of tomato plant were sprayed with different concentration (2%, 4% and 6%) of the essential oil extracted from the plant and acetone as control, cypermethrin (synthetic insecticide) was used as a standard check; and allow to dry for 15 to 20 minutes under laboratory condition. The sprayed plants were placed in plastic cup measuring 8.5cm at the top, 6cm in diameter at the bottom and 5cm deep lined with tissue paper and covered with muslin cloth. Ten 3rd instar larvae of *H. armigera* were introduced into the container covered with muslin cloth and allowed to feed. The setup was laid out in complete randomized design with 3 replications. Observation on larval mortality was made at 24, 48 and 72 h after introduction of the test insects.

Data Analysis

Mortality data obtained were corrected using Abbot's formula, and it was then subjected to analysis of variance using computer software

(Genstat Discovery edition), Significant means were separated using turkey (HSD) test at 5% level of probability.

RESULTS

Effect of Plant Parts, Control Materials and Concentration on Mortality of *H. armigera* Third Instar Larvae at 24, 48 and 72 Hours After Treatment

Table 1 shows mortality of *H. armigera* larvae fed with tomato leaves and fruits treated with different concentrations of moringa and balanites seed essential oils at 24, 48, and 72 hours.

Table (1) reveals that there is highly significant difference on larval mortality of *H. armigera* on the fruits and leaves treated with different concentrations of the treatments at 48 and 72 h after treatment (HAT) $p < 0.001$. At 48 HAT significantly high larval mortality of *H. armigera* were recorded on fruits compared to mortality recorded on leaves, however, at 72 HAT, high larval mortality of

H. armigera were recorded on leaves compared to fruits.

Irrespective of concentrations, the mortality of *H. armigera* at 24 and 48 HAT was insignificant. The mortality was however, significant ($P < 0.05$) at 72 HAT. High mortality was obtained at 6% concentration compared to 2% concentration, but was not significantly ($P > 0.05$) different with mortality obtain at 4% concentration, while the least mortality was obtained at 2% concentration.

At 24 HAT and 48 HAT, mortality *H. armigera* caused by the extracts of moringa, balanites, cypermethrin and control were insignificant. However, at 72 HAT, significant difference was observed in mortality of *H. armigera* cause by the treatments. At 72 HAT, significantly high mortality was recorded on plant parts treated with moringa seed oil compared to control, but this number was not different from the mortality obtained on plant part treated with balanites and cypermethrin.

Table 1: Effect of Seed Extracts of Moringa and Balanites on Mortality of *H. armigera*

Treatments	Mean number of larvae		
	24HAT	48HAT	72HAT
Plant parts			
Leaves	1.2a	0.4b	2.7a
Fruits	0.9a	1.4a	1.3b
SE±	0.162	0.15	0.21
Test Materials			
Moringa	1.6a	0.6a	2.9a
Balanites	1.6a	0.6a	1.9a
Cypermethrin	0.8a	0.4a	2.7a
Control	0.8a	0.3a	0.3b
SE±	0.22	0.20	0.30
Concentration			
2%	1.3a	0.8a	1.4b
4%	1.0a	0.9a	2.2ab
6%	0.9a	1.0a	2.3a
SE±	0.23	0.18	0.30
Interactions			
Pp x control materials	0.0053	0.0182	0.0001
Pp x Concentration	NS	NS	0.00246
Control materials x Concentration	NS	NS	NS
Pp x control materials x Concentration	NS	NS	NS

Mean followed by different letters in same column are significantly different at P= 0.05 level of probability according to Turkey test. Pp= plant parts.

Effect of Interaction between Plant Part and Control Materials on Mortality of *H. armigera* Third Instar Larvae at 22, 48 and 72 Hours after Treatment

Data presented in Table 2 shows a significant interaction between plant part and control materials on *H. armigera* third instar larvae mortality. At 48 hours after treatment. The Moringa seed EO had a significantly higher larval mortality on fruit than remaining tested control materials and control, also when leave is been considered Moring had a

higher larval mortality but was not different statistically from the larval mortality caused by the remaining tested control materials and control.

At 72 hours after treatment Moringa had a significantly higher larval mortality on leave than control, but was not statistically different from larval mortality caused by the remaining tested control materials. When fruit is been considered higher larval mortality was caused by cypermethrin, but was not different statistically from larval mortality caused by moringa.

Table 2: Effect of Interaction among tested materials on Mortality of *H. armigera* Third Instar Larvae at 48 and 72 Hours after Treatments

Control materials	Hours After Treatment			
	48 HAT		72 HAT	
	Fruit	Leaves	Fruit	Leaves
Moringa	3.23a	1.11b	1.44bc	4.44a
Balanites	1.23b	0.00b	0.33c	3.61a
Cypermethrin	0.8b	0.33b	2.77ab	2.61ab
Control	0.23b	0.00b	0.60c	0.00c
LS		*		**

Mean followed by different letters in same column are significantly different at P= 0.05 level of probability according to Turkey test, LS = Level of Significance

Effect of Interaction between Plant Part and Concentration of on Mortality *H. armigera* Third Instar Larvae at 72 Hours after Treatment

Result presented in Table 3 shows a significant interaction between plant part and concentration on mortality *H. armigera* third instar larvae at 72 hours after treatment. 4% concentration gives higher larval mortality on fruit, but was at par with larval mortality caused by the remaining concentrations. Similarly, when leave is been considered 4% concentration had significantly higher larval mortality compared to 2% concentration but was not statistically different from the larval mortality caused by 6% concentration.

Qualitative and Quantitative Analysis of Moringa and Balanite Seed Essential Oils

Results of Qualitative Phytochemical Screening of moringa and balanites seed oil are presented in Table 4. Five and nine compounds were identified in balanites and moringa seed oils respectively.

Approximately 11 components were detected in oils of moringa seed (Table 5), among which 1-Methylpentyl cyclopropane (64%) and 11-Octadecenoic acid, methyl ester (22.3%) were the dominants followed by Docosanoic acid methyl ester (3.2%), Hexadecanoic acid, methyl ester (2.6%) and p-Xylene (2.2%). In balanites, approximately 21 components were detected (Table 6), among which 1-Methylpentyl cyclopropane (59.2%), 9-Octadecanoic acid, methyl ester (9.3%) and Benzene, 1,2-diethyl- (9.3%) and P-xylene (7%) were the dominants followed by Benzene, 1-ethyl-3-methyl- (3.1%), Hexane (2.6%), Mesitylene (2.3%) and Hexadecanoic acid, methyl ester (2.2%).

Table 3: Interactive Effect of Plant Parts and Concentrations on Mortality of *H. armigera* Third Instar Larvae at 72 Hours After Treatments

Concentration	Plant Part	
	Fruit	Leaves
2%	1.25b	1.42b
4%	1.67b	3.33a
6%	1.42b	3.33a
LS		*

Mean followed by different letters in same column are significantly different at P= 0.05 level of probability according to Turkey test, LS = Level of Significance.

DISCUSSIONS

Effect of Control Materials on the mortality of *H. armigera* larvea

The result of this study shows that leaves recorded significantly higher larval mortality. Kyung -Jun lee *at el.*, (2016) reported that tomato leaves contain steroidal, alkaloids and phenolics such as hydroxycinnamic acids and Flavonoids, which are known to be involved in host- plant defense. This study found that all treatments were better than control but Moringa seeds EO caused higher mortality than that of balanites and cypermethrin. This may be attributed to active constituents present in moringa seed EO. Sule and Ahmed (2009) reported that effect of botanicals depend on its constituent. Lale (2002) reported that toxicity of lemon oil is due to leonine content in the oil.

The major components of the moringa seed EO are 1-methyl prophyll cyclopropane and 11-octadecenoic acid methyl ester, followed by Hexadecanoic acid methyl ester and P-xylene. Similarly, the major components of the balanites seed EO are 9-octadecanoic acid methyl ester and Benzene, 1,2-diethyl- followed by Benzene,1-ethyl-3-methyl-, Heaxane, mestityle and Hexadecanoic acid methyl ester.

Mathalaimuthu *et al.* (2017) reported that 11-octadecenoic acid methyl ester have insecticidal properties against *Aedis aegyptica* larvae. Hexadecanoic acid methyl Ester was reported by Ravi *et al.* (2018) to have pesticidal and nematicidal activities. Repellency of P-xylene was reported by Kahwa and Adalu (2018) against insect pests. Oleic acid which is among the minor component was also reported to have pesticidal and insecticidal activities by Ravi *et al.* (2018).

Effect of Interactions of plant parts, control materials and their concentration on the mortality of *H. armigera* larvea

On effect of plant parts and control materials, it was observed that fruits treated with moringa seed EO caused higher larval mortality at 48 HAT. However, leaves treated with balanites seed EO caused higher mortality at 72 HAT. This may also be attributed to presence of bioactive constituent of tomato leaves which interacted with bioactive component of balanites seed EO. Tikunov *et al.* (2005), Hanson *et al.* (2012), Norma *et al.* (2015), Juliana *et al.* (2016), and Ghada *et al.* (2017) reported that tomato leaves contain phenols, flavonoids, hexadecenoic acid ethyl ester, hexadecanoic acid, hexadecanoic acid methyl ester and

octadecanoic acid ethyl ester, which are known to be involved in host-plant defense. Regarding difference in time of exposure, David *et al.* (2000) also reported that effect of botanicals differs according to the duration of treatment. Mortality observed when fruits treated with the moringa seed EO at 48HAT may be due to biodegradability of the EO. Nadia and Huda (2018) reported that oil extracts from plants are biodegradable. Mortality at 72 HAT on leaves treated with balanites seed EO may be attributed to longer duration of the exposure. Hojat *et al.* (2008) reported mortality of *Sitophilus oryzae* (L) when treated with botanical extract from family of *Scrophulariaceae* increases with increase in exposure interval. Addisu *et al.* (2014) also reported that potency of botanicals against *Microtermes* spp increases with increased exposure.

On effect of the interaction between plant parts and concentrations of the EOs on mortality, Plant parts treated with 0% concentration of moringa and balanites seed EOs had lower mortality. This effect may be due to bioactive constituent of the two essential oils. Bassolé and Juliana (2010) and Cosić *et al.* (2010) reported that bioactive compounds accumulated in plant tissues have insecticidal properties.

Quantitative Analysis of Seed essential Oils of Moringa and Balanites

The result of quantitative analysis of moringa and balanites seeds essential oils shows that the dominant component of moringa essential oil are 1-Methyl pentyl cyclopropane C₁₉H₁₈ (64%), 11-Octadecenoic acid, methyl ester C₁₉H₃₆O₂ (22.3%), Docosanoic acid methyl ester C₂₃H₄₆O₂ (3.3%) followed by Hexadecanoic acid, methyl ester C₁₇H₃₄O₂ (2.6%) and P-xylene C₈H₁₀ (2.2%). These result is not in consistence with Olaye and Kukwa (2018) whom identify seven (7) component from

moringa oil among which the major ones are 12-methyl-E-E-2. 13 octadecadien-1-01, 5, 5-dimethyl-1, 11-hexadecadienal. Adegbe *et al.* (2016) reported twenty four (24) component, the major ones are oleic acid, 9-octadecenol and palmic acid.

The quantitative analysis results also reveals that dominant component identified from balanites essential oil are 1-Methyl pentyl cyclopropane C₁₉H₁₈ (59%), 9-Octadecenoic acid, methyl ester C₁₇H₃₄O₂ (9.3%), Benzene 1, 2, diethyl- C₁₀H₁₄ (8.5%) and P-xylene C₈H₁₀ (7%) followed by Benzene, 1-ethyl-3methyl- C₉H₁₂ (3.1%), Hexane C₆H₁₄ (2.6%), mestitylene C₉H₁₂ (2.3%) and Hexadecanoic acid methyl ester C₁₇H₃₄O₂ (2.2%). This result is in contrast with Dass *et al.* (2018) who reported 10 component from GC-MS analysis of balanites seed oils using catalyst from mahogany fruits shell, among which the major ones are Hexadecanoic acid (Z), methyl ester, 12-octadecenoic acid (Z), methyl ester, oleic acid 3-hydrophyl ester and 9-octadecanoic acid (Z), methyl ester.

Most the compounds identified from the seeds essential oils of balanites and moringa in this study were reported by many authors to poses insecticidal and larvicidal activity. 1-methyl prophyll cyclopropane is the major constituent of both Balanites and moringa seed essential oils with 64 and 59% respectively. This component is a hydrocarbon which belongs to terpene, terpene earlier reported to have toxic effect to variety of insects (Bakkali *et al.*, 2008). 9-octadecenoic acid, methyl ester Hexadecanoic acid methyl ester, Linoleic acid, and Oleic acid from *Ricinus communis* extracts were reported by Nisha *et al.* (2018) to have larvicidal activity against adult and larvae of anopheles mosquito. Manta *et al.* (2019) also reported that 9- Octadecanoic acid methyl ester, Hexadecanoic acid methyl ester, Linoleic acid ethyl esters from *Annona*

squamosa and *Gliricidia sepium* hexane and methyl extract have larvicidal effect against *Aedes aegypti* (Linn.). P-xylol, and Mestilylene from *Vernonia colorata* leaf essential oil were also reported by Frank *et al.*

(2019) to have insecticidal and larvicidal activities. Arun *et al.* (2009) reported that benzene derivatives and terpenes have toxic properties against *Periplaneta americana*.

Table 4: Chemical Compound of Balanites and Moringa Seed Essential oils

S/No.	Phytochemical	Balanite	Moringa
1	Flavonoid	-	+
2	Phenol	-	+
3	Alkaloid	+	+
4	Saponin	-	+
5	Tannin	-	+
6	Glycoside	+	+
7	Sterols	+	+
8	Steroid	+	-
9	Terpenoids	-	-
10	Oxalate	-	+
11	Anthraquinone	-	-
12	Carbohydrate	+	+

+ indicate presence of compound and – indicate absence of compound

Table 5: Composition of *Moringa* Seeds Essential oils (GC-MS Analysis)

Component	Formula	Mol./Wt.	R/ Time (min)	% in total oil V/V	Peak Area
1-Propene, 3-propoxy-	C ₆ H ₁₂ O	100	8.74	1	1414134
1-Methylpentyl cyclopropane	C ₉ H ₁₈	126	9.45	64	86763404
p-Xylene	C ₈ H ₁₀	106	10	2.2	3040605
12,15-Octadecadiynoic acid, methyl ester	C ₁₉ H ₃₀ O ₂	290	10.42	0.9	1263782
Eicosapentaenoic acid	C ₂₀ H ₃₀ O ₂	290	10.57	0.3	341574.2
Ethyl iso-allocholate	C ₂₆ H ₄₄ O ₅	438	12.23	0.7	936641.7
Hexadecanoic acid, methyl ester	C ₁₇ H ₃₄ O ₂	270	17.34	2.6	3528733
Docosanoic acid, methyl ester	C ₂₃ H ₄₆ O ₂	350	17.62	3.2	4277089
Octadecadienoic acid (Z,Z)-, 2,3- dihydroxypropyl ester	C ₂₁ H ₃₈ O ₄	354	17.99	1	1293663
11-Octadecenoic acid, methyl ester	C ₁₉ H ₃₆ O ₂	296	19.19	22.3	30199870

Table 6: Composition of Balanites Seeds Essential oils (GC-MS Analysis)

Component	Formula	Mol./Wt.	R/ Time (min)	% in total oil V/V	Peak Area
Butane, 2,2-dimethyl-	C ₆ H ₁₄	86	8.752	1.8	2E+07
Hexane	C ₆ H ₁₄		8.929	2.6	2.9E+07
1-Methylpentyl cyclopropane	C ₉ H ₁₈	126	9.462	59.2	6.7E+08
p-Xylene	C ₈ H ₁₀	106	10.028	7	8E+07
Benzene, 1-ethyl-3-methyl-	C ₉ H ₁₂	120	10.434	3.1	3.5E+07
Mesitylene	C ₉ H ₁₂	120	10.583	2.3	2.6E+07
Benzene, 1,2,3-trimethyl	C ₉ H ₁₂		10.755	0.1	1629873
Benzene, 1,2-diethyl-	C ₁₀ H ₁₄	134	10.852	0.8	9649454
Benzene, 1,2-diethyl-	C ₁₀ H ₁₄		10.852	8.5	9.6E+07
p-Cymene	C ₁₀ H ₁₄	134	11.012	0.4	4354444
Carene, 2-(acetylmethyl)- Acetamide, N-(4,6,6-trimethylbicyclo [3.1.1]hept-3-en-2-yl)-, (1 α ,2 β ,5 α)-	C ₁₃ H ₂₀ O	102	11.224	0.2	2703308
	C ₁₂ H ₁₉ NO	193	11.464	0.5	5605384
2,5-Octadecadiynoic acid, Hydrocinnamic acid, o-[(1,2,3,4-tetrahydro-2- naphthyl)methyl]-	C ₁₈ H ₂₇ O ₂		11.653	0.2	2139457
	C ₂₀ H ₂₂ O ₂	294	11.733	0.4	4145122
1H-Indene, 2,3-dihydro-1,2-dimethyl-	C ₁₁ H ₁₄	146	11.928	0.1	636519
2,5-Octadecadiynoic acid, methyl ester	C ₁₉ H ₃₀ O ₂		12.036	0.1	704406
Benzocycloheptatriene	C ₁₁ H ₁₀	142	12.426	0.1	708177
5,8,11-Eicosatriynoic acid, methyl ester	C ₂₁ H ₃₀ O ₂	314	12.546	0	110388
Hexadecanoic acid, methyl ester	C ₁₇ H ₃₄ O ₂		17.352	2.2	2.5E+07
9-Octadecanoic acid, methyl ester	C ₁₇ H ₃₄ O ₂		19.212	9.3	1.1E+08
Methyl stearate	C ₁₉ H ₃₈ O ₂		19.406	0.9	1E+07
Oleic Acid	C ₁₈ H ₃₄ O ₂	282	19.618	0.4	4925572
				100	1.1E+09

CONCLUSION

The seed essential oils of moringa and balanites were observed to cause mortality to *H. armigera* third instar larvae and 1-methyl cyclopropane was found to be dominant component of the two essential oils. Based on the finding of this study, it is recommended that farmers should use 2% concentration of balanites seed oil in managing *H. armigera* larval infestation on tomato plant leaves and fruits.

ACKNOWLEDGMENT

Authors sincerely appreciate Department of Crop Protection, Bayero University Kano and Department of Chemistry, Yobe State University Damaturu for using their laboratory facilities

REFERENCES

- Abbott, W.S. (1925).** A method of computing the effectiveness of an insecticide. *Journal of Economic Entomology*, 18, 265-267.
- Addisu, S., Mohammed, D. and Waktole, S. (2014).** Efficacy of Botanical Extracts Against *Macotermes Spp* (Isopteran: Termitidae) Under Laboratory Conditions. *International Journal of Agricultural Research*, 9:60-73.
- Adegbe, A. A., Larayetan, R. A. and Omojuwa, T. A. (2016).** Proximate Analysis, Physico Chemical Properties and Chemical Constituents Characterization of *Moringa oleifera* (Moringaceae) Seed Oil using GC-MS Analysis. *American Journal of Chemistry*, 6(2):23-28.
- Bakkali, F., Averbeck, S., Averbeck, D. and Idaomar, M. (2008).** Biological Effects of Essential Oils. *A Review of Food and Chemical Toxicology*, 46: 44-475.
- Bassolé, I.H.N. and Juliani, H. R. (2010).** Essential Oils in Combination and Their Antimicrobial Properties. *Molecules*, 17:3989-4006.
- Dass, P. M., Louis, H., Andrew, A., Amos, P. I., Bifam, M., and Ago, M. A. (2018).** Production of Biodiesel Oil from Desert Dates (*Balanites aegyptiaca*) Seed Oils using a Heterogeneous Catalyst Produced from Mahogany (*Khaya senegalensis*) Fruits Shells. *Analytical Chemistry: An Indian journal*, 18(1):1-12.
- David, J. P., Rey, D., Pautou, M.P. and Meyran, J.C. (2000).** Differential Toxicity of Leaf Litter to Diptera Larvae of Mosquito Developmental Sites. *International Journal of Invertebrate Pathology*, 75:9-18.
- Elumalai, K., Mathivanan, T., Elumalai, A., Jeyasankar, A., Dhanasekaran, S. and Krishnappa, K. (2013).** Larvicidal and ovicidal properties of selected Indian medicinal plant extracts against American bollworm, *Helicoverpa armigera* (Hub). (Lepidoptera: noctuidae). *International Journal of Interdisciplinary Research and Reviews* 1(7):5-11.
- Frank, N. M., Amos, F. O., Eni, I. E., Helem, A. N. and Marshal, A.I. (2019).** Chemical Composition, Anthelmintic, Insectical and Antimicrobial Activities of *Vernonia corlorata* Leaf Essential Oil. *International Journal of Herbal Medicine* 7(4): 45-50.
- Ghada, E. A., Manal, E.A., Amal, E.M. and Hala, E.M. (2017).** Application of Tomato Leaves Extract as Pesticides against *Aphis gossypii*. *International*

- Journal of Advance Research* 5(4):286-290.
- Global Positioning System, (2023).** Coordinate of Entomology Laboratory of Crop Protection, Bayaro University Kano.
- Juliana, A., Mariana, S. and Luzia, G. (2016).** Down- Regulation of Tomato Phytol Kinase Strongly Impairs Tocopherol Biosynthesis and Affect Prenylipid Metabolism in an Organ-Specific Manner. *Journal of Experimental Botany*, 67(3):919-934.
- Kahwa, I. and Adaku, C. (2019).** Characterization of Essential Oil from Leave of *Euphorbia heterophylla* and its Insect Repellent Potentials. *African Journal of Pharmaceutical Research and Development*, 10(2):099-106.
- Kumar, S. (2012).** Bio pesticide: An Environment Friendly Pest Management Strategy Bio-Fertilizer. *Bio-pesticides*, 6:1-27).
- Kumar, V., Mahla, M.K., Jhumar, W. and Singh, V. (2017).** Effect of abiotic factors on the seasonal incidence of fruit borer, *Helicoverpa armigera* (Hub) on tomato with and without marigold as trap crop. *Journal of Entomology and Zoology Studies*, 5(2):803-807.
- Kyung-Jun lee, G., Anlee, K., Sebastin, R., Yang-Hee, C. and Jung-Ro lee, J. (2016).** Chemical Constituent and Antioxidant Activities of Tomato Leaf Extracts. *Plant Breeding Biotechnology* 4(3): 362-372.
- Lale, N.E.S., (2002).** Stored Product Entomology and Acarology in Tropical Africa. *Mole publication*, Maiduguri. Pp 204.
- Mailafiya, D. M., Degri, M. M., Maina, Y.T., Gadzama, U.N. and Galadima, I.B. (2014).** Preliminary Studies on Insect Pest Incidence on Tomato in Bama, Borno State, Nigeria. *International Letters of Natural Sciences*, 10:45-54
- Manta, G., Laxmikart, S. and Ranjit, B. (2019).** Study of Chemical Composition and Larvicidal Efficacy of Secondary Metabolites from Aromatic Phyto Extracts against Dengue Vector: *Aedes aegypti* (Linn) (Diptera: Culicidae). *International Journal of Mosquito Research*, 6(1):26-33.
- Mathalaimuthu, B., Shanmugam, D., Kalimuthu, K., Kadarkarai, M. and Jayapad, G. (2017).** *Coleus aromaticus* Leaf Extract Fraction: A Source of Novel Ovicides, Larvicides and Repellents against *Anopheles aedes* and *Culex* Mosquito Vectors. *Journal of Process Safety and Environmental Protection*, 106: 22-33.
- Nadia, Z.D. and Huda, E. (2018).** Bioactivities of *Moringa oleifera* Leaf Powder towards the Cowpea Beetle *Callosobruchus maculatus* F. Under Laboratory Conditions. *Journal of Innovations in Pharmaceutical and Biological Sciences*, 5(1):86-91
- Nisha, S., Neera, K., Himmat, S., Smrili, S., Nayak, A. and Naggal, B.N. (2018):** Larvicidal Activity Of *Ricinus Communis* Extract Against Mosquito. *Journal of Vector Borne Diseases* 55(4): 282-290.
- Ravi, R., Nor, S., Husna, Z., Nurulmadiyah, R. N. k; R., Nik, Y., Mohd, S.R., Muhammad, I.A., Zulhazman, H., Intan, H., Ishak, K. and Mohammad, F. M. (2018).** Evaluation of two Different Solvents for *Azolla pinnata* Extract on Chemical Composition and Larvicidal Activity against *Aedes albopictus*

(Diptera: culicidae). *Journal of chemistry* ,1-8 Article ID 7453816, 8 pages.

Tikunov, Y., Arjen, L., Harrie, A., Robert, D. and Arnaud, G. (2005). A Novel Approach for Non- Target Data Analysis for Non- Target Data Analysis for Metabolics. Large- Scale Profiling Of Tomato Fruits Volatiles. *Plant Physiology*, 139: 1125-1137

NJE Vol. 40(2): 1-14, 2024

Nigerian Journal of Entomology

Published by the Entomological Soc. of Nig.

www.esnjournal.com.ng

DOI.10.36108/NJE/4202/04.0210

