NJE Vol. 41(2): 80-91, 2025
Nigerian Journal of Entomology
Published by the Entomological Soc. of Nig.
www.esnjournal.com.ng
DOI.10.36108/NJE/5202/14.0260

EFFICACY OF NEEM AND LANTANA LEAVES AQUEOUS EXTRACTS UNDER FIELD CONDITION ON *Spodoptera frugiperda* J.E. SMITH (LEPIDOPTERA: NOCTUIDAE)

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Abstract

Spodoptera frugiperda (J. E. Smith) is one of the important insect pests of maize plant. This pest destroys the fresh leaves which impair the growth and ultimately reduce the yield of the crop. The research was conducted to determine the efficacy of neem (*Azadirachta indica* A. Juss.) and lantana leaf extract on the insect using cypermethrin as the standard control. Neem and Lantana leaf extracts were prepared by cold maceration extraction. Quantitative phytochemicals analysis of the botanicals was determined to determine the chemical constituents. Experimental land of about 204.25 m^2 was demarcated into 24 sampling plots each measuring 4.25 m × 1.25 m with 1 m alleyway. A 75 cm intera- and 25 cm inter-row spacing was adopted laid in a Randomized Complete Block Design (RCBD) replicated three times. Two weeks after planting, the extracts and cypermethrin were sprayed separately onto the plants in the various plots at the rate of 0.0, 5.0, 10.0, and 15.0 v/v %. Application of the extracts significantly reduced population density of *S. frugiperda* when compared with the experimental control that still harboured the insects in high density. There was no significant difference between plots treated with cypermethrin and neem plus lantana leaf extracts. This finding therefore suggests that combination of neem and lantana leaf extracts or neem alone at 15 v/v % can be an effective ecofriendly alternative for controlling *S. frugiperda* in maize farm**.**

Keywords: Neem Extract, Lantana Extract, Efficacy, Maize, Fall Army worm.

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INTRODUCTION

Spodoptera frugiperda (J. E. Smith) (Lepidoptera: Noctuidae), commonly called fall armyworm (FAW) is one of the important insect pests of cereal crop especially maize plant. It destroys the fresh leaves which impair the growth and ultimately reduce the yield of the crop. The use of chemical

insecticides has been the major strategy for controlling this menace, however, their indiscriminate use has resulted in the development of resistance to insecticides, secondary pest outbreaks, pest resurgence, bioaccumulation in the food chain, environmental pollution, human health hazards and destruction of non-target organisms (Joshi *et al*., 2020). Furthermore, farmers always complain about the local unavailability of synthetic products, poorly labelled packaged products and also frequently adulterated and sometimes, some products are sold after the expiry date (Stevenson *et al*., 2012).

Environmentally acceptable insecticides are known for their relatively low toxicity to non-target organisms and biodegradability due to their botanical origin. This makes it possible to incorporate such insecticides into integrated pest management programs (Shannag *et al*., 2013; Nawa and Mabubu, 2016). Due to the rise in the advocacy for the use of safer insecticides, several research works have been conducted in search of plant sources of safe insecticides. Many African plants contain chemical metabolites with remarkable biological activities which can be considered for the management of agricultural insect pests. Among these botanicals are Neem and Lantana (Salako, 2008; Baidoo and Adam, 2012). This is because botanicals are eco-friendly when compared with synthetic insecticides. For instance, asteroid-like tetranortriterpenoid (azadirachtin) obtained from neem tree (*Azadirachta indica*), has been identified as a key insect repellent in vegetables (Shannag *et al*., 2013). Moreover, neem has an insecticidal effect on insects that suck plant sap and those which chew plant parts. The active ingredient in neem, azadirachtin, serves as a growth regulator as well as a feeding and oviposition deterrent. It acts as a growth regulator by reducing the level of ecdysone, a hormone that disrupts the moulting process of the insects and thus prevents larvae from developing into adults (Silva *et al*., 2015).

Studies have also shown that lantanine from extract of *Lantana camara* exhibits a defensive mechanism against insect pests and it can display antimicrobial, fungicidal, insecticidal and nematicidal properties. These could be linked to its phytochemical constituents such as flavonoids, alkaloids, glycosides, saponins, steroids, triterpenes and tannin (Baidoo and Adam, 2012; Yang *et al*., 2018). Karamanoli *et al*. (2011) corroborated this report by explaining that tannins exert their action by a combination of mechanisms that include iron chelation and enzyme inhibition. Also, the presence of saponins and cardiac glycosides could be linked to the insecticidal interaction with cholesterol which resulted in impairing ecdysteriod synthesis (Lengai *et al*., 2020). The lantadene content of lantana leaves is variable, and potentially toxic plants contain at least 80 and 200 mg kg^{-1} of lantadenes A and B, respectively (Ghisalberti, 2000). In practice, this is equivalent to a dosage of 40 g of fresh material per kilogram of weight. Currently, Mvumi and Maunda (2018) sought to determine the efficacy of lantana leaf extract (LLE) in controlling aphids in rape by assessing adult aphid mortality over varied periods (hours) of exposure to the treatment and it was found to be very effective. The plant has also been used in traditional herbs medicines for treating a variety of ailments including cancer, skin-itches, leprosy, rabies,

chicken pox, measles, asthma and ulcers (Dehou *et al*., 2021). This work therefore aimed at evaluating the potentials of aqueous extracts from lantana and neem leaves for the management of fall armyworm insect pests associated with maize plant in Plateau State, Nigeria.

MATERIALS AND METHODS

Study Area: This research work was carried out at the Federal College of Forestry, Jos experimental site in the Jos North Local Government Area (LGA) of Plateau State (Figure 2). The College falls between latitude 9º 51' N and longitude 8º 53' E with an altitude of 1200 m above sea level, and it is located within the Northern Guinea Savanna Agro-ecological zone of Nigeria. Mean rainfall is about 1500 mm received in 130-150 days from May to September (Danbaba and Fogah, 2013) and daily temperature ranges between 10 ºC to 32 ºC, minimum and maximum respectively (University of Jos Meteorological section, 2020). The climate of the area is generally humid and tropical and is characterized by two distinct wet and dry seasons. The wet season starts in late April and ends in October, while the dry season starts from November to mid-April.

Synthetic Insecticide and Plant materials: Cypermethrin was purchased in a certified Ago-Chemical shop. Fresh neem (*Azadirachta indica*) leaves were obtained from 15 different neem trees at Toro Local Government Area of Bauchi State. Lantana leaves were also obtained from Experimental farm of College of Forestry, Jos.

Pre-treatment of neem leaves: The leaf samples of neem and lantana were separately washed with tap water followed by distilled water to remove dust. The samples were then dried on flat trays in the laboratory for about 4 weeks under room temperature (to get a constant weight). The dried leaves were milled separately with an electric laboratory hammer mill. One kilogram of each powder was soaked in 500mls distilled water for 48 hours (this is for complete extraction of the samples). The supernatant was then filtered out with the use of 1mm sieve and the filtrate was kept in a desiccator until it was used as bio-pesticides on Maize plant using 2-liter hand sprayer. This is in line with Mathur and Kongsdal (2003) extract procedure.

Experimental Layout and Design: The experimental land of about 204.25 m^2 was ploughed and harrowed after which 24 sampling plots each measuring 4.25 m long by 1.25 wide were demarcated. 1 m alleyway was provided between sampling plots. A 75 cm intera- and 25 cm inter-row spacing was adopted giving the population of approximately 20 plants per plot (i.e., 23,500 plants ha^{-1}) laid out in a Randomized Complete Block Design (RCBD) and replicated three times.

Application of Insecticides: Two weeks after planting, the extracts from neem, lantana leaves and their combinations, and cypermethrin (Standard control) were sprayed separately onto the plants in the various plots at the rate of 0.0 (Experimental control), 5.0, 10.0, and 15.0 v/v %. Observation on population of insect pests started as soon as their infestation was noticed. Population

density was determined on randomly selected plants at weekly interval. This is in accordance with Baidoo and Adam (2012) method.

Data collection and Data Analysis: Data collection commenced after 2 weeks of planting. Observations on the *S. frugiperda* population from the selected plants were recorded before spray and 3 days after spray for 4 weeks. The simple random sampling method was used to tag infested plants. The main and the interactive effects of the extracts on population density of the insect was recorded on five randomly selected plants on the basis of number of larvae per plant. All the open leaves and heads of the selected plants were observed thoroughly and the number of larvae found were recorded and percentage leaf damaged was calculated in accordance with Tulashie *et al*. (2019). Percentage yield for each treatment was also calculated. Data obtained were analyzed statistically using analysis of variance and the efficacy of the insecticides and botanical extracts were calculated.

Quantitative analysis of phytochemicals of *Lantana camara* and *Azadirachta indica*

The determination of total phenols was carried out using the method of Edeoga *et al.* (2005). Tannin was determined by the method of Van-Burden and Robinson (1981). While saponin was determined by the method of Obdoni and Ochuko (2001). Alkaloid determination using Harborne (1973) method. Flavonoid was determined by the method of Bohm and Kocipai-Abyazan (1994). Qualitative analysis of Vitamins was carried out by the method of Pearson (1976).

RESULTS

Quantitative phytochemical analysis of *Lantana camara* and *Azadirachta indica*

Table 1 showed the phytochemical constituents of the aqueous extract of *Lanatana camara* leaves as biopesticides in this study. It was indicated that flavonoids have the highest concentration (43.31±0.081), followed by Alkaloids (35.14± 0.029), then Saponin (20.15 ± 0.029), Phenol (25.14 ± 0.094) and Tannins (15.05±0.026). While *Azadirachta indica* leaf extract showed that flavonoid (13.1 ± 0.08) had the highest concentration, followed by Tannin (13.4 ± 0.31), then Phenols (12.77 ± 0.5), Alkaloids (10.73 ± 0.29) and Saponin (2.53 ± 0.14), respectively.

Table 1: Quantitative Phytochemical Analysis of *Lantana camara* and *Azadirachta indica* Leaf Extracts

Phytochemical mg / g)	Lantana Leaves	Neem leaves
Phenols	25.14 ± 0.09	12.77 ± 0.50
Alkaloids	35.14 ± 0.03	10.73 ±0.29
Tannin	15.05 ± 0.03	13.40 ± 0.31
Saponin	20.15 ± 0.03	2.53 ± 0.14
Flavonoids	43.31 ± 0.08	13.10 ±0.08

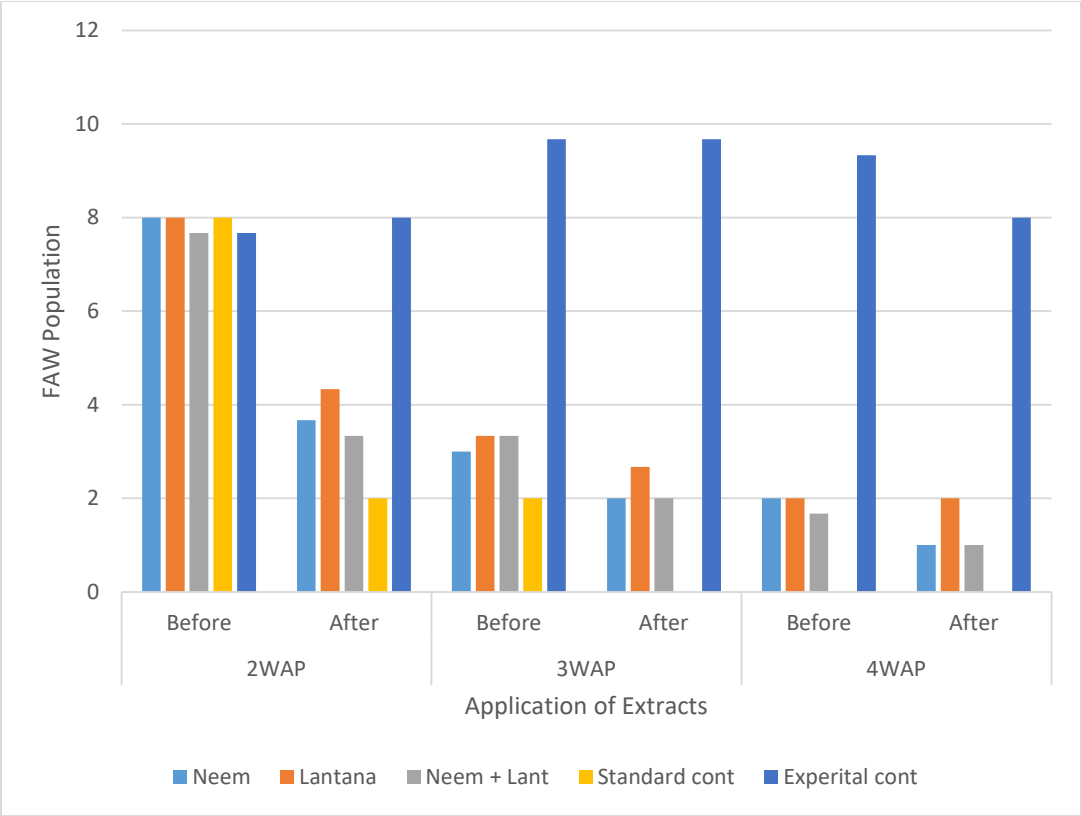
Key: mg = Milligrams, g = gram

Effects of *Lantana camara* (L.) and *Azadirachta indica* Extracts on *Spodoptera frugiperda*

It was observed in this study that the larvae first appeared on maize plant in the 2nd weeks after planting. Before the application of the insecticides, all the plots were infested with high number of larvae of fall army worm, concentrated on the growing points and destroying the young succulent leaves of the plant by their feeding activities. However, with the application of the extracts, there was significant reductions in the population density which resulted in low levels of infestation except for the experimental control that still harboured the insects in high density throughout the experimental period (Figure 1). There was no significant difference in the efficacy of the treatments however, at 5 ml / L neem and combination of the botanicals had control efficacy above 50 %. Standard control insecticide has the highest control efficacy of 80.01 % on fall army worms. At 15 v/v % cypermethrin had 100 % control efficacy followed by combinations of neem and lantana, and neem with 81.82 %, then lantana with 71.58 % efficacy (Figure 1). It was also observed that as the concentrations of the botanicals increased, a significant percentage population of *S. frugiperda* drops with the lowest populations at concentration 15 v/v % in all the treatments. However, cypermethrin had 100 % control while neem and the combination had reduced population density up to about 90 % respectively. This result showed no significant difference between the cypermethrin, neem plus lantana and neem extract treatments but significant differences exist when compared with experimental control and lantana alone. (Table 2).

As the concentration of the extract increased, the percentage of leaf damage reduced. However, overall result showed that cypermethrin had lower percentage leaf damage when compared to other treatments. It was also revealed that in all the treatments, 15.00 v/v % of the extract treatments had the lowest percentage levels of leaf damage (20.00 – 0.00 %). However, analysis of variance showed significant difference among the different concentrations (Table 3).

Treatment with various insecticides gave better yield compared to untreated stands. However, treatment with different concentrations of the insecticides generally showed significant differences from each other and as the concentration increased the yield also increased (Figure 2). Treatment with cypermethrin had the highest yield of 1.70 kg followed by neem + lantana (1.44 kg) which showed no significant difference, while 0.89 kg and 0.79 kg was recorded for neem and lantana treatments respectively and these were significantly different from cypermethrin treatment (Figure 2).



Key: FAW =Fall Army Warm, WAP = Weeks After Planting

Figure 1: Effect of extracts on the population of Fall Army Worm

Table 2: Interactive effects of botanicals and concentrations on the populations of Fall Army Worm infesting maize

Extracts	Conc (v/v) %	2WAP		3WAP		4WAP	
		Before	After	Before	After	Before	After
N	5.0	7.67 [a]	5.33 [b]	4.67 [bc]	3.33 [d]	3.33 [d]	2.67 [e]
	10.0	8.00 [a]	4.67 [bc]	4.67 [bc]	3.33 [d]	3.00 [de]	2.00 [ef]
	15.0	8.00 [a]	4.67 [bc]	4.67 [bc]	2.67 [e]	2.67 [e]	1.00 [fg]
L	5.0	8.00 [a]	5.33 [b]	5.33 [b]	3.67 [cd]	3.67 [cd]	3.00 [de]
	10.0	7.67 [a]	5.33 [b]	4.33 [c]	3.67 [cd]	3.00 [de]	2.33 [ef]
	15.0	8.00 [a]	4.33 [c]	4.33 [c]	2.67 [e]	2.00 [ef]	2.00 [ef]
N+L	5.0	7.33 [a]	4.67 [bc]	4.33 [c]	3.67 [cd]	3.67 [cd]	2.00 [ef]
	10.0	8.00 [a]	4.33 [c]	4.00 [c]	3.33 [d]	3.00 [de]	1.67 [f]
	15.0	8.00 [a]	4.33 [c]	3.67 [cd]	2.67 [e]	2.67 [e]	1.00 [fg]
Std Cant	5.0	7.17 [a]	4.33 [c]	4.33 [c]	3.00 [de]	2.00 [ef]	1.00 [fg]
	10.0	7.33 [a]	3.67 [cd]	2.00 [ef]	1.67 [f]	1.00 [fg]	0.00 [g]
	15.0	7.67 [a]	3.00 [d]	3.00 [de]	0.00 [g]	0.00 [g]	0.00 [g]
Expt Cont	5.0	7.33 [a]	7.67 [a]	9.00 [a]	8.00 [a]	7.67 [a]	7.33 [a]
	10.0	7.67 [a]	7.67 [a]	8.00 [a]	8.00 [a]	7.33 [a]	6.67 [ab]
	15.0	7.67 [a]	8.00 [a]	9.00 [a]	9.00 [a]	7.67 [a]	7.00 [a]
F. Value		1.36	4.46	34.89	30.68	17.29	35.51
P. Value		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

Means with the same letter in the same column are not significantly different ($P < 0.05$)

Table 3: Percentage mean Leaf Damage after Treatments with Different Insecticides

Concn. (v/v) %	Lantana	Neem	Lant + Neem	Cyper
0.0	93.33±6.66 [a]	86.67±6.66 [a]	93.33±11.55 [a]	86.67±6.66 [a]
5.0	80.00±6.67 [b]	53.33±6.66 [b]	73.33±6.67 [b]	46.67±6.67 [b]
10.0	46.67±11.54 [c]	40.00±6.67 [c]	40.00±0.00 [c]	20.00±6.67 [c]
15.0	20.00±0.00 [d]	19.99±11.55 [d]	20.00±6.67 [d]	13.33±11.55 [c]

Means with the same letter in the same column are not significantly different ($P < 0.05$)

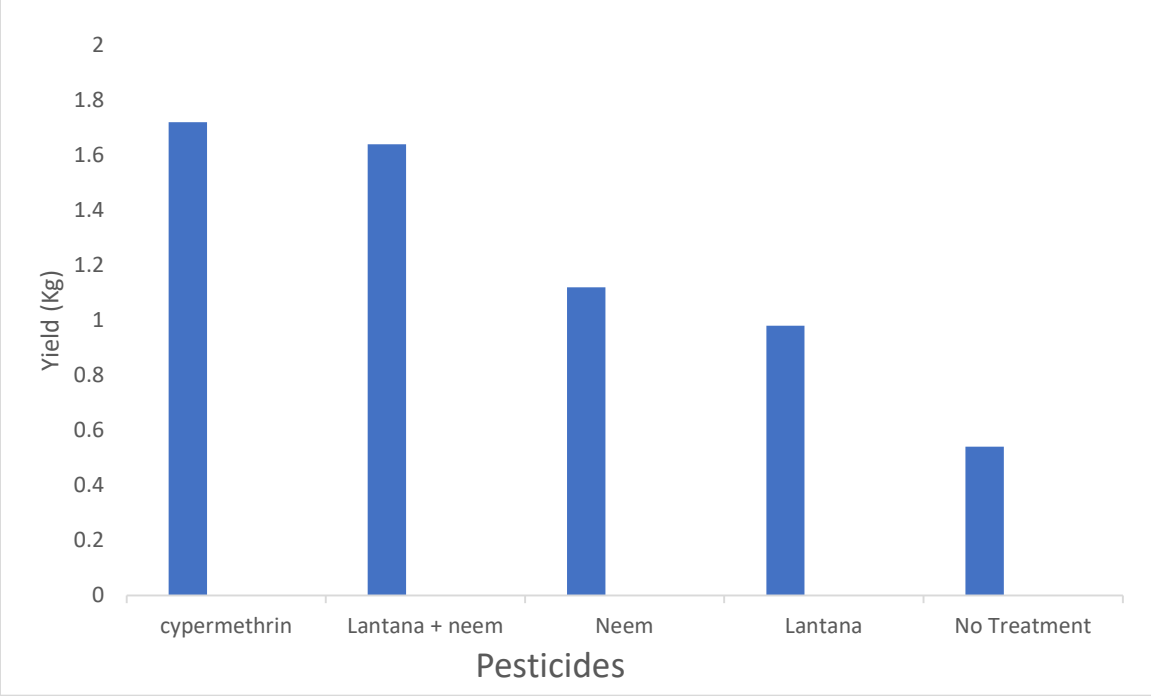


Figure 2: Percentage Maize Yield per Stand after Various Insecticide Application

DISCUSSION

The result of the phytochemicals analysis of neem and lantana leaves extracts revealed the presence of bioactive constituents like phenols, alkaloids, tannins, saponins and flavonoids in the leaves of neem and lantana. This result is in line with the work of Kilani-Morakchi *et al*. (2021). Azadirachtin in neem leaves also known to induce a physiological effect on insects by interfering with the synthesis and release of ecdysteriods which disrupts larval moulting in hemi- and holometabolous insects as suggested by Fening *et al*. (2020). Also, troterpenoid lantadene in lantana extract was marked to be responsible for its antifeedant properties as suggested by Martini *et al*. (2003)

The consistent and significant decrease in the number of insects of botanically treated plots indicated the effectiveness of the plant extracts and this inversely related to the crop yield. The highest insect pest reduction was observed at 15 v/v %. This finding aligns with the report of Bambawale and Bhagat (2012); Shah *et al*. (2019); Hossani *et al.* (2020) who used various African plant extracts against insect pests. The reduction in insect numbers could be due to the anti-feedant, repellant or insecticidal properties of the extracts which caused mortality as suggested by Baidoo and Adam (2012). Benson *et al*., 2014 and Ileke *et al*. (2016) also affirmed this suggestion by adding that the insecticidal properties of many botanicals involve interfering with regular breathing which can lead to asphyxia which are lethal to this target pest. The result of this study also shows that the efficacy of the botanicals increased as the concentrations of

the extracts increased with the lowest FAW population reduction in highest concentration (15 v/v %.). This agreed with the study carried out by Muzemu *et al*. (2011) on African plant extracts that the higher the concentration, the more the efficacy and the lower the concentration, the lower the efficacy against insect pest. The interaction between the botanicals and concentrations showed that all the botanicals had some levels of control effects on the pest, and as the concentration increases the levels control efficacy also increased against fall armyworm

CONCLUSION

Useful insecticidal and repellent of neem and lantana leaf extracts at concentration 15 v/v % can be used to suppress Fall Armyworm in maize crop effectively. Since these plant extracts are common, ecofriendly and affordable for small scale farmers, they ought to be promoted as an alternative to synthetic insecticides for the control of *Spodoptera frugiperda*.

Funding:
Acknowledgments:
Conflicts of Interest:

REFERENCES

Baidoo, P.K. and Adam, J. I. (2012). The Effects of Extracts of *Lantana camara* (L.) and *Azadirachta indica* (*A. Juss*) on the Population Dynamics of *Plutella xylostella*, *Brevicoryne brassicae* and *Hellula undalis* on Cabbage. *Sustainable Agriculture Research Journal*; 1(2); ISSN 1927-050X E-ISSN 1927-0518.

Bambawale, O. M. and Bhagat, S. R. (2012). Registration related issues in effective use of biopesticides in pest management in Biopesticides in Environment and Food Security: Issues and Strategies (eds. Koul, O., Dhaliwal, G. S., Khokhar, S. & Singh, R.) 265–285 (Scientific Publishers).

Benson, G.A.S.; Obadofin, A.A. and Adesina, J.M. (2014). Evaluation of plant extracts forcontrolling insect pests of pepper (Capsicum spp.) in Nigeria humid rainforest. New York Science Journal 7(1): 39-43

Boham, B.A. and Kocipai-Abyazan, R. (1994). Flavonoids and condensed tannins from leaves of Hawaiian vaccinium vaticulatum and V. calycinum. *Pacific Sci*. **48**: 458-463.

Danbaba, A.K. and Fogah, J. (2013). Effect of amount of Mulch and Rates of NPK 15:15:15 Fertilizer application on Potato production at Kuru, Plateau State.Unpublished (manuscript).

Dehou, R.J.; Abissi,Y.G.; Kpossou,G.; Tchogou, P.; Lokonon,E.; Agbogba, F.; Houngbeme, A.; A ttakpa, E.; Anago, E.; Baba-Moussa, L. and Senou, M. (2021). Bactericidal effect of the aqueous extract of the leaves of *Lantana camara* L. (Verbenaceae), a plant used in Benin in the treatment of skin infections. *Journal of Applied Biosciences* **167**: 17406 – 17412. ISSN 1997 – 5902

Edeoga, H.O, Okwu, D.E. and Mbaebie, B.O. (2005). Phytochemical constituents of some Nigerian medicinal plants.

African Journal of Biotechnology. **4**(7): 685-688.

Fening, K.O.; Forchibe, E.E. and Afreh-Nuamah, K. (2020). Neem as a cost-effective and Potent biopesticide against the diamondback moth *Plutella xylostella* L. (Lepidoptera: Plutellidae) and the cabbage webworm *Hellula undalis* F. (Lepidoptera: Crambidae). *West African Journal of Applied Ecology,* **28**(2): 52 – 63

Ghisalberti, E.L. (2000). *Lantara camara* L. (Verbenaceae). *Fitoterapia*. **71**:467-486. **Harborne, J.B. (1973).** Phytochemical methods, London. Chapman and Hall, Ltd., 49-188 pp.

Hossain, M. E., Rahman, M. M., Akter, S., Akhter, N. and Khan, M. S. I. (2020). Eco friendly management of major Lepidopteran insect pests of summer cabbage by six commonly used botanicals. *Journal of Bioscience and Agriculture Research*, **25**(01), 2060-2068.

Ileke, K.D.; Adesina, J.M. and Obajulaye, E.O. (2016). Synergistic effects of two botanical entomocides as pest-protectants in maize grains. *Journal of Biological Research*. 89: 34-39.

Joshi, M. J.; Solanki C. B.; Inamdar, A. G.; Birari, V. V. and Varadharasu, P. R. (2020). Latest trends in zoology and entomology sciences. In: D.S. Ganguly (ed.), Botanical Insecticides: A Venture Toward Organic Farming, pp. 53-75. Delhi, India: AkiNik Publications.

Karamanoli, K.; Bouligaraki, P.; Constantinidou, H.I.A. and Lindow, S.E. (2011). Polyphenolic compounds on leaves limit iron availability and affect growth of epiphytic bacteria. *Annuals of Applied Biology*. **159**: 99-108.

Kilani-Morakchi, S.; Morakchi-Goudjil, H. and Sifi, K. (2021). Azadrirachtin-Based Insecticide: Overview, Risk Assessments and Future Directions. *Frontiers in Plant Science, https//doi.org/10.3389/fagro.2021.676208*

Lengai, G. M., Muthomi, J. W. and Mbega, E. R. (2020). Phytochemical activity and role of botanical pesticides in pest management for sustainable agricultural crop production. *Sci. Afr.* **7**, e00239

Martini, D.M.; Gershenzon, J. and Bohlmann, J. (2003). Induction of volatile Terpenes biosynthesis and Diurnal emission by methyl jasmonata in foliage of Norway spruce. *Plant physiology* **132**(3): 1556-1559.

Mathur, S.B. and Kongsdal, O. (2003). Common laboratory seed health testing method for dectecting fungi. Published by International seed testing Association, 8303 Bassersdorf, CH-Switzerland.

Muzemu, S.; Mvumi, B.M.; Nyirenda, S.O.M.; Sileshi, G.W.; Sola, P.; Chikukura, I.; Kamunula, J.F.; Belmain, S.R. and Stevenson, P.C. (2011). Pesticidal effects of indigenous plant extracts against rape aphids and

tomato red spider mites. *Afr. Crop Sci. Confer. Proc*. **10**:169-171.

Mvumi, C. and Maunda, P. R. (2018). Efficacy of lantana (*Lantana camara*) extract Application against aphids (*Brevicoryne brassicae*) in rape (*Brassica napus*) over varied periods of time. *African Journal of Biotechnology*, **17**(8): 249-254 DOI:10.5897/AJB2017.16160

Nawaz, M. and Mabubu, J. H. H. (2016). Current status and advancement of biopesticides: microbial and botanical pesticides. *J. Entomol. Zool. Stud.,* v4 pp. 241-246

Obdoni, B.O. and Ochuko, P.O. (2001). Phytochemical studies and comparative efficacy of the crude extracts of some Homostatic plants in Edo and Delta States of Nigeria. *Global J. Pure Appl. Sci.* **8**(2): 203-208.

Pearson, D. (1976). *The Chemical Analysis of Food*, 17th ed. Churchill Livingstone, London, 3-

Salako, E. A. (2008). A review of neem biopesticide Shadia utilization and challenges in central Nigeria.

Shah, F. M.; Razaq, M. and Hardy, C.W. (2019). Field evaluation of synthetic and neem- derived alternative insecticides in developing action thresholds against cauliflower pests. *Sci. Rep*. **9**(1): 1–13

Shannag, H.K.; Capinera, J.L. and Freihat, N.M. (2013). Use of neem-based insecticides against southern armyworm, *Spodoptera eridania* (Stoll) (Lepidoptera : Noctuidae) v9

Silva, M.S.; Broglio, S.M.F.; Trindade, R.C.P.; Ferrreira, E.S.; Gomes, I.B. and Micheletti, L.B. (2015). Toxicity and application of neem in fall armyworm *Comun. Sci*., 6. pp. 359-364, 10.14295/CS.v6i3.808

Stevenson, P.C.; Nyirenda, S.P.; Mvumi, B.M.; Sola, P.; Kamanula, J.F.; Sileshi, G.W. and Belmain, S.R. (2012). Pesticidal plants: A viable alternative insect pest management approach for resource-poor farming in Africa. In: O, Koul, GS, Dhaliwal S, Khokhar and Singh R (Eds.), botanicals in environment and food security, *Jodhpur*: Scientific Publishers, pp. 212-238.

Tulashie, S.K.; Boadu, E.K. and Dapaah, S. (2019). Plastic waste to fuel via pyrolysis: a key way to solving the severe plastic waste problem in *Ghana Therm. Sci. Eng. Prog*., 11, pp. 417-424, 10.1016/j.t

University of Jos Metrological Station (2020). Metrological Station Geography and Planning Department, Faculty of Environmental Science University of Jos, Jos Nigeria.

Van-Burden, T.P. and Robinson, W.C. (1981). Formation of complexes between protein and Tannin acid. *J Agric. Food Chem*. **1**:77.

Yang, H., Piao, X., Zhang, L., Song, S. and Xu, Y. (2018). Ginsenosides from the

stems and leaves of *Panax ginseng* show antifeedant activity against *Plutella xylostella* (Linnaeus). *Indan Crops Prododuction Journal* **124**: 412–417.

NJE Vol. 41(2): 80-91, 2025
Nigerian Journal of Entomology
Published by the Entomological Soc. of Nig.
www.esnjournal.com.ng
DOI.10.36108/NJE/5202/14.0260