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Bioinsecticidal Effect of Neem (*Azadirachta indica* A. Juss) Seed Oil on Some Cowpea (*Vigna unguiculata* L. Walp.) Field Insect Pests

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Abstract

Cowpea is one of the important sources of relatively cheap source of protein to poor families and fodder to farm animals in West Africa and insures food security to millions of people. This study aimed at evaluating the efficacy of neem seed oil for the management of field insect pests of cowpea. The research was conducted in two batches of experiments at the Teaching and Research Farm, Faculty of Agriculture, University of Maiduguri. Dried Neem seeds were shelled by pounding and then winnowed to separate the kernels from the shells. The kernels were ground into a fine powder using a mortar and pestle, then sieved through a 180µm mesh. The powder was mixed with cold water and kneaded by hand until oil started to ooze out. The oil was then filtered and kept in a tight bottle until used for the experiment, 5ml/1litre of water was used for the application. The treatments were laid out in a split plot design replicated three times. Four cowpea varieties were allocated to the main plot factors and three (3) insecticidal treatments were also used as the subplot factors in the experiment. The neem seed oil was used at weekly intervals for the treatment of cowpea plants against insect pests. Sampling for insect pest infestations was done after each insecticide treatment once every week against insect pest which included foliage feeders (whiteflies and aphids), flower feeders (thrips) and pod borers (legume pod borer and pod sucking bugs). Results from this study revealed that there was no significant difference (P>0.05) between the efficacy of neem seed oil and that of cypermethrin insecticide. Thus, there was a significant reduction in insect pest's population which in turn increases the grain yield of cowpea.

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Hence, the aqueous neem seed extract could be a good substitute for synthetic insecticide in the management of insect pest of cowpea which could boost cowpea yield and ensuring food security.

Keywords: Cowpea; Cypermethrin; Insecticide; Neem seed oil

INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp.) is a major grain legume used as vegetables and pulses (Aryal *et al.,* 2021; Hamzavi *et al*., 2022; Manibharathi *et al*., 2024; and Nwagboso *et al*., 2024). The dried grains can be processed and fried to make cakes "*kosai*" or boiled to make "*moimoi*", or porridge (Onyibe *et al*., 2006) taken as meal. Cowpea constitutes a valuable source of food to livestock where supplementary feeding of 20 kg of cowpea haulms per day to young rams doubled their weight gain compared to feeding with sorghum stover (IITA, 2001 and Nwagboso *et al*., 2024).

Past research effort by the IITA has contributed to the release of cowpea varieties for different purposes in Africa (Boukar *et al*., 2018). Currently, improved varieties of cowpea have been developed by the International Institute of Tropical Agriculture (IITA); IT89KD-288, IT90K-822, IT97K-499-35, IT89KD-391 and IT99K-573-1-1 (Onyibe *et al*., 2006; Boukar *et al*., 2018) with the aim of improving productivity to meet up its demand by the consumers.

However, despite the importance of cowpea to man and national development, its cultivation is being faced with serious challenges of insect pests both in the field and in storage. Yield losses could be as high as 40% due to insect attack (Singh and Jackai, 1985) especially by myriad spectrum activities of arthropod pests in the field at different growth stages (Singh and Van dem, 1979). There are about 21 insect pests of different groups which are recorded to infest and damage cowpea crop from germination to maturity (Dhakal *et al.,* 2018). Insect pests attack cowpea both in the field and in stores. Omoigui *et al*. (2020) reported *Aphis craccivora* (Koch), bruchids (*Callosobruchus maculatus* (Fabricius)), beetles (*Ootheca mutabilis*), *Maruca* (*Maruca vitrata*), leafhoppers and foliage beetles as major field pests of cowpea. There is a need to use alternative methods for insect pest control to reduce the frequency of synthetic insecticides utilized for pest management (Prasannath and Mahendran, 2013; Aina, 2022), which has adverse effects on man and his environment. Although, total abandonment of chemicals insecticides might not be possible (Stern, 1973), however, its use needs to be minimal in consonance with other control measures so as to minimize its negative impact on man and the environment hence the concept of Integrated Pest Management (IPM) in which all available compatible effective techniques are developed in a unified programme, so that the pest populations can be maintained below the economic threshhold level.

Additionally, the cost of chemical insecticides is becoming increasingly inaccessible to farmers, particularly in developing countries (Gillett *et al*., 2009). This, together with the demand for contaminant-free food has fostered the search for alternative methods of control (Ekesi *et al*., 1998). Reports in the literature have shown that the use of some plant extracts such as Neem (*Azadirachta indica* A. Juss Fam. Meliaceae) have proven to be a promising alternative control measure (Schmutterer, 1990; Isirima *et al*., 2010; Ileke *et al*., 2020) on a wide range of insect pest groups, such as Lepidoptera, Diptera, Coleoptera, Homoptera and Hemiptera species (Sadre *et al*., 1983; Okrikata and Anaso, 2008). The increasing public concern over synthetic pesticide safety and possible adverse effect to environment has resulted in increasing attention being given to natural products for the management of insect

pests of cowpea. This study focuses on the evaluation of neem (*Azadirachta indica* A. Juss) seed extract for the management of some field insect pests of cowpea (*V. unguiculate).*

The study therefore, demonstrated that neem seed oil is as effective as the synthetic insecticide Cypermethrin in controlling key field insect pests of cowpea, including aphids, whiteflies, thrips, and pod borers. By providing empirical evidence of neem's efficacy, this research highlights a viable, eco-friendly, and cost-effective alternative to chemical pesticides, which is particularly beneficial for resource-limited farmers in developing regions. The study also underscores the potential of neem-based pest management in boosting cowpea yield, thereby contributing to food security while minimizing environmental and health risks associated with synthetic insecticides.

MATERIALS AND METHODS

Study Site

The research was conducted in two experiments in 2018, at the Teaching and Research Farm, Faculty of Agriculture, University of Maiduguri located at Latitude 11^{o} 15′ and Longitude 13^{o} 50′ in the Sahel Savanna agro-ecological zone of Nigeria (Dalorima *et al*., 2014).

Land Preparation and Experimental Design

The land was cleared, ploughed using Disc harrow and levelled manually using simple farm tools. The treatments were laid out in a split plot design replicated three times. Each replicate was made up of twenty treatment plots size of 3 m by 3 m, with inter-plots spacing of 0.5 m and alley of 1 m between replications was maintained. After marking out the plots, four cowpea varieties Kanannado, Borno Brown, IT288 and IT573 obtained from Borno State Agricultural Development Programme (BOSADP) Maiduguri were randomly allocated to the four blocks of the main plot factors while five insecticidal treatments regime were randomly used as the sub-plot factors in the experiment. Sowing was done on the 3rd week of July, 2018 cropping season and first week of December, 2018. Erect cowpea varieties were planted at a spacing of 50 cm between rows and 20 cm within rows. For semi-erect varieties, spacing was 75 cm between rows and 25–30 cm within rows. For prostrate varieties, planting was done at a spacing of 75 cm between rows and 50 cm within rows. For all recommended plant spacing, 3 seeds/hole were sown. Thinning to two stands was done at two weeks after planting as described by (Dugje *et al*., 2009 and Omoigui *et al*., 2020).

Source of Synthetic Pesticide and Preparation of Oil Neem *A. indica* Seed Extract

The synthetic pesticide (cypermethrin) was purchased from an Agro-pesticide store in Maiduguri. Mature neem seeds were collected under Neem trees within and outside the University of Maiduguri. The seeds were air-dried and all foreign materials removed to obtain the pure seed samples. The methods of preparation of neem extracts was chosen based on its simplicity, ease of adoption and convenience of use by the local farmers as described by (Anaso, 1999; Oluwole *et al*., 2015). The completely dried seeds were shelled by pounding to get clean kernels. The pound seeds were then subjected to winnowing to separate the seeds from the shells. Kernels were crushed in a mortar with pestle by pounding them to powder. Sieving of ground Neem seed to obtain fine particles was carried out using a mesh size of 180µm. The ground Neem seed powder were transferred into a bowl, and cold water was added a little at a time and kneaded with hand to form a dough and continuously kept kneading until oil starts oozing out from the dough (Anaso, 1999; Oluwole *et al*., 2015). The oil was then filtered and kept in a tight bottle until used for the experiment, 5ml/1litre of water was used for the application.

Application of Treatments
There were three treatments, each were replicated three times: neem seed oil, cypermethrin and the untreated control. Application of the neem seed oil treatments was done at weekly intervals. The cypermethrin treatment was applied according to manufacturer's instruction biweekly. Application of treatments commenced when insect pest infestation had already established on the cowpea crops. On each spraying occasion, all experimental units were treated in the same day. All plants in each subplot were sprayed until complete coverage or wetting was achieved. Weeding was done manually using fabricated simple hoe and all the treatments spraying was done using knapsack sprayer.

Sampling for Insect Pest Infestation
Sampling for insect pest infestations was done after each insecticide treatment once every week. Six randomly selected plants inside each plot were tagged for insect pests sampling. Insect pests found include: Foliage feeders (Whiteflies and Aphids), Flower feeders (Thrips) and Pod borers (Legume pod borer and Pod sucking bugs). All the insects were identified at the Department of Crop Protection, Faculty of Agriculture University of Maiduguri. Thrips sampling was carried out at flower bud initiation at flowering stage. Beginning from flower bud initiation to 50 % flowering, 10 flower buds were randomly collected from each subplot. The number of thrips in each flower was then counted and recorded (Oyewale *et al*., 2014). Observation on the aphid population was taken from the tagged plants on three leaves, each from top, middle and bottom of plants in each plot. Aphid population was counted and recorded (Roshan *et al*., 2018). Pod borer *M. vitrata* sampling was carried out between about 50 % flowering and first pod maturity. The legume pod borer was counted from the flowers and pods of plants on each of the randomly selected cowpea stand. Sampling was done in morning hours throughout the flowering and podding stage as described by Usman (2012). Pod-Sucking Bugs (PSBs) (*C. tomentosicollis*) infestation was carried out between the podding and the harvest stages. Visual counts of PSB species was made on rows of cowpea plants within the marked area in each subplot and then recorded for abundance (Oyewale *et al*., 2014).

Grain Yield (kg/ha) Assessment
The grain yield from each treatment was assessed after harvest. The harvested pods were sun dried and winnowed to obtain grains. The grains from each plot were weighed using a scale and recorded as weight of grain per plot. The grain yield in kg per hectare were calculated as; Grain yield (kg/ha) = Grain yield/net plot 10000 m^2 divided by net plot size (m^2).

Data Analysis
Data collected were computed and subjected to analysis of variance (ANOVA) using SPSS Statistic Package Version 21. Differences between means were determined using Tukey's Honestly Significance Difference (HDS) Test at 5% level of probability.

RESULTS
The results of the efficacy of the neem seed oil and cypermethrin are presented in Table 1. The results showed no significant difference ($P<0.05$) between insect pest's population (*M. sjostedti, M. vitrata* and *C. tomentosicollis*) in plots treated with neem extracts and cypermethrin (synthetic insecticide). However, insect pest's populations were significantly lower in plots treated with neem seed oil, cypermethrin than that of the control which had higher populations. Population reduction of insect pests observed all through the five weeks of the experiment in Kanannado variety had similar level of significances (Table 1).

Table 1**:** Mean number of insect pest population on kananando cowpea variety based on weeks

Insects	Insecticide	Week1	Week2	Week3	Week4	Week5
Thrips	NSO	47.00^{b}	22.33^{b}	19.33^{b}	12.00^{b}	7.33^{b}
	CYPER	36.00^{b}	16.00^{b}	8.67^{b}	11.33^{b}	6.67^{b}
	CTROL	85.33^{a}	101.67^{a}	111.33^{a}	98.67^{a}	112.67^{a}
	SE±	9.31	9.49	8.68	10.24	11.56
Maruca vitrata						
	NSO	16.33^{b}	6.33^{b}	6.00^{b}	8.33^{b}	5.67^{b}
	CYPER	13.33^{b}	13.00^{b}	3.00^{b}	0.67^{b}	2.33^{b}
	CTROL	29.67^{a}	33.00^{a}	36.00^{a}	43.00^{a}	56.00^{a}
	SE±	3.53	3.81	3.68	6.43	5.56
C.tomentosicollis						
	NSO	6.67^{b}	7.33^{b}	5.00^{b}	1.67^{b}	3.00^{b}
	CYPER	8.67^{b}	2.00^{b}	1.67^{b}	1.65^{b}	1.33^{b}
	CTROL	20.00^{a}	24.00^{a}	26.33^{a}	29.00^{a}	29.33^{a}
	SE±	2.28	2.52	3.47	3.66	1.89

Means in the same column (within species) followed by the same letters are not significantly different at 5% level of probability using Tukey's test.
Keys: NSO = Neem Seed Oil; CYPER = Cypermethrin and CTROL= Control

Effect of Neem seed oil and Cypermethrin insecticides on insect pest population in Borno Brown cowpea variety

The results showed no significant difference (P<0.05) between insect pest's population (*M. sjostedti, M. vitrata* and *C. tomentosicollis*) in plots treated with Neem seed oil and Cypermethrin (synthetic insecticide). However, there was a significant difference between insect pest's population in plots treated each with neem seed oil, Cypermethrin and that of the control. Similar trends of population reduction of insect pests were observed all through the five weeks of the experiment in Borno Brown variety (Table 2).

Table 2**.** Mean number of insect pest population on Borno Brown cowpea variety based on weeks

Insects	Insecticide	Week1	Week2	Week3	Week4	Week5
Thrips	NSO	28.00^{b}	28.00^{b}	16.33^{b}	7.33^{b}	6.00^{b}
	CYPER	44.00^{b}	10.33^{b}	13.33^{b}	10.67^{b}	5.33^{b}
	CONTROL	78.33^{a}	93.00^{a}	123.33^{a}	80.00^{a}	114.67^{a}
	SE±	8.65	7.15	8.51	13.93	10.14
Maruca vitrata						
	NSO	17.67^{b}	10.67^{b}	6.67^{b}	3.67^{b}	3.00^{b}
	CYPER	10.33^{b}	7.00^{b}	4.33^{b}	7.67^{b}	1.67^{b}
	CONTROL	31.00^{a}	29.00^{a}	37.00^{a}	47.33^{a}	55.67^{a}
	SE±	4.86	4.87	4.15	4.71	3.29
C.tomentosicollis						
	NSO	8.00^{b}	2.00^{b}	2.67^{b}	3.00^{b}	1.67^{b}
	CYPER	9.00^{b}	1.67^{b}	1.33^{b}	2.00^{b}	1.00^{b}
	CONTROL	25.33^{a}	30.33^{a}	25.67^{a}	34.67^{a}	20.67^{a}
	SE±	2.95	2.37	3.87	1.97	1.34

Means in the same column (within species) followed by the same letters are not significantly different at 5% level of probability.
Keys: NSO = Neem Seed Oil; CYPER = Cypermethrin and CTROL= Control

Effect of Neem seed oil and Cypermethrin insecticides on insect pest population on IT288 cowpea variety

The results showed no significant difference (P≥0.05) between insect pest's population (*M. sjostedti, M. vitrata* and *C. tomentosicollis*) in plots treated with Neem seed oil and Cypermethrin (synthetic insecticide). However, there was a significant (P≤0.05) difference between insect pest's population in plots treated with neem seed oil, Cypermethrin relative

to that of the control. Population reduction of the three insect pests species followed similar pattern all through the five weeks of the experiment in IT288 variety (Table 3).

Table 3. Mean number of insect pest population on IT288 cowpea variety based on weeks

Insects	Insecticide	Week1	Week2	Week3	Week4	Week5
Thrips	NSO	22.33^{b}	21.00^{b}	8.67^{b}	5.67^{b}	3.33^{b}
	CYPER	16.00^{b}	22.33^{b}	6.00^{b}	5.33^{b}	1.00^{b}
	CTROL	101.67^{a}	99.33^{a}	94.67^{a}	121.33^{a}	105.33^{a}
	SE±	9.49	6.87	5.22	9.21	12.64
Maruca vitrata						
	NSO	15.00^{b}	9.33^{b}	2.67^{b}	3.33^{b}	2.67^{b}
	CYPER	8.33^{b}	3.67^{b}	3.33^{b}	0.67^{b}	0.01^{b}
	CTROL	28.00^{a}	26.67^{a}	23.33^{a}	54.67^{a}	64.67^{a}
	SE±	3.68	5.88	6.96	4.01	4.15
C. tomentosicollis						
	NSO	6.00^{b}	3.33^{b}	3.67^{b}	4.00^{b}	1.33^{b}
	CYPER	9.33^{b}	5.67^{b}	0.67^{b}	3.33^{b}	0.67^{b}
	CTROL	20.00^{a}	27.00^{a}	25.33^{a}	22.00^{a}	19.33^{a}
	SE±	3.33	3.65	3.66	4.63	2.91

Means in the same column (within species) followed by the same letters are not significantly different at 5% level of probability using Tukey's test.
Keys: NSO = Neem Seed Oil; CYPER = Cypermethrin and CTROL= Control

Effect of Neem seed oil and Cypermethrin insecticides on insect pest population in IT573 cowpea variety

Effect of Neem seed oil and Cypermethrin insecticides on insect pest population in IT573 cowpea variety is presented in table 4. The results showed no significant difference (P≤0.05) between insect pest population (*M. sjostedti, M. vitrata* and *C. tomentosicollis*) in plots treated with Neem extract and Cypermethrin (synthetic insecticide). However, there was a significant difference between insect pests population in plots treated with neem seed oil and Cypermethrin compared to the control. This trend of population reduction of insect pests was observed all through the five weeks of the experiment in IT288 variety (Table 4).

Table 4**.** Mean number of insect pest population on IT573 cowpea variety based on weeks

INSECT	INSECTICIDES	WK1	WK2	WK3	WK4	WK5
Thrips	NSO	49.00^{b}	14.33^{b}	18.33^{b}	12.67^{b}	6.67^{b}
	CYPER	44.67^{b}	10.00^{b}	18.63^{b}	15.67^{b}	3.33^{b}
	CTROL	84.67^{a}	101.33^{a}	103.67^{a}	93.67^{a}	105.33^{a}
	SE±	9.87	5.43	8.57	11.19	8.64
Maruca vitrata						
	NSO	9.33^{b}	5.33^{b}	6.33^{b}	1.33^{b}	0.33^{b}
	CYPER	6.67^{b}	5.00^{b}	3.33^{b}	3.00^{b}	1.67^{b}
	CTROL	31.00^{a}	28.00^{a}	36.67^{a}	41.00^{a}	40.00^{a}
	SE±	4.61	4.83	3.87	4.45	9.24
C.tomentosicollis						
	NSO	9.00^{b}	1.33^{b}	2.67^{b}	3.33^{b}	1.00^{b}
	CYPER	6.00^{b}	1.67^{b}	3.67^{b}	0.67^{b}	0.12^{b}
	CTROL	18.33^{a}	17.33^{a}	28.00^{a}	34.00^{a}	26.00^{a}
	SE±	2.47	2.23	3.22	3.48	4.97

Means in the same column (within species) followed by the same letters are not significantly different at 5% level of probability using Tukey's test.
Keys: NSO = Neem Seed Oil; CYPER = Cypermethrin and CTROL= Control

Effect of variety on grain yield (kg/ha) of cowpea

The result showed significant (≤0.05) difference on the performance of the four cowpea varieties, (Kanannado, Borno Brown, IT288 and IT573) on the grain yield of cowpea. However, IT288 and IT573 varieties recorded higher grain yields compared to kanannado and Borno brown verities (Table 5).

Table 5**. Performance of the effect of variety on the grain yield of cowpea**

Cowpea Varieties	Yield (kg/ha)
Kanannado	0.7133[c]
BornoBrown	0.7800[bc]
IT573	1.2333[a]
IT288	1.0133[a]
SE±	0.1319

Means in the same column followed by the same letters are not significantly different at 5% level of probability using test.

Performance of grain yield (kg/ha) of cowpea at the end of the treatments

The grain yield of the four cowpea varieties under all the Neem extracts and the synthetic insecticides treatments were significantly higher over control. However, IT288 & IT573 varieties recorded highest grain yield compared to kanannado and Borno brown under all the treatments (Table 6).

Table 6**.** Performance of grain yield of cowpea at the end of the treatments

Table 4.6. Performance of grain yield of cowpea at the end of the treatments

Treatment	Cowpea Varieties (kg/ha)			
	Kanannado	BBrown	IT288	IT573
NSO	0.933[a]	0.867[a]	1.133[a]	1.400[a]
CYPER	0.867[a]	0.933[a]	1.200[a]	1.233[a]
CONTROL	0.300[b]	0.267[b]	0.433[b]	0.867[b]
SE±	0.253	0.272	0.370	0.268

Means in the same column followed by the same letters are not significantly different at 5% level of probability using Tukey's test.

Keys: NSO = Neem Seed Oil; CYPER = Cypermethrin and CTROL= Control

Assessment of Efficacy of Neem Seed Oil Against Field Insect Pests of Cowpea in the second experiment

Effect of insecticides on insect pest population on Kanannado cowpea variety

The results showed no significant difference (P<0.05) between insect pests population (*Aphis craccivora, Bemisia tabaci* and *Clavigralla tomentosicollis*) in plots treated with Neem seed oil and Cypermethrin (synthetic insecticide). However, there was a significant difference between insect pests population in plots treated with neem seed oil, Cypermethrin and that of the control. Similar trends of population reduction of insect pests were observed all through the five weeks of the experiment in Kanannado variety (Table 7).

Table 7**:** Mean number of insect pest population on Kanannado cowpea variety based on weeks

Insects	INSECTICIDES	WK1	WK2	WK3	WK4	WK5
Aphids	NSO	82.33^{b}	21.67^{b}	12.33^{b}	10.00^{b}	6.67^{b}
	CYPER	63.33^{b}	18.00^{b}	20.00^{b}	17.67^{b}	12.00^{b}
	CTROL	122.67^{a}	124.00^{a}	122.00^{a}	89.62^{a}	107.00^{a}
	SE±	10.67	9.26	13.26	12.62	17.83
Whiteflies	NSO	27.33^{cd}	7.76^{b}	12.33^{b}	4.67^{b}	3.67^{b}
	CYPER	22.33^{d}	6.67^{b}	8.33^{b}	7.00^{b}	8.67^{b}
	CTROL	40.00^{a}	38.67^{a}	49.33^{a}	42.33^{a}	44.33^{a}
	SE±	3.09	3.08	4.48	5.46	5.01
C.tomentosicollis	NSO	11.00^{b}	7.00^{b}	5.67^{b}	4.67^{b}	2.00^{b}
	CYPER	9.00^{b}	7.76^{b}	1.33^{b}	1.33^{b}	0.67^{b}
	CTROL	22.33^{a}	15.67^{a}	16.33^{a}	17.67^{a}	15.67^{a}
	SE±	1.93	3.06	2.56	2.35	2.22

Means in the same column (within species) followed by the same letters are not significantly different at 5% level of probability using Tukey's test.
Keys: NSO = Neem Seed Oil; CYPER = Cypermethrin and CTROL= Control

Effect of insecticides on insect pest population on Borno Brown cowpea variety

The results showed no significant difference (P<0.05) between insect pests population (*Aphis craccivora, Bemisia tabaci* and *Clavigralla tomentosicollis*) in plots treated with Neem seed oil and Cypermethrin (synthetic insecticide). However, there was a significant difference between insect pests population in plots treated with neem seed oil, Cypermethrin and that of the control. Similar trends of population reduction of insect pests were observed all through the five weeks of the experiment in Borno Brown variety (Table 8).

Table 8. Mean number of insect pest population on Borno Brown cowpea variety based on weeks

INSECT	INSECTICIDES	WK1	WK2	WK3	WK4	WK5
Aphids						
	NSO	45.67^{b}	21.00^{b}	10.33^{b}	10.33^{b}	5.00^{b}
	CYPER	61.67^{b}	9.33^{b}	17.33^{b}	20.33^{b}	22.67^{b}
	CTROL	93.67^{a}	115.00^{a}	124.00^{a}	97.00^{a}	90.00^{a}
	SE±	12.57	10.02	6.87	10.15	
Whiteflies						
	NSO	30.67^{b}	9.00^{b}	4.33^{b}	6.33^{b}	6.67^{b}
	CYPER	19.67^{b}	4.67^{b}	7.67^{b}	6.00^{b}	7.00^{b}
	CTROL	47.67^{a}	36.67^{a}	57.33^{a}	56.33^{a}	46.00^{a}
	SE±	7.15	3.63	6.63	5.85	5.37
C.tomantosicollis						
	NSO	5.33^{b}	4.67^{b}	5.67^{b}	2.00^{b}	0.33^{b}
	CYPER	9.67^{b}	3.67^{b}	4.00^{b}	1.33^{b}	1.00^{bc}
	CTROL	12.67^{a}	10.67^{a}	13.33^{a}	14.33^{a}	11.00^{a}
	SE±	5.44	1.94	2.80	2.67	0.97

Means in the same column (within species) followed by the same letters are not significantly different at 5% level of probability using Tukey's test.
Keys: NSO = Neem Seed Oil; CYPER = Cypermethrin and CTROL= Control

Effect of insecticides on insect pest population on IT288 cowpea variety

The results showed no significant difference (P<0.05) between insect pests population (*Aphis craccivora, Bemisia tabaci* and *Clavigralla tomentosicollis*) in plots treated with Neem seed oil and Cypermethrin (synthetic insecticide). However, there was a significant difference between insect pests population in plots treated with neem seed oil, Cypermethrin and that of the control. Similar trends of population reduction of insect pests were observed all through the five weeks of the experiment in IT288 variety (Table 9).

Table 9: Mean number of insect pest population on IT288 cowpea variety based on weeks

Insects	INSECTICIDES	WK1	WK2	WK3	WK4	WK5
Aphids	NSO	117.33^{b}	26.67^{b}	13.33^{b}	11.33^{b}	7.67^{b}
	CYPER	78.67^{b}	11.67^{b}	23.67^{b}	24.33^{b}	19.00^{b}
	CTROL	129.33^{a}	107.67^{a}	130.00^{a}	130.33^{a}	123.33^{a}
	SE±	12.39	6.67	7.75	3.88	7.67
Whiteflies						
	NSO	30.33^{b}	6.67^{b}	10.67^{b}	4.67^{b}	5.00^{b}
	CYPER	27.33^{b}	10.00^{b}	7.33^{b}	4.67^{b}	4.33^{b}
	CTROL	53.33^{a}	40.00^{a}	42.33^{a}	53.33^{b}	43.00^{a}
	SE±	6.03		2.52	5.64	2.52
C.tomantosicollis						
	NSO	12.67^{b}	4.33^{b}	4.00^{b}	7.67^{b}	2.33^{b}
	CYPER	17.33^{b}	6.00^{b}	2.33^{b}	3.33^{b}	0.00^{b}
	CTROL	11.00^{a}	13.00^{a}	16.33^{a}	16.00^{a}	14.00^{a}
	SE±	4.71	1.46	2.51	2.49	1.56

Means in the same column (within species) followed by the same letters are not significantly different at 5% level of probability using Tukey's test.
Keys: NSO = Neem Seed Oil; CYPER = Cypermethrin and CTROL= Control

Effect of insecticides on insect pest population on IT573 cowpea variety

The results showed no significant difference (P<0.05) between insect pests population (*Aphis craccivora, Bemisia tabaci* and *Clavigralla tomentosicollis*) in plots treated with Neem seed oil and Cypermethrin (synthetic insecticide). However, there was a significant difference between insect pests population in plots treated with neem seed oil, Cypermethrin and that of the control. Similar trends of population reduction of insect pests were observed all through the five weeks of the experiment in IT573 variety (Table 10).

Table 10. Mean number of insect pest population on IT573 cowpea variety based on weeks

Insects	INSECTICIDES	WK1	WK2	WK3	WK4	WK5
Aphids	NSO	80.00^{b}	21.67^{b}	12.00^{b}	10.00^{b}	5.00^{b}
	CYPER	68.33^{b}	11.67^{b}	17.67^{b}	19.00^{b}	22.67^{b}
	CTROL	110.67^{a}	102.00^{a}	104.33^{a}	94.33^{a}	90.00^{a}
	SE±	15.73	8.26	15.39	6.44	15.19
Whiteflies						
	NSO	28.00^{b}	9.00^{bc}	4.67^{b}	3.67^{b}	4.67^{b}
	CYPER	22.67^{b}	10.00^{b}	8.67^{b}	4.67^{b}	2.67^{b}
	CTROL	49.00^{a}	49.00^{a}	33.67^{a}	37.33^{a}	45.00^{a}
	SE±	4.32	4.36		5.64	5.09
C.tomentosicolli						
	NSO	5.00^{b}	2.33^{b}	4.67^{b}	2.00^{b}	0.33^{b}
	CYPER	4.33^{b}	3.33^{b}	1.33^{b}	1.33^{b}	1.67^{b}
	CTROL	24.33^{a}	11.33^{a}	13.67^{a}	14.67^{a}	18.67^{a}
	SE±	4.01	2.47	1.46	3.72	1.65

Means in the same column (within species) followed by the same letters are not significantly different at 5% level of probability using Tukey's test.
Keys: NSO = Neem Seed Oil; CYPER = Cypermethrin and CTROL= Control

Effect of variety on grain yield (kg/ha) of cowpea

The result showed significant difference on the performance of the four cowpea varieties, (Kanannado, Borno Brown, IT288 and IT573) on the grain yield of cowpea. However, IT288 and IT573 varieties recorded highest grain yield compared to kanannado and B-brown (Table 11).

Table 11**. Performance of the effect of variety on the grain yield of cowpea**

Cowpea Varieties	Yield (kg/ha)
Kananando	0.2800[c]
BornoBrown	0.5133[c]
IT573	1.2133[a]
IT288	1.5200[a]
SE±	0.589

Means in the same column followed by the same letters are not significantly different at 5% level of probability using Tukey's test.

Measurement of performance of grain yield (kg/ha) of cowpea at the end of treatments

The grain yield of the four cowpea varieties under all the Neem seed oil and the synthetic insecticides treatments were significantly higher over control. However, IT288 and IT573 recorded the highest grain yield compared to Kanannado and Borno brown under all the treatments (Table 4.12).

Table 12**.** Performance of grain yield of cowpea at the end of the treatments

Treatment	**Cowpea Varieties** (kg/ha)			
	Kanannado	BBrown	IT288	IT573
NSO	0.400[a]	0.533[a]	0.767[a]	0.967[a]
CYPER	0.233[a]	0.233[a]	0.800[a]	0.900[a]
CONTROL	0.100[b]	0.100[b]	0.300[b]	0.200[b]
SE±	0.132	0.109	0.149	0.132

Means in the same column followed by the same letters are not significantly different at 5% level of probability using Tukey's test.
Keys: NSO = Neem Seed Oil; CYPER = Cypermethrin and CTROL= Control

DISCUSSION

This study focused on some common field insect pests of cowpea crops in Maiduguri, arid zone of Nigeria. The commonly identified pests groups included thrips, *maruca*, aphids, whiteflies and pod sucking bugs all attacking the crop at different stages of growth. The common occurrence of these pests agrees with the earlier reported that Thrips, *Maruca vitrata* and pod sucking bug (PSB) are the most important insect pests of cowpea in Nigeria (Amatobi1995; Kyamanyawa, 1996; Karungi *et al*., 2000; Dzemo *et al*., 2010 and Omoigui *et al*., 2020).

Findings from this study revealed that Neem seed oil was effective in the management of insect pests of cowpea. This concurred with FAO/TECA, (2012); Sanusi and Ibrahim, (2024); and Bagamla *et al*., (2024) where neem, pawpaw and mint species were found to be effective on both *maruca* and other pests like thrips with neem having better results. Sadre *et al*. (1983) also reported similar trend on the insecticidal effect of neem on several insect groups including Lepidoptera, Diptera, Coleoptera, Homoptera and Hemiptera species. A Study by Obeng-Ofori, and Sackey, (2003) also demonstrated the efficacy of actellic, neem extracts and *Bacillus thuringiensis* (Bt) against major insect pests of okra in Ghana. These products caused

significant reduction in the numbers of insect pests collected on treated plants. It is significant to note that as much as 46% fruit damage was recorded on fruit harvested from untreated plants compared to less than 3% on Neem-treated plants. This suggested promising potential for the use of neem products and Bt to manage pests of okra in Ghana. It is encouraging that many farmers are rapidly adopting the use of crude Neem extracts in a variety of crop production systems in Ghana including cereals, legumes and vegetables.

Applications of both synthetic Cypermethrin and Neem seed oil have worked effectively on the insect pests population reduction. This study, however, has shown no significant difference between the synthetic Cypermethrin and Neem seed oil. The ability of Neem application to obtain high reduction of *M. vitrata* populations similar to that of the synthetic insecticides was an indication of the potential of Neem as a possible control option against damage by insect pests in cowpea. The overall effectiveness of the botanicals and the synthetic insecticides also agrees with the findings of Seshu Reddy, (1988); Mailu, (1997); Asawalam *et al., (*2007); Okrikata and Anaso, (2008); Wakawa, (2013); Jahan *et al*., (2019): Parajuli *et al*., (2020) and Ileke *et al*., (2020) who all reported that botanicals gave similar and sometimes even better level of control when compared with synthetic insecticides. However, these results contradict earlier reports by Agona *et al*., (2001, 2002) where synthetics were found to be more effective than the botanical pesticides.

The results from the present study showed the effectiveness of neem seed oil formulation against the reduction in population of field insect pest of cowpea. Neem seed extracts-based formulations have been reported to give significant reduction against green peach aphid on pepper, current lettuce aphid on lettuce and strawberry aphids on strawberry with LC_{50} values ranging from 0.2 to 1.4% (Lowery *et al.,* 1993; Adnan *et al.,* 2014 and Canarte-Bermudez *et al*., 2020, Aina, 2022). Ganda *et al*., (2018) also reported that, infestations of cotton leaves by larvae of *S. derogata* were reduced by neem oil spray in the field. The present study also showed that neem seed oil formulation was as effective as aqueous neem seed formulation in reducing field insect pests of cowpea populations. Previous works also points out that Neem oil and various additives were successfully employed in management of the sucking pests. Roy and Gurusubramanian (2011) reported that application of Neem formulation to tea plants provided more than 75% reduction of three sucking pests.

The results have shown that significant reduction in insect pest's population increases the grain yield of cowpea in the two experiments. This is observed when compared with the control which produces less. Application of Neem seed oil and the synthetic pesticides have protected plants and consequently resulted to high yield in grains of treated plants than the control. However, IT288 & IT573 varieties recorded highest grain yield in two experiments compared to kanannado and B-brown under all the treatments. Similar result was reported by Dalorima, *et al*. (2014), that improved varieties had significantly higher grain yield (kg/ha), compared to local varieties in this agroecological zone. Moreover, higher grain yield was obtained in the control of IT288 & IT573 compared to kanannado and Bbrown. This suggests that of IT288 & IT573 performed better than the local varieties (kanannado and Bbrown). The efficacy of the neem seed oil could be attributed to the presence of phytochemicals which includes azadirachtin, gedunin, nimbin, azaridione and epoxy of azaridione, all of which are environmentally safe, making Neem suitable for ecologically based crop protection strategies against insect pest of cowpea (Sharma and Singh, 2014).

CONCLUSION

This study portrayed that neem seed oil could serve as a good bio-insecticide, since its efficacy is significantly the same when compared to cypermethrin, a known insecticide for the treatment of cowpea related insects. Since both treatments performed well compared to the non-treated control. Thus, neem seed oil, having greater potential as an insecticide, can be a substitute to synthetic insecticides by farmers in the management of crop pests. The local abundance of the tree in the sub-region is an added advantage and will ensure food security.

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