



## Research Article

# Comparative Evaluation of Neem Seed Extract as Bio-insecticide for the Control of Three Field Insect Pests of Cowpea in Maiduguri, Borno State, Arid Zone of Nigeria

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### ABSTRACT

Cowpea *Vigna unguiculata* is an important source of nutritious food for man for healthy living and provides fodder to the animal for optimum production and grows in the ecological part of Nigeria. However, despite its importance to man and national development, its main cultivation challenge is insect pests which sometimes account for as high as 40 % loss in production. The continuous use of conventional insecticides to control pests is resulting in unbearable health hazards, hence the need for alternative control measures such as the use of botanicals. This study evaluated the efficacy of neem seed extract biopesticide compared to cypermethrin synthetic insecticide for the management of *Thrips*, *Maruca vitrata* and *Clavigralla tomentosicollis* on cowpea varieties in Maiduguri, Borno State of Nigeria. The neem seed extract was extracted following standard procedures and used as a treatment alongside cypermethrin against the three pests at weekly intervals on four cowpea varieties. Pest population buildup was monitored for five weeks on treated and untreated (control) crops beginning from 24 hours after each treatment on weekly bases. The result revealed a significant reduction ( $P>0.05$ ) in the population buildup of the three pests on both neem seed oil and cypermethrin-treated crops compared to the control. No significant difference ( $P>0.05$ ) in population reduction was observed between crops treated with neem seed extract and Cypermethrin. Consequently, there was a significant increase in the grain yield of cowpea on treated plots compared to untreated plots. The neem seed extract has demonstrated a high potential substitute for synthetic insecticide to control the three insect pests.

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## INTRODUCTION

Cowpea (*Vigna unguiculata*) is among the major leguminous grain used as food sources in most parts of Africa and especially Nigeria, and constitutes a valuable source of food to man and livestock (IITA, 2001; Aryal *et al.*, 2021). The dried grains can be processed into different forms of meal for different purposes such as cake making, porridge and soup which can be taken a meal (Onyibe *et al.*, 2006; Boukar *et al.*, 2018). Currently, improved varieties of cowpea have been produced by the International Institute of Tropical Agriculture (IITA) to include; IT89KD-288, IT90K-822, IT97K-499-35, IT89KD-391 and IT99K-573-1-1 (Onyibe *et al.*, 2006; Boukar *et al.*, 2018) to improve productivity to meet up its demand. However, despite the importance of cowpea to man and national development, their cultivation is being faced with serious challenges insects attach both in the field and storage. Yield losses due to insect infestation have been estimated to be as high as 40 % in some regions of Africa especially in the field at different growth stages (Singh and Van dem, 1979; Singh and Jackai, 1985). There are more than 20 insect pest groups which have been reported on cowpea crops or recorded damaging cowpea crops both in the field and in stores (Dhakal *et al.*, 2018; Omoigui *et al.*, 2020) which include among others Aphids, Bruchids, Maruca, leafhoppers and some foliage beetles.

Currently, the main control strategy for insect pests of cowpea is the use of synthetic chemical insecticides. However, the increasing public concern over pesticide safety and possible damage to the environment has resulted in increased attention being given to natural products for the management of insect pests of cowpea. The application of various synthetic insecticides has led to several problems related to environmental pollution,

health hazards due to pesticide residues in food grains, insecticide resistance and toxicity to non-target organisms. Additionally, chemical insecticides are not easily affordable due to their high cost of procurement; particularly in developing countries, such as Nigeria. Therefore, there are strong advocates for alternative control measure that is eco-friendly to reduce the frequency of the use of synthetic insecticides (Prasannath and Mahendran, 2013). Although, total abandonment of synthetic chemicals might not be possible (Stern, 1973), however, its use needs to be reduced to a minimal level in consonance with other control measures to minimize their negative impact on both man and the environment hence the concept of Integrated Pest Management (IPM) in which all available effective techniques are developed in a unified programme, so that the pest populations can be managed properly. Additionally, the fact that the cost of chemical insecticides is becoming increasingly inaccessible to farmers (Gillett *et al.*, 2009), together with the demand for contaminant-free food has fostered the search for alternative methods of control (Ekesi *et al.*, 1998). Considerable literature has shown that the use of botanical insecticides such as neem products seems to be a promising alternative control measure (Schmutterer, 1990; Isirima *et al.*, 2010) on a wide range of insect pest groups, (Sadre *et al.*, 1983; Okrikata and Anaso, 2008), however, information on its activities on cowpea pests seems to be very scarce. This study was carried out to investigate the efficacy of neem seed oil extract as an alternative pesticide to cypermethrin for the management of *Thrips*, *Maruca vitrata* and *Clavigralla tomentosicollis* on some cowpea varieties in Maiduguri, Northeast arid zone of Nigeria.

## MATERIALS AND METHODS

### Study Site

The study was conducted at the Teaching and Research Farm, Faculty of Agriculture, University of Maiduguri (Latitude 11° 15' and Longitude 13° 50') in the Sahel Savanna agroecological zone of Nigeria (Dakorima *et al.*, 2014).

### Land Preparation and Experimental Design

Land preparation was carried out following standard agricultural operation procedures as described by Dugje *et al.*, (2009) and Omoigui *et al.*, (2020) from the pre-planting to the harvesting stage.

The experimental plots were laid out in a split-plot design and replicated three times. Each plot was made up of twenty sub-plots size 3 m by 3 m, with an inter-plots spacing of 0.5 m and an alley of 1 m between replications. After marking out the plots, four cowpea varieties (Kanannado, BornoBrown, IT288 & IT573) were obtained from Borno State Agricultural Development Programme (BOSADP). They were allocated to the main plot factors alternating with each other. The varieties were randomly allocated to each plot. The planting of seeds was done following the standard recommended spacing. 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 while for prostrate varieties, planting was done at a spacing of 75 cm between rows and 50 cm within rows. Thinning to two stands was done two weeks after planting as described by (Dugje *et al.*, 2009 and Omoigui *et al.*, 2020).

### Preparation and application of treatment materials

Freshly fallen Neem seeds were collected on the ground under Neem trees at the University of Maiduguri. The seeds were air-dried in a normal room and all foreign materials were removed to obtain the pure seed sample. The

methods of preparation of Neem extracts were chosen based on the simplicity of adoption and convenience of use by the local farmers as described by (Anaso, 1999; Oluwole *et al.*, 2015). Dried Neem seeds were blended into a pulverized mass and 250 g was measured into a container for the extraction of the neem seed extract. Five litres of distilled water was added and stirred vigorously for one minute and left to stand overnight (about 12 hours). The mixture was filtered with a muslin cloth and the filtrate obtained was the aqueous neem seed extract used for application (Prasannath and Mahendran, 2013).

The Cypermethrin insecticide was purchased from an Agricultural store in Maiduguri and the application was done according to the manufacturer's instructions. Application of the Neem treatments was done at weekly intervals; following the assertion that Neem extracts are highly biodegradable compared to synthetic insecticides (Anaso, 2006) while Cypermethrin treatment was applied biweekly. Application of treatments commenced when insect pest infestation had already been established on the cowpea crops. On each spraying occasion, all experimental units were treated between 6:00 – 6:30 am and 6:00 – 6:30 pm each day while the counting of pest population took place 24 hours after treatment. All plants in each subplot were sprayed with one insecticide treatment until complete coverage or wetting was achieved using a handheld knapsack sprayer.

### Sampling for Insect Pest Infestation and population count

Sampling for insect pest infestations was done after each insecticide treatment once a week. Six randomly selected cowpea varieties inside each plot were tagged for a sampling of foliage feeders (Whiteflies and Aphids), flower feeders (Thrips) and Pod borers (Legume pod borer and Pod sucking bugs). All the insects were identified following

standard methods (Oyewale *et al.*, 2014; Roshan *et al.*, 2018).

Thrips sampling was carried out at flower bud initiation at the 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 using a hand lens and recorded following the method of Oyewale *et al.*, (2014). A sampling of population buildup was taken from the tagged plants on three leaves, each from the top, middle and bottom of plants in each plot. Each population was counted and recorded as described by Roshan *et al.*, (2018). *Maruca vitrata* pest sampling was carried out on 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 stands. Sampling was done in the morning hours throughout the flowering and podding stage as described by Usman, (2012). Pod-Sucking Bug (*Clavigralla tomentosicollis*) infestation was carried out between the podding and the harvest stages. Visual counts of Pod Sucking Bugs species were made on rows of cowpea plants within the marked area in each subplot and then recorded for abundance (Oyewale *et al.*, 2014).

#### **Data Analysis**

Data collected were analyzed using SPSS Statistic Package Version 21. The mean

comparison was subjected to an Analysis of Variance (ANOVA). The differences between the means were determined by Turkey's Test.

#### **RESULTS AND DISCUSSION**

##### **Effect of treatments on insect pest population on different varieties of cowpea**

Overall, findings from this study revealed that Neem extracts just like cypermethrin exhibited a significant effect ( $P > 0.05$ ) in the management of the insect pest of cowpea. From Table 1- 4, it can be observed that both the cypermethrin and neem extracts had a similar effect on controlling the population buildup of Thrips, *M. vitrata* and *C. tomentosicollis* with a significant decrease of population buildup on all the cowpea varieties all through the study period. This observation is in concordance with several works which reported that Neem extracts appear to have strongly inhibited the feeding activity of some insect pests after application (FAO, 2012) where Neem plant products were found to be effective on both *Maruca* and Thrips attacks. It is also in agreement with the report of Sadre *et al.* (1983) and Ofori, and Sackey, (2003) who also reported that neem products were found to be effective against Lepidoptera, Diptera, Coleoptera, Homoptera and Hemiptera pests on okro vegetable. Of more interesting, this study showed no significant difference between the use of Cypermethrin and neem seed oil extracts in terms of performance (Table 1- 4).

**Table 1:** Mean number of insect pest population on *kamado* cowpea variety

Insects	Insecticide	Week1	Week2	Week3	Week4	Week5
<b>Thrips</b>	ANSE	48.00 <sup>b</sup>	33.33 <sup>b</sup>	10.67 <sup>b</sup>	9.00 <sup>b</sup>	7.33 <sup>b</sup>
	CYPER	30.00 <sup>b</sup>	28.00 <sup>b</sup>	8.67 <sup>b</sup>	11.33 <sup>b</sup>	6.67 <sup>b</sup>
	CTROL	85.33 <sup>a</sup>	101.67 <sup>a</sup>	111.33 <sup>a</sup>	98.67 <sup>a</sup>	112.67 <sup>a</sup>
	SE±	9.31	9.49	8.68	10.24	11.56
<i>Maruca vitrata</i>	ANSE	10.67 <sup>b</sup>	11.00 <sup>b</sup>	3.67 <sup>b</sup>	9.00 <sup>b</sup>	7.33 <sup>b</sup>
	CYPER	13.33 <sup>b</sup>	13.00 <sup>b</sup>	6.00 <sup>b</sup>	0.67 <sup>c</sup>	2.33 <sup>c</sup>
	CTROL	29.67 <sup>a</sup>	33.00 <sup>a</sup>	36.00 <sup>a</sup>	43.00 <sup>a</sup>	56.00 <sup>a</sup>
	SE±	3.53	3.81	3.68	6.43	5.56
<i>C. tomentosicollis</i>	ANSE	7.00 <sup>b</sup>	4.00 <sup>b</sup>	1.33 <sup>b</sup>	2.67 <sup>b</sup>	0.00 <sup>b</sup>
	CYPER	8.67 <sup>b</sup>	2.00 <sup>b</sup>	1.67 <sup>b</sup>	1.65 <sup>b</sup>	1.33 <sup>b</sup>
	CTROL	20.00 <sup>a</sup>	24.00 <sup>a</sup>	26.33 <sup>a</sup>	29.00 <sup>a</sup>	29.33 <sup>a</sup>
	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: ANSE = Aqueous neem seed extract; CYPER = Cypermethrin and CTROL= Control

**Table 2:** Mean number of insect pest population on *Borno Brown* cowpea variety

Insects	Insecticide	Week1	Week2	Week3	Week4	Week5
<b>Thrips</b>	ANSE	48.00 <sup>b</sup>	26.00 <sup>bc</sup>	14.67 <sup>b</sup>	19.33 <sup>b</sup>	8.67 <sup>b</sup>
	CYPER	18.00 <sup>c</sup>	10.33 <sup>b</sup>	13.33 <sup>b</sup>	10.67 <sup>b</sup>	5.33 <sup>b</sup>
	CONTROL	78.33 <sup>a</sup>	93.00 <sup>a</sup>	123.33 <sup>a</sup>	80.00 <sup>a</sup>	114.67 <sup>a</sup>
	SE±	8.65	7.15	8.51	13.93	10.14
<i>Maruca vitrata</i>	ANSE	13.33 <sup>b</sup>	12.67 <sup>b</sup>	6.33 <sup>b</sup>	5.67 <sup>b</sup>	6.00 <sup>b</sup>
	CYPER	10.33 <sup>b</sup>	7.00 <sup>c</sup>	4.33 <sup>b</sup>	7.67 <sup>b</sup>	1.67 <sup>b</sup>
	CONTROL	31.00 <sup>a</sup>	29.00 <sup>a</sup>	37.00 <sup>a</sup>	47.33 <sup>a</sup>	55.67 <sup>a</sup>
	SE±	4.86	4.87	4.15	4.71	3.29
<i>C. tomentosicollis</i>	ANSE	9.00 <sup>b</sup>	4.33 <sup>b</sup>	3.33 <sup>b</sup>	1.67 <sup>b</sup>	1.00 <sup>b</sup>
	CYPER	4.00 <sup>c</sup>	1.67 <sup>c</sup>	1.33 <sup>b</sup>	2.00 <sup>b</sup>	1.00 <sup>b</sup>
	CONTROL	25.33 <sup>a</sup>	30.33 <sup>a</sup>	25.67 <sup>a</sup>	34.67 <sup>a</sup>	20.67 <sup>a</sup>
	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: ANSE = Aqueous neem seed extract; CYPER = Cypermethrin and CTROL= Control

**Table 3:** Mean number of insect pest population on *IT288* cowpea variety

Insects	Insecticide	Week1	Week2	Week3	Week4	Week5
<b>Thrips</b>	ANSE	33.33 <sup>b</sup>	21.00 <sup>b</sup>	12.33 <sup>b</sup>	4.67 <sup>b</sup>	2.00 <sup>b</sup>
	CYPER	16.00 <sup>b</sup>	22.33 <sup>b</sup>	9.00 <sup>b</sup>	5.33 <sup>b</sup>	1.00 <sup>b</sup>
	CTROL	101.67 <sup>a</sup>	99.33 <sup>a</sup>	94.67 <sup>a</sup>	121.33 <sup>a</sup>	105.33 <sup>a</sup>
	SE±	9.49	6.87	5.22	9.21	12.64
<i>Maruca vitrata</i>	ANSE	10.33 <sup>b</sup>	10.33 <sup>b</sup>	6.67 <sup>b</sup>	2.67 <sup>b</sup>	1.67 <sup>b</sup>
	CYPER	8.33 <sup>b</sup>	3.67 <sup>bc</sup>	3.33 <sup>bc</sup>	0.67 <sup>bc</sup>	0.01 <sup>bc</sup>
	CTROL	28.00 <sup>a</sup>	26.67 <sup>a</sup>	23.33 <sup>a</sup>	54.67 <sup>a</sup>	64.67 <sup>a</sup>
	SE±	3.68	5.88	6.96	4.01	4.15
<i>C. tomentosicollis</i>	ANSE	9.67 <sup>b</sup>	4.33 <sup>b</sup>	4.67 <sup>b</sup>	2.66 <sup>b</sup>	2.33 <sup>b</sup>
	CYPER	9.33 <sup>b</sup>	5.67 <sup>b</sup>	0.67 <sup>b</sup>	3.33 <sup>b</sup>	0.67 <sup>b</sup>
	CTROL	20.00 <sup>a</sup>	27.00 <sup>a</sup>	25.33 <sup>a</sup>	22.00 <sup>a</sup>	19.33 <sup>a</sup>
	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: ANSE = Aqueous neem seed extract; CYPER = Cypermethrin and CTROL= Control

**Table 4:** Mean number of insect pest population on *IT573* cowpea variety

INSECT	INSECTICIDES	WK1	WK2	WK3	WK4	WK5
<b>Thrips</b>	ANSE	44.33 <sup>b</sup>	17.33 <sup>b</sup>	15.00 <sup>b</sup>	10.00 <sup>b</sup>	10.33 <sup>b</sup>
	CYPER	37.67 <sup>b</sup>	13.00 <sup>b</sup>	18.63 <sup>b</sup>	15.67 <sup>b</sup>	3.33 <sup>bc</sup>
	CTROL	84.67 <sup>a</sup>	101.33 <sup>a</sup>	103.67 <sup>a</sup>	93.67 <sup>a</sup>	105.33 <sup>a</sup>
	SE±	9.87	5.43	8.57	11.19	8.64
<i>Maruca vitrata</i>	ANSE	6.33 <sup>b</sup>	7.67 <sup>b</sup>	3.00 <sup>b</sup>	2.33 <sup>b</sup>	3.67 <sup>b</sup>
	CYPER	1.67 <sup>c</sup>	3.00 <sup>c</sup>	3.33 <sup>b</sup>	3.00 <sup>b</sup>	1.67 <sup>bc</sup>
	CTROL	31.00 <sup>a</sup>	28.00 <sup>a</sup>	36.67 <sup>a</sup>	41.00 <sup>a</sup>	40.00 <sup>a</sup>
	SE±	4.61	4.83	3.87	4.45	9.24
<i>C. tomentosicollis</i>	ANSE	9.00 <sup>b</sup>	4.67 <sup>b</sup>	1.67 <sup>bc</sup>	1.00 <sup>b</sup>	0.33 <sup>b</sup>
	CYPER	6.00 <sup>b</sup>	1.67 <sup>bc</sup>	3.67 <sup>b</sup>	0.67 <sup>bc</sup>	0.12 <sup>b</sup>
	CTROL	18.33 <sup>a</sup>	17.33 <sup>a</sup>	28.00 <sup>a</sup>	34.00 <sup>a</sup>	26.00 <sup>a</sup>
	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 Turkey’s test. Keys: ANSE = Aqueous neem seed extract; CYPER = Cypermethrin and CTROL= Control

From the results presented in tables 1 – 4 above, it can be deduced that there was no significant difference (P<0.05) between insect pests population buildup in plots treated with Neem extracts and Cypermethrin insecticides from week one to week five of the experiment except for *Maruca vitrata* at week 4 and 5 on Kamado Cowpea variety. However, there was a significant difference in population buildup

in plots treated with ANSE and Cypermethrin compared to control all through the study periods. A significantly lower population were recorded in ANSE and Cypermethrin treated plot compared to the control. Similarly, for the Borno Brown cowpea variety, there was also no significant difference (P<0.05) between insect pests population in plots treated with ANSE and Cypermethrin except at weeks 1



and 2 for Thrips and *C. tomentosicollis*, and week 2 for *Maruca vitrata* but there was a significant decline in population buildup in treated plots compared to control (Table 2). A similar trend was also noticed on IT288 and IT573 varieties (Tables 3 and 4) where no significant difference ( $P < 0.05$ ) was found between Thrips population buildup on treated plots but *Maruca vitrata* was found to be significant.

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

Generally, the grain yield in kg/plot of the four cowpea varieties was significantly higher on the treated plots compared to the control. However, IT288 & IT573 varieties recorded the highest grain yield compared to kanannado and Borno brown (Table 6). The observed variation might not be unconnected to the quality of the seed used in the study. IT288 & IT573 are recently improved varieties. It would not be a surprise if there were interactive effects between variety and treatments which has not been investigated in this study.

**Table 6:** Comparative performance grain yield of cowpea varieties in relation to treatment effects

Treatment	Cowpea Varieties (kg/plot)			
	Kanannado	Borno Brown	IT288	IT573
ANSE	0.900 <sup>a</sup>	0.967 <sup>a</sup>	1.100 <sup>a</sup>	1.000 <sup>a</sup>
CYPER	0.867 <sup>a</sup>	0.933 <sup>a</sup>	1.200 <sup>a</sup>	1.233 <sup>a</sup>
CONTROL	0.300 <sup>b</sup>	0.267 <sup>b</sup>	0.433 <sup>b</sup>	0.867 <sup>b</sup>
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: ANSE = Aqueous neem seed extract; CYPER = Cypermethrin and CTROL= Control

Nevertheless, the fact that the cypermethrin treatment could not outperform better than neem seed extract in suppression of population buildup of these three insect pests is a strong suggestion that the neem seed extract could be an alternative control option against damage by insect pests. This seems to agree with Seshu Reddy, (1988); Mailu, (1997); Asawalam *et al.*, (2007) and Parajuli *et al.*, (2020) whom all proposed that the use of botanicals might soon replace conventional insecticides. Neem seed oils and seed extracts-based formulations have been reported to give significant reduction against green peach aphids on pepper (Lowery *et al.*, 1993; Adnan *et al.*, 2014), aphids on lettuce and

strawberry (Canarte-Bermudez *et al.*, 2020), *S. derogate* cotton leaves (Ganda *et al.*, 2018). Previous works also point out that Neem seed extract and various additives were successfully employed in the management of the sucking pests where Roy and Guru Subramanian (2011) reported that the application of Neem formulation to tea plants provided more than 75 % reduction of three sucking pests. The results have shown that a significant reduction in the insect pest 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 extracts and synthetic pesticides have protected plants and

consequently resulted in high yields in grains of treated plants than the control. However, IT288 & IT573 varieties recorded the highest grain yield in two experiments compared to kanannado and B-brown under all the treatments. A 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 agro-ecological zone. Moreover, higher grain yield was obtained in the control of IT288 & IT573 compared to kanannado and Brown. This suggests that IT288 & IT573 performed better than the local varieties (kanannado and Brown). The efficacy of the aqueous neem extract 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).

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## CONCLUSION

This study has revealed that neem seed extract can control Thrips, *Maruca vitrata* and *Clavigralla tomentosicollis* pests of cowpea crops. Its application on cowpea beginning from the flowering stage has reduced the population buildup of this pest to below the economic threshold. When comparing its effect with cypermethrin, no significant difference ( $P > 0.05$ ) was observed in its efficacy cypermethrin in the reduction of population buildup of these pests on the four varieties of cowpea evaluated. A further test of the neem seed extract on mortality could be useful to ascertain its lethal status because based on this study, the extract seems to work as an antifeedant. However, this finding suggested that the neem seed extract could serve as a substitute for cypermethrin insecticides to farmers, especially in an arid environment where rainfall is scarce with little effect of wash away by rain after application.

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