



**EFFICACY OF SELECTED BOTANICAL EXTRACTS FOR THE MANAGEMENT OF
INSECT PESTS OF COWPEA (*Vigna unguiculata* Linnaeus. WALP.) IN
NIGER STATE, NIGERIA**

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ABSTRACT

This study evaluated the efficacy of neem (*Azadirachta indica*), garlic (*Allium sativum*), and chilli pepper (*Capsicum frutescens*) extracts at 100%, 75%, and 50% concentrations for the management of key insect pests of cowpea under field conditions in Niger State, Nigeria. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Data were collected on vegetative growth, flower abortion, pod damage, and yield parameters. The result revealed that, all botanical treatments significantly reduced pest damage and improved growth and yield compared to the untreated control. The result further indicated that, neem extract at 100% concentration consistently recorded the lowest flower abortion and pod damage while producing superior vegetative growth. Garlic and chilli pepper extracts at 100% also performed well, particularly in yield parameters. The result also showed that, lower concentrations were less effective than the higher concentrations. The study demonstrated that neem extract at full concentration is a highly effective, environmentally friendly alternative for managing insect pests of cowpea, with garlic and chilli pepper offering viable complementary options. Based on the findings of this study, the use of botanical extracts especially neem extract is recommended for safer and environmentally friendly means of controlling cowpea field pests.

Keywords: *Azadirachta indica*, Biopesticides, *Capsicum frutescens*, Cowpea, Pests.

INTRODUCTION

Cowpea (*Vigna unguiculata* [L.] Walp.) is a vital leguminous crop in sub-Saharan Africa, serving as a major source of dietary protein, essential minerals, and income for millions of smallholder farmers (Ojiwe et al., 2021). In Nigeria, it plays a central role in food security and rural livelihoods, particularly in regions where animal protein is scarce. Its adaptability to semi-arid conditions and capacity for biological nitrogen fixation make it valuable for sustainable farming systems. Despite its importance, insect pest pressure remains a primary constraint, often causing yield losses exceeding 80% in unprotected fields (Togola et al., 2023; Tamò et al., 2023).

The major insect pests of cowpea in Nigeria include the pod borer (*Maruca vitrata*), aphids (*Aphis craccivora*), flower thrips (*Megalurothrips sjostedti*), and pod-sucking bugs (*Clavigralla tomentosicollis*). These pests attack the crop from the vegetative stage through pod formation and filling, resulting in flower abortion, pod damage, and significant grain loss (Tamò et al., 2023). For decades, farmers have relied heavily on synthetic chemical insecticides for control. However, indiscriminate use has led to serious drawbacks, including the development of pest resistance, environmental contamination, soil degradation, destruction of natural enemies, and acute health risks to farmers and consumers, with documented cases of pesticide poisoning in Nigeria (Okonya et al., 2024).

In response to these challenges, botanical extracts and other biopesticides have emerged as promising, environmentally benign alternatives within integrated pest management (IPM) frameworks (Abtew et al., 2023; Sahayaraj and Muthukumar, 2024). Plant-derived products such as neem (*Azadirachta indica*), garlic (*Allium sativum*), and chilli pepper (*Capsicum frutescens*) contain bioactive compounds that can disrupt insect feeding, growth, reproduction, and survival while posing minimal risk to non-target organisms and human health. These botanicals align with the United Nations Sustainable Development Goals (SDG 2: Zero Hunger and SDG 15: Life on Land) and support



Nigeria's National Agricultural Technology Adoption Policy, which promotes sustainable and climate-resilient practices (FMARD, 2023).

Although previous studies in other parts of Nigeria (e.g., Kano State and Southwest Nigeria) have demonstrated the potential of neem, garlic, and chilli-based extracts (Ibrahim *et al.*, 2024; Adebowale *et al.*, 2023), there remains limited field-based information on their comparative efficacy and optimal concentrations under the specific agroecological conditions of Niger State in the Southern Guinea Savanna zone. Factors such as local climate, pest pressure, and varietal interactions may influence performance. Moreover, adoption of botanical pesticides by smallholder farmers is still constrained by inconsistent efficacy data, lack of standardized application protocols, and limited extension support (Oguh *et al.*, 2023; Mkenda *et al.*, 2024).

The present study was therefore designed to evaluate the field efficacy of selected botanical extracts (neem, garlic, and chilli pepper) at three concentration levels (100%, 75%, and 50%) for the management of major insect pests of cowpea in Niger State, Nigeria. The objectives were to determine their effects on pest damage, vegetative growth, and yield parameters, and to identify the most effective and practical option for resource-poor farmers. Findings from this research are expected to provide evidence-based recommendations for sustainable pest management, reduce dependence on synthetic pesticides, and contribute to improved cowpea productivity and food security in the region.

MATERIALS AND METHODS

Study Area

The field experiment was conducted during the 2023 cropping season at the Teaching and Research Farm of the School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Niger State, Nigeria. The site is located in the Southern Guinea Savanna agroecological zone (latitude 9° 40' N, longitude 6° 30' E, altitude 258 m above sea level). The area has a sub-humid tropical climate with a distinct wet season (May–October) and dry season (November–April). The soil is a sandy loam classified as Typic Haplustalf with moderate fertility. Total annual rainfall during the experimental period was 1,124 mm, with mean monthly temperatures ranging from 24°C to 32°C.

Experimental Treatments

The experiment consisted of three botanical extracts neem (*Azadirachta indica*) leaf extract, garlic (*Allium sativum*) bulb extract, and chilli pepper (*Capsicum frutescens*) fruit extract each tested at three concentration levels (100%, 75%, and 50%). A control (distilled water only) was included, making ten treatments in total (Table 1). These botanicals were selected based on their reported insecticidal properties and local availability to farmers.

Table 1: Experimental Treatments and Concentration Levels

Treatment	Botanical Material	Plant Part Used	Concentration Level (%)
T1	Neem	Leaves	100
T2	Neem	Leaves	75
T3	Neem	Leaves	50
T4	Garlic	Cloves	100
T5	Garlic	Cloves	75
T6	Garlic	Cloves	50
T7	Chilli pepper	Fruits	100
T8	Chilli pepper	Fruits	75
T9	Chilli pepper	Fruits	50
T10	Water	Solvent	0%

Preparation of Botanical Extracts

Botanical extracts were prepared fresh for each application following standard protocols with slight modifications. For neem extract, 100 g of fresh, mature leaves were washed, chopped into small pieces, soaked in 1 L of distilled water for 24 hours, and filtered through double-layered muslin cloth.



Garlic extract was prepared by crushing 100 g of fresh cloves into a paste, soaking in 1 L of distilled water for 24 hours, filtering, and adding 2 mL of liquid soap (as a surfactant/sticker). Chilli pepper extract was made by blending 100 g of fresh ripe fruits with 1 L of distilled water, allowing the mixture to stand for 12 hours, and filtering. The 100% concentration represented the undiluted filtrate (stock extract). The 75% concentration was prepared by mixing 750 mL of stock extract with 250 mL of distilled water, while the 50% concentration was prepared by mixing 500 mL of stock extract with 500 mL of distilled water. Extracts were prepared on the day of application or stored at 4°C and used within 24 hours.

Experimental Design and Field Management

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Each plot measured 3 m × 3 m (9 m²), with 1 m spacing between plots and 2 m between blocks to minimize cross-contamination. A locally adapted, improved cowpea variety (IT99K-573-2-1) was sown at a spacing of 75 cm × 25 cm (two seeds per stand) and thinned to one plant per stand two weeks after sowing (WAS). Recommended cultural practices were followed: poultry manure was applied at 5 t/ha two weeks before planting, and plots were kept weed-free by manual weeding at 3 and 6 WAS. No synthetic fertilizers or pesticides were applied.

Application of Treatments

Botanical extracts were applied as foliar sprays using a calibrated 15-L knapsack sprayer fitted with a cone nozzle. Spraying was done at the onset of flowering (approximately 6 WAS) and continued weekly for four consecutive weeks during early morning (6:00–8:00 a.m.) to minimize evaporation and drift. Each plot received approximately 400–500 mL of spray solution per application, ensuring thorough coverage of foliage, flowers, and pods.

Data Collection

Data were collected on the following parameters:

Growth parameters: Plant height (cm), number of branches, and number of leaves per plant at 2, 4, and 6 WAS (five randomly selected plants per plot).

Pest damage parameters: Number of aborted flowers per plant and percentage pod damage at harvest. Pod damage was assessed as the proportion of harvested pods showing visible feeding punctures, holes, or deformation caused by pests.

Yield parameters: Number of pods per plant, pod length (cm), number of grains per pod, 100-seed weight (g), and grain yield (kg/ha) adjusted to 12% moisture content.

Statistical Analysis

Data were subjected to analysis of variance (ANOVA) using SAS software version 9.4. Significant differences among treatment means were separated using Duncan's Multiple Range Test (DMRT) at the 5% probability level. Prior to ANOVA, data were checked for normality and homogeneity of variances using Shapiro-Wilk and Levene's tests, respectively. Percentage data were arcsine-transformed where necessary.

RESULTS AND DISCUSSION

Effect of Botanical Extracts on Flower Abortion and Pod Damage

The result as presented in Table 2 revealed that, untreated control recorded the highest number of aborted flowers (18.4 per plant) and pod damage (40.2%). The result further showed that, all botanical treatments significantly reduced the damage parameters compared to the control. Neem extract at 100% concentration was the most effective, recording the lowest flower abortion (2.7 per plant) and pod damage (8.3%). This was followed closely by garlic 100% (5.7 aborted flowers, 9.6% pod damage) and chilli pepper 100% (4.7 aborted flowers, 10.8% pod damage). Lower concentrations (75% and 50%) of all botanicals showed progressively reduced efficacy, confirming a clear concentration-dependent response.

The superior performance of neem is attributable to azadirachtin and related limonoids, which act as potent antifeedants, growth regulators, and oviposition deterrents against key cowpea pests such as *Maruca vitrata* and pod-sucking bugs (Abtew *et al.*, 2023; Ibrahim *et al.*, 2024). These findings corroborate earlier reports on the efficacy of neem-based biopesticides in Northern Nigeria.

Table 2: Effect of Botanical Extracts at Different Concentrations on Insect Pest Damage Assessment Parameters

Treatment	Number of Aborted Flowers per Plant	Pod Damage Assessment (%)
Neem 100%	2.7 ^f	8.3 ^f
Neem 75%	5.3 ^e	13.1 ^e
Neem 50%	7.7 ^d	19.4 ^d
Garlic 100%	5.7 ^e	9.6 ^f
Garlic 75%	8.7 ^d	15.3 ^{de}
Garlic 50%	11.7 ^c	22.7 ^c
Pepper 100%	4.7 ^e	10.8 ^{ef}
Pepper 75%	7.7 ^d	17.2 ^d
Pepper 50%	10.7 ^c	26.4 ^b
Control (T0)	18.4 ^a	40.2 ^a
SE $\pm$	0.61	1.24

Means within the same column followed by different superscript letters are significantly different at $p \leq 0.05$ (DMRT). T0 = untreated control. SE = standard error of treatment means

Effect of Botanical Extracts on Vegetative Growth

The results in Table 3 and 4 indicated that, botanical treatments significantly improved plant height, number of branches, and number of leaves compared to the control. The results further revealed that, neem at 100% concentration consistently produced the tallest plants (68.5 cm at 6 WAS), the highest number of branches (8.3), and the greatest leaf number. This enhanced growth is likely due to reduced pest pressure, which allowed better photosynthetic activity, nutrient uptake, and resource allocation to vegetative structures. Similar trends have been reported in legume systems treated with botanical pesticides (Adebowale *et al.*, 2023).

Table 3: Effect of Botanical Extracts at Different Concentrations on Plant height (cm)

Treatment	2 WAS	4 WAS	6 WAS
Neem 100%	21.4 ^a	45.7 ^a	68.5 ^a
Neem 75%	20.6 ^b	43.3 ^b	65.5 ^b
Neem 50%	19.8 ^c	41.2 ^c	62.1 ^c
Garlic 100%	20.4 ^b	42.7 ^b	65.2 ^b
Garlic 75%	19.6 ^c	40.2 ^c	61.0 ^c
Garlic 50%	18.8 ^d	38.5 ^d	58.5 ^d
Pepper 100%	20.0 ^b	41.3 ^c	60.3 ^c
Pepper 75%	18.6 ^d	37.5 ^d	57.7 ^d
Pepper 50%	17.9 ^e	36.3 ^e	55.9 ^e
Control (T0)	17.2 ^f	34.8 ^f	51.4 ^f
SE $\pm$	0.12	0.28	0.35

Means within the same column followed by different superscript letters are significantly different at $p \leq 0.05$ (DMRT). T0 = untreated control. SE = standard error of treatment means



Table 4: Effect of Botanical Extracts at Different Concentrations on Number of Branches

Treatment	2 WAS	4 WAS	6 WAS
Neem 100%	2.1 ^a	4.6 ^a	8.3 ^a
Neem 75%	2.0 ^a	4.0 ^b	7.3 ^b
Neem 50%	1.7 ^b	3.0 ^c	6.3 ^c
Garlic 100%	2.0 ^a	4.0 ^b	7.0 ^b
Garlic 75%	1.7 ^b	3.0 ^c	6.0 ^c
Garlic 50%	1.5 ^c	3.0 ^c	5.3 ^d
Pepper 100%	1.8 ^b	3.0 ^c	6.0 ^c
Pepper 75%	1.5 ^c	2.8 ^c	5.0 ^d
Pepper 50%	1.3 ^d	2.3 ^d	4.7 ^e
Control (T0)	1.2 ^d	2.1 ^d	3.5 ^f
SE $\pm$	0.07	0.25	0.35

Means within the same column followed by different superscript letters are significantly different at $p \leq 0.05$ (DMRT). T0 = untreated control. SE = standard error of treatment means

Table 5: Effect of Botanical Extracts at Different Concentration on Number of Leaves per Plant

Treatment	2 WAS	4 WAS	6 WAS
Neem 100%	12 ^a	26 ^a	50 ^a
Neem 75%	11 ^b	24 ^b	47 ^b
Neem 50%	10 ^c	22 ^c	44 ^c
Garlic 100%	11 ^b	24 ^b	46 ^b
Garlic 75%	10 ^c	22 ^c	43 ^c
Garlic 50%	9 ^d	21 ^d	40 ^e
Pepper 100%	10 ^b	22 ^c	42 ^d
Pepper 75%	9 ^d	19 ^e	39 ^e
Pepper 50%	8 ^e	19 ^e	37 ^f
Control (T0)	7 ^f	17 ^f	33 ^g
SE $\pm$	0.14	0.44	0.58

Means within the same column followed by different superscript letters are significantly different at $p \leq 0.05$ (DMRT). WAS = weeks after sowing. T0 = untreated control. SE = standard error of treatment means.

Effect of Botanical Extracts on Yield Parameters

All botanical treatments significantly increased yield components and grain yield over the control (Table 6). The highest grain yields were obtained from chilli pepper 100% (1100.00 kg/ha) and garlic 100% (1077.78 kg/ha), which were statistically similar to neem 100% (966.67 kg/ha) and superior to lower concentrations and the control (300.00 kg/ha). Improvements in pods per plant, pod length, grains per pod, and 100-seed weight followed the same trend.

Although neem excelled in pest suppression and vegetative growth, the slightly higher yields in garlic and chilli pepper 100% may be linked to additional growth-promoting or micronutrient effects of their bioactive compounds. The results demonstrate that higher concentrations (100%) of all three botanicals provided substantial yield protection, with neem offering the best balance of pest control and growth enhancement.

Table 6: Effect of Botanical Extracts at Different Concentrations on Yield Parameters of Cowpea

Treatment	Pods per Plant	Pod Length (cm)	Grains per Pod	100-Seed Weight (g)	Grain Yield (kg/ha)
Neem 100%	41 ^b	18.3 ^b	9 ^b	17.1 ^b	966.67 ^b
Neem 75%	35 ^d	16.5 ^c	7 ^c	15.8 ^c	933.33 ^b
Neem 50%	27 ^f	14.2 ^e	5 ^e	13.4 ^e	688.89 ^d
Garlic 100%	42 ^b	18.7 ^{ab}	9 ^b	17.4 ^{ab}	1077.78 ^a
Garlic 75%	36 ^{cd}	16.8 ^c	7 ^c	16.0 ^c	944.44 ^b
Garlic 50%	30 ^e	14.5 ^e	5 ^d	13.6 ^e	555.56 ^e
Pepper 100%	44 ^a	19.1 ^a	12 ^a	17.8 ^a	1100.00 ^a
Pepper 75%	37 ^c	16.2 ^{cd}	8 ^b	15.6 ^{cd}	700.00 ^d
Pepper 50%	30 ^e	14.0 ^e	6 ^{cd}	13.1 ^e	533.33 ^e
Control (T0)	19 ^g	10.8 ^f	3 ^f	10.2 ^f	300.00 ^f
SE ±	2.0	0.38	0.52	0.41	111.11

Means within the same column followed by different superscript letters are significantly different at $p \leq 0.05$ (DMRT). T0 = untreated control. SE = standard error of treatment means

The concentration-dependent effects observed across all parameters underscore the importance of using sufficiently high concentrations of botanical extracts for effective field performance. These findings align with previous studies on biopesticides in cowpea (Ibrahim *et al.*, 2024; Abteu *et al.*, 2023) and confirm their potential as sustainable alternatives to synthetic insecticides under Nigerian conditions.

CONCLUSION AND RECOMMENDATION

The study demonstrated that foliar application of neem, garlic, and chilli pepper extracts significantly reduced insect pest damage and improved the growth and yield of cowpea compared to the untreated control. Among the treatments, neem extract at 100% concentration provided the best overall performance by minimizing flower abortion and pod damage while supporting strong vegetative growth. Garlic and chilli pepper extracts at 100% concentration also delivered competitive yields. A clear concentration-dependent response was observed, with 100% extracts being most effective.

These findings indicated that botanical pesticides, particularly neem-based extracts, can serve as sustainable and environmentally friendly alternatives to synthetic insecticides for cowpea pest management in the Southern Guinea Savanna zone of Nigeria. Farmers are encouraged to adopt 100% neem extract as a primary option, with garlic and chilli pepper as potential supplements depending on local availability. Further studies on large-scale validation, cost-benefit analysis, and integration into IPM packages are recommended.

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