



EFFECTS OF SELECTED BOTANICAL OILS FOR THE CONTROL OF COPEA POD BORER (*MARUCA VITRATA*) AND PERFORMANCE OF COWPEA UNDER SCREENHOUSE CONDITIONS IN MINNA, NIGER STATE, NIGERIA

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ABSTRACT

This study evaluated the biopesticidal efficacy of neem oil (*Azadirachta indica*), jatropha oil (*Jatropha curcas*), and castor oil (*Ricinus communis*), applied singly, binary and ternary combinations, for managing cowpea pod borer infestation and cowpea performance in a screenhouse. A Completely Randomized Design (CRD) with nine treatments replicated three times was used. Treatments included neem oil (3 ml/L), jatropha oil (2 ml/L), castor oil (1 ml/L), three binary combinations, one ternary combination, cypermethrin (standard), and a control. Data on pest damage, growth and yield parameters were analysed using ANOVA, with means separated by Duncan's Multiple Range Test (DMRT) at $p \leq 0.05$. Results revealed a significant difference among the treatments for pest damage and most growth parameters. The result further indicated that, castor oil (1 ml/L) was the most effective treatment, recording the lowest plant infestation score (2.00), flower infestation score (1.67), and pod damage (18.3%), as well as the tallest plants (155.47 cm at 6 WAS) 100-seed weight (10.80 g). Neem oil (3 ml/L) also provided reliable pest suppression. The ternary combination recorded pest damage levels which were not statistically significant from the control and also produced the lowest grain yield (0.03 kg/pot). Yield components showed no significant differences. The absence of significant differences may partly reflect the restricted rooting volume under pot conditions, although this possibility was not directly investigated. Single-oil applications, especially Castor oil at 1 ml/L showed potential as a botanical alternative for managing cowpea pod borer under screenhouse conditions. Based on the result of this study, combining multiple botanical oils at the tested concentrations is not recommended.

Keywords: Biopesticides, Botanical, Oil, Pod, Damage, *Maruca vitrata*.

INTRODUCTION

Cowpea (*Vigna unguiculata* (Linnaeus) Walp) is a highly significant legume crop cultivated predominantly in the semi-arid tropics of Africa, Asia, and Latin America. Globally, it serves as a vital source of dietary protein, particularly in low-income regions where access to animal protein is both limited and costly. Its resilience to drought, high temperatures, and poor soil conditions positions it as an essential crop for food security, poverty alleviation, and nutritional enhancement (Mekonnen *et al.*, 2022). Sub-Saharan Africa accounts for over 94% of global cowpea production, with Nigeria standing out as the world's largest producer and consumer, contributing approximately 4.28 million tonnes of dry cowpeas in 2024 alone (Food and Agriculture Organization of the United Nations (FAO), 2025). Despite its significance, cowpea production is severely constrained by insect pest infestations. Key pests such as the cowpea weevil (*Callosobruchus maculatus*) and the pod borer (*Maruca vitrata*) are responsible for substantial yield losses, with *Maruca vitrata* alone capable of reducing yield by up to 70% if not effectively controlled (Baidoo and Mochiah, 2016). Other major pests including cowpea aphid (*Aphis craccivora*), flower thrips (*Megalurothrips sjostedti*), and pod-sucking bugs (*Clavigralla tomentosicollis*) attack cowpea at different growth stages, compounding yield and quality losses (Togola *et al.*, 2021).

Farmers have traditionally relied on synthetic insecticides to manage these pests. However, the adverse effects of chemical pesticides including environmental contamination, human health risks, and increasing pest resistance have raised serious concerns and highlighted the need for more sustainable alternatives (Ifeyanize *et al.*, 2022). The escalating cost of chemical insecticides and the poor purchasing power of smallholder farmers have further widened the gap between effective pest control



and practical accessibility (Ileke *et al.*, 2022). Biopesticides derived from natural plant materials offer a promising solution. Botanical oils such as neem (*Azadirachta indica*), jatropha (*Jatropha curcas*), and castor (*Ricinus communis*) possess insecticidal, repellent, and antifeedant properties against several agricultural pests. Neem contains azadirachtin, a bioactive compound that interferes with insect feeding, growth, and reproduction. Jatropha oil exhibits contact toxicity and oviposition deterrence, while castor oil is rich in ricinoleic acid, which disrupts insect cuticular waxes and cellular membrane integrity. While several studies have reported the effectiveness of these botanicals individually, their comparative efficacy when applied singly and in combinations for managing cowpea insect pests under screenhouse conditions remains inadequately documented.

This study was therefore conducted to evaluate the biopesticidal efficacy of neem, *jatropha*, and castor oils applied singly and in binary and ternary combinations against *Maruca vitrata* infestation, and to determine their effects on the growth and yield performance of cowpea under screenhouse conditions in Minna, Niger State.

MATERIALS AND METHODS

The experiment was conducted in the screenhouse of the Department of Crop Production, School of Agronomy and Forestry Technology, Federal University of Technology, Gidan Kwano Campus, Minna, Niger State, Nigeria. The location lies between latitude 9° 37' N and longitude 6° 28' E in the Southern Guinea Savanna agro-ecological zone of Nigeria.

The treatments consisted of nine botanical extracts at different concentrations (Neem oil at 3 ml/L, Jatropha oil at 2 ml/L, Castor oil at 1 ml/L, Neem oil + Jatropha oil at 1.5 + 1 ml/L, Neem oil + Castor oil at 1.5 + 0.5 ml/L, Jatropha oil + Castor oil at 1 + 0.5 ml/L, Neem + Jatropha + Castor oil at 1.5 + 1 + 0.5 ml/L, Cypermethrin at 1 ml/L and a Control (no spraying). These were laid out in a Completely Randomized Design (CRD) replicated three times, resulting in a total of 27 experimental pots. Each pot was filled with 15 kg of sterilized soil.

Top soil was collected from the Teaching and Research Farm at a depth of 0–30 cm, sterilized by the steam method, and allowed to cool before filling into experimental pots. The Ife-Brown cowpea variety, characterized by a smooth seed coat and high susceptibility to insect pests, was sourced from Techni Seed Limited, Farm Center Minna. Two seeds were sown per pot at 2–4 cm depth and thinned to one healthy seedling per stand at two weeks after sowing.

Larvae of *Maruca vitrata* were sourced from the Department of Crop Protection, Ahmadu Bello University, Zaria. At the onset of flowering, two larvae of *Maruca vitrata* (per plant) were infested into the flower of the cowpea plants using a camel hairbrush to simulate natural pest pressure under controlled conditions, artificial infestation was done once at the onset of flowering.

Botanical oil treatments were applied as foliar sprays on the flowers of the cowpea plant using a hand sprayer with water as the diluent. Applications were made once weekly in the morning for four consecutive weeks, commencing two weeks after *Maruca vitrata* larvae was infested into the plants.

Data were collected on: (i) pest damage, flower infestation and pod damage percentage; (ii) growth parameters - plant height (cm), number of leaves per plant, and number of branches per plant, and (iii) yield parameters - number of pods per plant, pod length (cm), number of seeds per pod, 100-seed weight (g), and grain yield per pot (kg).

Data collected were subjected to Analysis of Variance (ANOVA) using Statistical Analysis Software (SAS) version 9.4. Significantly different treatment means were separated using Duncan's Multiple Range Test (DMRT) at a 5% level of probability.

RESULTS

Effects of Botanical Oils at Different Concentrations on *Maruca vitrata* Infestation

The result as presented in Table 1 revealed that, significant differences ($p \leq 0.05$) were observed among treatments for plant infestation score, flower infestation, and pod damage percentage (Table 1). The result also showed that, castor oil (1 ml/L) recorded the lowest plant infestation score (2.00), flower infestation score (1.67), and pod damage (18.3%). Neem oil (3 ml/L) performed statistically similar to castor oil. Both single-oil treatments were significantly better compared to cypermethrin. The untreated



control exhibited the most severe damage (plant infestation score 5.33, flower infestation score 5.33, pod damage 65.3%), which was statistically similar to the ternary combination of Neem (1.5 ml) + Jatropha (1 ml) + Castor (0.5 ml)

Table 1: Effects of Botanical Oils at Different Concentrations on *Maruca vitrata* Infestation

Treatment	Plant Infestation Score (0–7)	Flower Infestation Score (0–7)	Pod Damage (%)
Neem oil (3 ml/L)	2.67 ^d	2.00 ^d	24.7 ^d
Jatropha oil (2 ml/L)	3.33 ^c	3.00 ^c	31.3 ^c
Castor oil (1 ml/L)	2.00 ^d	1.67 ^d	18.3 ^d
Neem (1.5 ml) + Jatropha (1 ml)	4.00 ^b	4.33 ^b	45.0 ^b
Neem (1.5 ml) + Castor (0.5 ml)	3.67 ^{bc}	3.67 ^{bc}	39.3 ^{bc}
Jatropha (1 ml) + Castor (0.5 ml)	4.33 ^b	4.00 ^b	42.7 ^b
Neem (1.5 ml) + Jatropha (1 ml) + Castor (0.5 ml)	5.67 ^a	5.67 ^a	68.7 ^a
Cypermethrin (1 ml/l)	3.00 ^c	2.67 ^c	32.0 ^c
Control (no spraying)	5.33 ^a	5.33 ^a	65.3 ^a
SEM ±	0.48	0.51	4.12

Means within the same column followed by the same superscript letter are not significantly different at $p \leq 0.05$ using (DMRT). SEM = Standard Error of the Mean.

Effects of Botanical Oils at Different Concentrations on Plant Height

Result as presented in Table 2 indicated that, significant differences ($p \leq 0.05$) were observed among treatments for plant height at 2, 4, and 6 WAI (Table 2). Castor oil consistently produced the tallest plants across the sampling periods, 34.97 cm, 94.47 cm, and 155.47 cm at 2, 4, and 6 WAI, respectively while the ternary combination of neem, Jatropha, and castor oils produced the shortest plants. At 2 and 4 WAI, castor oil produced significantly taller plants than cypermethrin and the untreated control. At 6 WAI, castor oil was statistically similar to some of the treatments with higher plant height but remained numerically superior to cypermethrin and the control. The ternary combination consistently produced significantly shorter plants recording 13.83 cm, 27.80 cm, and 49.53 cm at 2, 4, and 6 WAI, respectively, than the control. These results indicate that castor oil was associated with better plant growth, whereas the ternary combination had the poorest effect on plant height.

Table 2: Plant Height (cm) of Cowpea as Influenced by Different Concentrations Botanical Oils

Treatment	2 WAI	4 WAI	6 WAI
Neem oil (3 ml/L)	25.33 ^b	71.93 ^b	124.67 ^b
Jatropha oil (2 ml/L)	24.70 ^b	69.13 ^b	135.23 ^{ab}
Castor oil (1 ml/L)	34.97 ^a	94.47 ^a	155.47 ^a
Neem (1.5 ml) + Jatropha (1 ml)	16.83 ^c	77.23 ^b	140.23 ^{ab}
Neem (1.5 ml) + Castor (0.5 ml)	17.27 ^c	62.80 ^c	97.10 ^b
Jatropha (1 ml) + Castor (0.5 ml)	18.83 ^c	58.40 ^c	108.87 ^b
Neem (1.5 ml) + Jatropha (1 ml) + Castor (0.5 ml)	13.83 ^d	27.80 ^d	49.53 ^c
Cypermethrin (1 ml)	16.87 ^c	53.23 ^c	101.20 ^b
Control (No spraying)	17.73 ^c	57.40 ^c	94.77 ^b
SEM ±	3.69	11.13	18.11

Means within the same column followed by the same superscript letter are not significantly different at $p \leq 0.05$ using (DMRT). SEM = Standard Error of the Mean; WAI = Weeks After Infestation



Effects of Botanical oils at Different Concentrations on Number of Leaves

Result in Table 3 showed that, significant differences ($p \leq 0.05$) were observed among treatments in the number of leaves at 2, 4, and 6 WAI (Table 3). Neem oil produced the highest number of leaves (31.67) at 2 WAI, whereas castor oil produced the highest number at 4 and 6 WAI recording (60.67) and (90.33) respectively. The ternary combination consistently recorded the lowest number of leaves throughout the sampling periods. At 2 WAI, neem and castor oils produced significantly more leaves than cypermethrin, while at 4 and 6 WAI, the individual oils generally produced higher leaf numbers than cypermethrin and the untreated control. The ternary combination produced significantly fewer leaves than the control and showed the poorest performance among the treatments.

Table 3: Number of Leaves as Influenced by Different Concentrations of Botanical Oils

Treatment	2 WAI	4 WAI	6 WAI
Neem oil (3 ml/L)	31.67 ^a	53.00 ^a	81.33 ^a
Jatropha oil (2 ml/L)	21.33 ^c	54.00 ^a	86.33 ^a
Castor oil (1 ml/L)	25.67 ^b	60.67 ^a	90.33 ^a
Neem (1.5 ml) + Jatropha (1 ml)	17.33 ^d	56.67 ^a	87.67 ^a
Neem (1.5 ml) + Castor (0.5 ml)	21.33 ^c	48.00 ^b	78.67 ^b
Jatropha (1 ml) + Castor (0.5 ml)	19.33 ^c	37.00 ^c	73.67 ^b
Neem (1.5 ml) + Jatropha (1 ml) + Castor (0.5 ml)	8.67 ^e	16.33 ^d	23.33 ^c
Cypermethrin (1 ml)	16.00 ^d	34.67 ^c	64.33 ^c
Control (no spraying)	20.33 ^c	38.33 ^c	63.67 ^c
SEM $\pm$	3.36	8.00	10.91

Means within the same column followed by the same superscript letter are not significantly different at $p \leq 0.05$ using (DMRT). SEM = Standard Error of the Mean; WASI= Weeks After Inoculation.

Effects of Botanical Oils at Different Concentrations on Number of Branches

The result revealed that, no significant differences ($p > 0.05$) were observed among treatments for the number of branches at 2, 4, and 6 WAI (Table 4). Branch counts ranged from 2.00 to 4.67 at 2 WAI, 3.33 to 6.67 at 4 WAI, and 4.67 to 7.67 at 6 WAI, with castor oil producing the highest counts across each sampling period.

Table 4: Number of Branches as Influenced by Different Concentrations of Botanical Oils

Treatment	2 WAI	4 WAI	6 WAI
Neem oil (3 ml/L)	3.67 ^a	5.67 ^a	6.00 ^a
Jatropha oil (2 ml/L)	3.33 ^a	6.00 ^a	6.00 ^a
Castor oil (1 ml/L)	4.67 ^a	6.67 ^a	7.67 ^a
Neem (1.5 ml) + Jatropha (1 ml)	2.67 ^a	5.33 ^a	7.00 ^a
Neem (1.5 ml) + Castor (0.5 ml)	3.00 ^a	5.33 ^a	6.00 ^a
Jatropha (1 ml) + Castor (0.5 ml)	3.33 ^a	5.00 ^a	5.67 ^a
Neem (1.5 ml) + Jatropha (1 ml) + Castor (0.5 ml)	2.00 ^a	3.33 ^a	5.00 ^a
Cypermethrin (1 ml)	2.67 ^a	3.67 ^a	4.67 ^a
Control (no spraying)	3.67 ^a	4.33 ^a	5.67 ^a
SEM $\pm$	0.73	0.73	0.89

Means within the same column followed by the same superscript letter are not significantly different at $p > 0.05$ using (DMRT). SEM = Standard Error of the Mean; WAI = Weeks After Infestation.

Effects of Botanical Oils at Different Concentrations on Yield and Yield Components

The result as presented in Table 5 indicated that, significant differences ($p \leq 0.05$) were observed only for 100-seed weight among yield parameters (Table 5). Castor oil (1 ml/L) recorded the highest 100-seed weight (10.80 g), which was significantly higher than all other treatments. The ternary combination recorded the lowest 100-seed weight (8.33 g), significantly lower than all other treatments. For number of pods per plant, pod length, number of seeds per pod, and grain yield per pot, no significant differences were observed among treatments ($p > 0.05$), though castor oil consistently produced the numerically higher values across all parameters (20.00 pods/plant, 18.97 cm pod length, 12.67 seeds/pod, and 0.07 kg/pot).

The absence of significant differences in most yield parameters under screenhouse conditions is likely due to the restricted rooting volume of the cowpea plant in the pots, which limited overall resource uptake and masked treatment effects on yield. This finding underscores the need for field validation, as controlled-environment studies often underestimate the true agronomic benefits of effective biopesticide treatments.

Table 5: Yield and Yield Components of Cowpea as influenced by Botanical Oils

Treatment	Number of Pods/Plant	Pod Length (cm)	Seeds/Pod	100-Seed Weight (g)	Grain Yield (kg/pot)
Neem oil (3 ml/L)	15.00 ^a	12.00 ^a	8.00 ^a	9.67 ^b	0.06 ^a
Jatropha oil (2 ml/L)	16.33 ^a	12.47 ^a	8.00 ^a	9.00 ^b	0.06 ^a
Castor oil (1 ml/L)	20.00 ^a	18.97 ^a	12.67 ^a	10.80 ^a	0.07 ^a
Neem (1.5 ml) + Jatropha (1 ml)	12.67 ^a	14.83 ^a	9.67 ^a	9.00 ^b	0.05 ^a
Neem (1.5 ml) + Castor (0.5 ml)	13.33 ^a	13.07 ^a	8.67 ^a	9.33 ^b	0.05 ^a
Jatropha (1 ml) + Castor (0.5 ml)	13.00 ^a	14.80 ^a	7.67 ^a	9.33 ^b	0.05 ^a
Neem (1.5) + Jatropha (1) + Castor (0.5)	9.33 ^a	9.00 ^a	7.00 ^a	8.33 ^c	0.03 ^a
Cypermethrin (1 ml)	14.33 ^a	11.10 ^a	9.00 ^a	8.67 ^b	0.05 ^a
Control (no spraying)	14.00 ^a	12.00 ^a	8.00 ^a	9.33 ^b	0.05 ^a
SEM $\pm$	2.31	11.52	1.35	0.43	0.01

Means within the same column followed by the same superscript letter are not significantly different at $p \leq 0.05$ using (DMRT). SEM = Standard Error of the Mean.

DISCUSSION

The experiment demonstrated that neem (3 ml), jatropha (2 ml), and castor oil (1 ml) differed in their effectiveness against *Maruca vitrata* infestation and damage on cowpea. The better performance of the individual botanical treatments, particularly castor oil, indicates its potential to reduce pest pressure under a controlled environment (screenhouse). This is important because *Maruca vitrata* is a major pest of cowpea production, and its feeding on flower buds, flowers, and pods can substantially reduce crop productivity. Castor oil treatment consistently produced stronger suppression of *Maruca vitrata* infestation and damage and was associated with superior vegetative growth. Neem oil also provided substantial protection, consistent with previous evidence of neem activity against *Maruca vitrata*. Traoré *et al* (2019) reported a marked reduction in *Maruca vitrata* egg viability following neem oil treatment. Combining the botanical oils did not improve pest infestation and pod damage when compared to the single botanical oil treatments. The binary mixtures generally provided minimum protection, whereas the neem + Jatropha + castor oil mixtures performed poorly. This observation



differs from Sokame *et al.* (2015), who reported improved pest control from combinations involving neem or jatropha oil and *Maruca vitrata* multinucleopolyhedrovirus. The difference may be related to the presence of the viral biopesticide in their mixtures, as well as differences in treatment composition and application conditions. Overall, the findings revealed castor oil, followed by neem oil, as promising treatments for further evaluation and demonstrate the need for empirical testing of botanical mixtures before their use in cowpea pest-management programmes.

CONCLUSION AND RECOMMENDATION

This study revealed that single botanical oil applications, particularly castor oil at 1 ml/L, were most effective in suppressing *Maruca vitrata* infestation and damage while supporting superior cowpea growth performance under screenhouse conditions. Neem oil at 3 ml/L also provided consistent and reliable pest suppression. In contrast, the ternary combination of neem, jatropha, and castor oils was of no advantage, the combination consistently produced pest damage levels and crop performance comparable to the control, the poorer performance of the combinations may reflect interactions among the oils or the concentration at which it was tested. These findings challenge the assumption that combining multiple botanicals automatically enhances efficacy and highlight the importance of empirical testing of botanical mixtures before field recommendations. Castor oil and neem oil are recommended as potential alternatives to synthetic insecticides for *Maruca vitrata* management. Further research should be done to investigate the optimal concentrations before recommendations.

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