

## **Comparative Evaluation of Neem and Pepper-based Botanical Insecticides for the sustainable Management of okro (*Abelmoschus esculentus* L.) Leaf Beetles (*Podagrica uniformer.*) In Umudike, South Eastern Nigeria**

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### **Abstract**

A field experiment was carried out at Micheal Okpara University of agriculture Umudike, South Eastern Nigeria to evaluate the effectiveness of some botanical insecticides in controlling okro leaf beetle (*Podagrica Uniformer*). The study was aimed at evaluating safer and friendly alternatives to synthetic insecticide in pest management. The experiment consisted of 8 treatments arranged in a Randomized Complete Block Design (RCBD) with 3 replications and planted at a distance of 50 x 25cm. The treatments included: Neem powder extracts applied at 1 week interval (NAIWAP), Neem powder extracts applied at 2 weeks interval (NA2WAP), *Capsicum frutescens* extract applied at lweek interval (PEIWAP), *Capsicum frutescens* extract applied at 2weeks interval (PE2WAP), Neem powder extracts + *Capsicum frutescens* applied at lweek interval (NA+PE1WAP), Neem powder extracts + *Capsicum frutescens* applied at 2weeks interval ((NA+PE2WAP), untreated Control and a synthetic chemical for comparison. Data was collected on leaf beetle population, percentage leaf defoliation, weight and number of pods/fruits per plot and percentage damaged pods/fruits per plot. Data was collected on 5 selected plants from the middle of each plot and was subjected to analysis of variance and means were separated using fisher's least significant difference at 5 % level of probability. Results from the experiment showed that all the botanical treatments reduced leaf beetle infestation when compared with the untreated control. The untreated plots recorded the highest mean leaf beetle population of (3.09 insects per plot) highest leaf damage (47.06%), highest number of pod damage ( 21.67) and lowest pod yield (1.62t/ha). In contrast, the combined neem and pepper extract applied at one week interval gave the best performance among the botanicals with a reduced mean beetle population of (1.53insects /plot), leaf damage of (7.57%), pod damage of (5.87%) and and pod yield of (3.48 t/ha) which was closely comparable to the yield of synthetic chemical insecticide that produced (3.63t/ha). All the botanical extracts performed better than the control. The study revealed that neem and pepper extracts especially their combination at weekly application possess strong insecticidal properties against okro flea beetle and can significantly improve okro yi eld when properly applied and therefore is recommended as cheap, safe and environmentally friendly option for sustainable okro production.

**KEYWORDS:** Extracts, *Capsicum frutescens* (pepper), Neem extract (*Azadirachta indica*), *Abelmoschus esculentus*, *Podagrica spp*

**Introduction:** Okra, (*Abelmoschus esculentus* L. Moench) is a warm season crop belonging to the family Malvaceae and is widely grown in the tropics and subtropic regions for its succulent green pods (Obeng-Ofori, D and SacKey J. 2003). Okra plants are presently grown commercially in many countries such as India, Japan, Turkey, Iran, West African countries, Malaysia, Cyprus, Southern United States etc (Benjawan *et al.*, 2017). It is an economically important vegetable crop widely cultivated in tropical and subtropical regions particularly in West Africa, where it plays an important role in household nutrition, food security and rural income generation. The crop is valued for its high content of vitamins, Minerals and dietary fibre.

Despite the importance of okro in human diet and income generation, its productivity remains significantly below its potential as a result of several biotic constraints among which insect pests infestation is a major limiting factor. (Omoeje *et al* 2018, Idowu *et al* 2022). Among the insect pests of okro, flea beetles are particularly destructive during the early stage. They create characteristics shot hole damage on leaves by feeding on leaf tissues and thereby reducing the photosynthetic area available for growth and development. Severe infestation results in chlorosis, stunted growth and yield losses. *Podagrica spp.* not only cause direct damage to okra plants but also serves as vector of okra mosaic virus (Emeasor *et al.*, 2017; Isman, 2016). It has also being

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implicated to have caused premature falling of pods (Asawalam and Constance, 2018; Uddin, and Odebiyi, 2011).

Research has shown that severe infestation can result in substantial economic losses if not well managed especially in small holder farming systems where there are limited pest control options (Rahman *et al* 2023). To manage these pests farmers have relied on synthetic chemical insecticides. The use of synthetic insecticides in the control of this destructive pest of okro has become a common practice in developing countries due to their quick effectiveness (Alao, 2011), but most of these synthetic insecticides have been implicated to have caused environmental hazard, destruction of beneficial organisms, pesticide residues on food crops, increased production costs and the growing problem of pest resistance and some have been proved as carcinogenic, (Ahmed *et al.*, 2016). These challenges have intensified the search for safer affordable and environmentally sustainable pest management alternatives such as botanical insecticides (Zubairu *et al* 2025). Botanical insecticides have gained increasing attention as promising aspects of integrated pest management. Plant derived insecticides like neem and hot pepper extracts contains certain biologically active compounds such as azadiractin and capsaicin which exhibit insecticidal, repellent, antifeedant and growth regulatory properties. Neem base products interfere with the insect hormonal systems and reproduction while pepper extracts has a strong feeding deterrent and repellents effects on the insects. Recent researches have shown that extracts of these plants can significantly suppress insect pests populations and improve crop yield when properly applied under field conditions (Idowu *et al* 2022). However, the effectiveness of these botanical insecticides is often influenced by their application frequency. Frequent application intervals have been reported to enhance pest suppression due to the rapid degradation of plant derived active compounds under field condition (Rahul *et al* 2026). Despite these advances, there is limited research on investigation of the combined use of neem powder and pepper extracts for the management of okro leaf beetles. Moreso, information on how different application intervals influence their comparative efficacy with synthetic insecticide remains insufficient. Therefore the purpose of this study was to evaluate the efficacy of neem powder extract, pepper extract and their combination at different application intervals in the management of okro leaf beetles in Umudike South Eastern Nigeria. The study also compares these botanical treatments with a chemical insecticide with the aim of identifying a practical, affordable and environmentally safe pest management option that can help improve okro production and at the same time reducing over reliance on the use of synthetic chemical.

#### **Materials and Methods: Experimental location and field layout**

The experiment was conducted in the year 2022 at the

Teaching and Research Farm of the College of Crop and Soil Sciences, Michael Okpara University of Agriculture, Umudike Nigeria. The study area was characterized by (longitude 07°33E, latitude 05°29N, altitude 122m) with annual rainfall of 2177mm, 27% relative humidity, ambient temperature of 17°C to 36°C. The plot was mapped out, ploughed harrowed and beds were made manually and divided into three blocks and each block was further divided into 8 plots with each plot measuring 3 m x 2 m (6m<sup>2</sup>) with an inter-plot space of 1 m and intra plot spacing of 0.5m. Standard agronomic practices were maintained throughout the experimental period.

**Experimental design and Treatments:** The experiment consisted of eight treatments; Neem powder extracts applied at 1 week interval (NAIWAP), Neem powder extracts applied at 2 weeks interval (NA2WAP), *Capsicum frutescens* extract applied at 1 week interval (PE1WAP), *Capsicum frutescens* extract applied at 2weeks interval (PE2WAP), Neem powder extract + *Capsicum frutescens* applied at lweek interval (NA+PE1WAP), Neem powder extract + *Capsicum frutescens* applied at 2weeks interval, Control and a synthetic chemical. The experiment was laid out in a randomized complete block design (RCBD) and was replicated 3 times. Sources, Preparation and application of treatments Fresh neem leaves were obtained from Michael Okpara University premises and *Capsicum frutescens* (hot pepper fruits) were obtained from one of the agrochemical stores around the environment. Okro seeds variety Clemson Spineless was obtained from one of the agrochemical stores around the area. Fresh and matured leaves of *Azadirachta indica* (Neem) were plucked and air dried to a very low moisture level so as to make sure that the process of drying did not affect the potency of the active ingredients. These materials were blended using an electric blender. 100g of each of the materials were placed separately into plastic cans containing one litter of water each and allowed to stand overnight to allow the active ingredients to be extracted. The solutions were filtered with muslin cloth into separately labeled clean cans to obtain a homogeneous substance that was used for spraying. This procedure was repeated at every application. The cans containing the aqueous solutions were taken to the field for spraying using a hand sprayer. Field application of the treatments commenced 14 days after planting (DAP) when early signs of leaf beetle infestation were observed. Botanical extracts were sprayed using a hand sprayer either at one week or two weeks interval depending on the treatment designation. The synthetic insecticide was applied according according to manufacturer's recommendation. Spraying was carried out in the early morning hours to minimize rapid evaporation and degradation.

**Data Collection:** Data collection started 2 weeks after crop emergence and continued after every 2 weeks. Sampling of the beetles was conducted by visual count which commenced 2 weeks after planting (WAP) in the

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morning hours between 6 - 8am when the insects were still inactive. The numbers of *Podagrica uniformer* were counted after each spray at 2 weekly intervals from 10 plants selected from the middle row of the plot and tagged as sample plants. Populations of the pest species were estimated by visual counting on selected plants in each plot. Data on percentage defoliation was carried out by counting the number of defoliated leaves. Percentage defoliation was calculated using the formula;

$$\text{Percentage Defoliation (PD)} = \frac{\text{Total number of leaves defoliated}}{\text{Total number of leaves in a sample}} \times 100$$

**Pod yield:** Harvesting of fresh pods started when they were due and continued until senescence set in and the plants stopped producing pods. For pod yield, fresh pods from the plants were harvested on weekly basis and the cumulative weight of harvested pods were determined using Kitchen Scale Electronic SF-400, at the end of the final harvest total number and weight of pods per plot were recorded.

**STATISTICAL ANALYSIS** All data collected were subjected to Analysis of Variance (ANOVA) and significant means were separated by Fisher's Least Significance Difference Test (LSD) at 5% level of probability.

**RESULTS:** Table 1 shows the effect of the plant extracts and synthetic pesticide on the insect population. The result revealed significant difference ( $P \leq 0.05$ ) among treatments. The untreated plot recorded the highest mean beetle population per plot (3.09). In contrast, Plots treated with neem powder extracts combined with pepper extracts at one week interval recorded the lowest mean beetle population per plot (1.53) and this was not significantly different from the synthetic insecticide with a mean population of (1.19). Generally, the plots treated with the plant extracts gave significantly ( $P \leq 0.05$ ) lower pest population than the control which recorded higher pest population count. All the plant extracts consistently recorded lower pest population at 2, 4, 6, 8, and 10 WAP. Neem and pepper extract combination at weekly application was the most effective and recorded (1.47), (1.34), (1.28), (2.43) and (2.58) of the pest population at 2, 4, 6, 8 and 10 WAP respectively with a mean population of (1.53) and was significantly different ( $P \leq 0.05$ ) from the control which recorded (1.81), (2.05), (3.30), (3.69) and (5.61) at 2, 4, 6, 8 and 10 WAP respectively with a mean population of (3.09). This was followed by pepper extracts at weekly application which gave a mean population density of (1.60) and this was also significantly different from the control. The synthetic insecticide (cypermethrin) recorded the lowest mean insect count (1.19) than all the treated plots though this was not significantly different from some of the treated plots. In summary all the treated plots significantly reduced the pest population and gave a significantly lower pest population than the untreated

plots. The trend was that as the application continues weekly, the pest population in the treated plots keeps reducing while that of the control keeps increasing meaning that if data collection was to go beyond 10 weeks more pest population would be recorded on the untreated plots while the treated plots will be left with minimal or no pest found.

**Table 2** recorded the effect of plant extract and synthetic chemical on the number of leaves defoliated by *podagrica* spp. The results from the treated plots were significantly lower ( $P \leq 0.05$ ) in reducing the leaf damage by the insect pests compared with the control with higher leaf damage percentage. Leaf damage assessment showed that plots treated with Neem+Pepper extract at weekly application had the lowest number of damaged leaves of (5.8, 6.18, 8.04, 7.71 and 10.10) at 2, 4, 6, 8 and 10 WAP respectively and this was followed by plots treated with Pepper extract at weekly application which recorded (7.3), (7.93), (8.80), (9.21) and (10.10) at 2, 4, 6, 8 and 10 WAP respectively while the control plots recorded the highest leaf damage percentage of (21.20), (45.08), (50.10), (53.40) and (65.5) at 2, 4, 6, 8 and 10 WAP respectively. However the synthetic chemical (Cypermethrin) was the most effective among all the treated plots and recorded (2.70, 5.26, 4.21, 4.11 and 6.50) at 2, 4, 6, 8, and 10 weeks after planting, but this was not significantly different from the plots treated with the extracts. All the treated plots significantly ( $P \leq 0.05$ ) recorded a lower leaf damage compared with the control.

**Table 3** shows the effect of plant extracts and chemical pesticide on the pod damage, pod number and weight of okra pods. Significant difference ( $P \leq 0.05$ ) was recorded in the pod number, weight and pod damage on the okra plants treated with the extracts when compared with the untreated plots (control). On the number of pods, the highest number was recorded when Neem extract was applied at two-week intervals (82.0) and this was followed by Neem extract and Pepper extract combination at one-week interval (79.3) and these were not significantly different from the chemical pesticide which recorded (84.0) but significantly different at ( $P \leq 0.05$ ) from the control which recorded (39.70). All the treated plots significantly gave higher number of pods than the untreated plots. On the pod weight among the botanicals, the highest pod weight was recorded with Pepper extracts at weekly application (3.38t/ha) and this was followed by neem and pepper extracts combination at weekly application (3.28t/ha) and these were not significantly different from synthetic chemical with a record of (3.68t/ha) but significantly different from the control with a record of (1.61t/ha). On pod damage the lowest pod damage was recorded on plot treated with chemical pesticides (3.87) and this was followed by Neem + Pepper extracts application on weekly interval which recorded (5.87) and this was significantly different ( $P \leq 0.05$ ) from the control that recorded (21.67) pod damage. All the plant extracts

recorded lower pod damage when compared with control and these were all significantly different ( $P \leq 0.05$ ) from the control. All the treated plots gave significantly higher pod weight, pod number and lower pod damage than the untreated plots (Control plots).

**Discussion:** From the study carried out it was observed that all the plant extracts used were effective in reducing the okro pest population, number of damaged leaves and pods and at the same time increased the yield of okro. The result revealed that the combination of the two plant extracts (Neem + Pepper extracts application on weekly intervals) was the most effective in reducing the pest population from 2WAP to 10WAP and compared very effectively with the synthetic chemical used. These plant extracts has earlier been recorded to exhibit antifeedant, repellent, pesticidal and inner growth disruption abilities. Krause (2002) reported that these plant extracts can incite sterility in some insects, impair egg fertility, repel the insects and also deter oviposition. Botanical pesticides have been extensively demonstrated to control several important pests of crops (Uyi *et al* 2021). Results from this experiment supports the findings of Basedow *et al* (2002) who reported that *A. indica* based-products were effective in the control of aphids and white flies. The result also is in line with the findings of Ayenigbara *et al* (2025) who reported that the combined use of the plant extracts provided stronger suppression of *podagrica uniformer* and *Nisota dilecta* infestation on okro than single plant extracts alone. The protective effect from the neem extract could be as a result of the presence of azadiractin and other phytochemical components of the neem leaf which affected the insect growth and reproduction. Pepper powder contains capsaicin, which can be toxic to certain pests. Capsaicin has a very strong pungent property that irritates insects' sensory organs. It also interferes with feeding signals, causing the insects to stop feeding, and this leads to

starvation, reduced growth, and eventually death of the insect. This is also in line with Eurumibe and Dede (2026) who reported the efficacy of pepper powder extracts in reducing the population of the maize armyworm. Similarly, Zubairu *et al* (2025) observed that neem based biopesticides effectively reduced insect pest population and improved okro yield in Ilorin, Nigeria. They reported that plots treated with neem extracts recorded lower pest infestation and better growth performance than untreated plots. The findings also corroborates with the findings of Idowu *et al* (2022) who reported that botanical extracts significantly reduced infestation of insect pests on okro while improving fruit yield and plant vigour. The plant materials reduced population of insect pest mainly due to contact toxicity and acting upon the nervous system of the insects. The highest number of pests in okro plants under the control treatment might be responsible for the increased damage of foliar parts which led to high economic injury level in the okro plant and reduced yield of the plant. This could be as a result of the non-application of the treatments hence the more a farmer neglects the use of insecticidal solution on his or her farm, the more exposure to high insect infestation. The superiority of weekly application over two-week application observed in this study suggests that the residual effects of botanical extracts under field conditions may be relatively short-lived. Environmental factors such as rainfall and sunlight may have accelerated degradation of active ingredients thereby reducing their persistence on plant surfaces. This corroborates the findings of Ibrahim *et al* (2026) who reported that repeated application of plant extracts at shorter intervals resulted to more effective control of okro flea beetles than longer spray intervals. The comparatively high performance of the synthetic insecticide

treatment was expected because synthetic insecticides generally possess rapid knockdown effects and longer residual activity. However the combined neem and pepper treatments produced results that were closely comparable to the chemical insecticide. This suggests that botanical insecticides can provide practical alternatives for resource poor farmers who may not be able to afford commercial pesticides. Overall, the study demonstrated that neem powder extracts and pepper extracts possess considerable insecticidal properties against okro flea beetles.

### Conclusion and Recommendation

The findings of this study revealed that neem powder extracts and pepper extracts possess significant insecticidal properties against okro leaf beetles. All the treatments reduced the beetle infestation, leaf damage and defoliation when compared with untreated control. The study further demonstrated that frequent application of botanical extracts enhanced their effectiveness as weekly application consistently performed better than two-week intervals. Based on the findings of this study, the combined application of neem powder extracts and pepper extracts at weekly intervals is recommended for the effective management of okro leaf beetles. The treatments significantly reduced beetle infestation. Minimized leaf damage, and improved okro yield while at the same time providing a safer and more environmentally friendly alternative to synthetic insecticide. Farmers should therefore be encouraged to adopt botanical insecticides as part of integrated pest management strategies in okro production. Agricultural extension agencies and research institutions should intensify farmer education on the preparation and proper application of botanical extracts for effective pest control. Furthermore, future studies should focus on optimizing formulation rates, evaluating the economic benefits of large scale application and assessing the residual effects and storage ability of the botanical extracts.

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Table 1. Effect of Botanical Insecticides on Leaf Beetle Population

	2WAP	4 WAP	6WAP	8 WAP	10 WAP	MEAN
<b>TREATMENT</b>						
NE 1WAP	1.14	1.00	1.28	2.16	2.28	1.57
PE 1WAP	1.14	1.00	1.28	2.15	2.43	1.60
NE 2WAP	1.00	1.14	1.62	2.28	2.10	1.61
PE 2WAP	1.28	1.14	1.41	2.15	2.23	1.64
NE+PE 1WAP	1.47	1.34	1.28	1.61	1.96	1.53
NE+PE 2WAP	1.28	1.33	1.28	2.43	2.58	1.78
CYPERMETHRIN	1.00	1.14	1.14	1.28	1.41	1.19
CONTROL	1.81	2.05	3.30	3.69	5.61	3.09
LSD (0.05)	<b>0.38</b>	<b>0.64</b>	<b>0.67</b>	<b>0.85</b>	<b>0.68</b>	

Footnote: Data values were transformed values. WAP= Weeks after planting, NE- Neem Extract, PE= Pepper extract.

Table 2. Effect of Neem extract, Pepper extracts and synthetic chemical on the number of leaves defoliated.

Footnote: NE= Neem Extract, PE= Pepper extract, WAP = Weeks After Planting.

TREATMENTS	WK2	WK4	WK6	WK8	WK10	MEAN
NE 1WAP	18.80	11.66	10.57	9.84	13.00	12.77
PE 1WAP	7.30	7.93	8.80	9.21	10.10	8.67
NE 2WAP	16.7	10.88	10.32	10.07	11.5	11.89
PE 2WAP	12.8	8.76	9.91	9.85	11.9	10.64
NA+PE 1WAP	5.80	6.18	8.04	7.71	10.10	7.57
NE+PE 2WAP	11.10	10.21	10.74	11.19	11.80	11.01
CYPERMETHRIN	2.70	5.26	4.21	4.11	6.50	5.54
CONTROL	21.2	45.08	50.10	53.40	65.50	47.06
LSD (0.05)	21.95	7.22	6.64	7.69	9.14	

Table 3. Effect of plant extract (Neem and Pepper extracts) on the number of fresh pods, pod weight and pod damage

TREATMENT	NUMBER OF PODS	WEIGHT OF PODS(t/ha)	DAMAGED PODS (%)
NE 1WAP	71.30	3.38	7.53
PE 1WAP	72.70	2.13	9.23
NE 2WAP	82.00	3.05	10.57
PE 2WAP	45.30	2.10	13.27
NE+PE 1WAP	79.30	3.28	5.87
NE+PE 2WAP	76.00	3.18	9.65
CYPERMETHRIN	84.00	3.63	3.87
CONTROL	39.70	1.61	21.67
LSD(0.05)	13.19	0.93	0.37

Footnote: NE= Neem Extract PE= Pepper extract, WAP - Weeks After Planting.

