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# MANAGEMENT OF ARTHROPOD PESTS OF GROUNDNUT (*Arachis hypogea* L.) WITH SELECTED PLANT EXTRACTS AND CYPERMTHRIN AT UMUDIKE, ABIA STATE

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**Abstract**
Field experiment was carried out at the Research farm of Michael Okpara University of Agriculture, Umudike, Abia State, during the cropping seasons (July-October, 2019) to determine the efficacy of leaf extracts of *Vernonia amygdalina* (Bitter leaf), *Carica papaya* (Paw-paw) and *Gmelina arborea* (Gmelina) and the synthetic insecticide (Cypermethrin) in the control of arthropod pests of groundnut (*Arachis hypogea* L.) and to assess the yield and yield components of the crop. The design was Randomized Complete Block Design (RCBD) with five treatments in three replicates. Data were collected at 4, 6, 8 and 10 weeks after planting (WAP) on the arthropod population, yield and yield components. The results indicated that arthropods belonging to two classes, four separate families, genera and species: arachnida (*Tetrnychus urticae*) and insecta (*Spodoptera litura*, *Oedaleus nigeriansis*, and *Empoasca kerri*) were identified with the aid of taxonomic keys and pictures. There was significant (P≤0.05) reduction in the population of arthropods in plots treated with plant extracts and Cypermethrin. At 10 WAP, the populations of the arthropods pests were significantly (P≤0.05) lower in *V. amygdalina* treated plots (2.33, 1.67, 1.33, and 4.00) compared with the untreated control plots (8.33, 5.00, 4.67, and 3.67). Treated plots also recorded significantly (P≤0.05) higher pod weights compared with control, except in *C. papaya* treated plot.

**Keywords**: **Groundnut, insect counts, botanicals, extracts, efficacy**

## Introduction

Groundnut (*Arachis hypogaea* L.) is a legume crop belonging to the family Fabaceae (Pasupuleti *et al.*, 2013). It originated from South America, and was later introduced into African continent from Brazil by the Portuguese in the 16th century (Adinya *et al.*, 2010). Other crops belonging to the family Fabaceae includes; Glycine *max* (soybean), *Phaseolus* (beans), *Pisum sativum* (pea), *Cicer arietinum* (chickpeas), *Medicago sativa* (alfalfa), *Ceratonia siliqua* (carob), and *Glycyrrhiza glabra* (liquorice) (Alege *et al.*, 2014). A number of species are also weedy pests in different parts of the world, including: *Cytisus scoparius* (broom), *Robinia pseudoacacia* (black locust), *Ulex europaeus* (gorse), *Pueraria montana* (kudzu), and a number of Lupinus species (Atwater and Barney, 2021). Groundnut is an annual herbaceous plant growing 30 to 50 cm (Ayozie, 2009). It has the bunch, erect and creeping type. The popular varieties in Nigeria are Kano local, Kano 50, Castle cary, Samnut 21, Samnut 22, and Samnut 23 (rosette resistant varieties) (Garba *et al.*, 2002)

Nigeria is the largest producer in Africa, with about 30% of the Continent's total production, followed by Senegal and Sudan (8% each) and Ghana and Chad (5% each) (Gwata *et al.*, 2003). In Nigeria, the crop is presently grown throughout the country with the exception of the riverine and swampy areas. The leading producing States include: Niger, Kano, Jigawa, Zamfara, Kebbi, Sokoto, Katsina, Kaduna, Adamawa, Yobe, Borno, Taraba, Plateau, Nasarawa, Bauchi, and Gombe (Yusuf, 2008). In Northern Nigeria, groundnut contributes 23% of household cash revenue (Ndjeunga *et al.*, 2010). Groundnut seeds are a rich source of oil (35–56%), protein (25-30%), carbohydrates (9.5–19.0%), minerals (P, Ca, Mg and K) and vitamins (E, K and B) (Gulluoglu *et al.*, 2016). It is an ideal crop in rotational systems to improve soil fertility due to its natural ability to fix atmospheric nitrogen (Jaiswal *et al.,* 2017). The kernels are eaten raw, roasted, sweetened or processed into peanut butter which is rich in protein and vitamins A and B. They are also consumed as confectionary product. Groundnut oil is edible and is also used in the production of soap, cosmetics, lubricants, olein, stearin and their salts (Himal, 2009). Groundnuts could prevent child malnutrition and are useful in the treatment of hemophilia, stomatitis and for the prevention of diarrhoea. The meal is beneficial for growing children, pregnant women, nursing mothers (Kenny and Finn, 2004) and is a good source of niacin, which contributes to brain health and blood flow. The most favourable climate for groundnut production is a well-distributed rainfall of at least 500mm, with adequate sunshine and relatively warm temperature. It requires an optimum temperature of between 25° and 30°C for optimum growth and development (Weiss, 2000) and does well on sandy – loam soil, with pH Range of 5-7. The soil should be rich in calcium and phosphorus which are essential for pod formation (Rezaul *et al*., 2013).

The production of this important crop has been limited by a number of factors which include; insect pest and diseases which attacks the plant and this result to low yield, reduction in pod size, poor yield quality and loss in market value (Jat and Tetarwal, 2014). The damages caused by these field pests have been mainly controlled with synthetic insecticides and despite the efficacy of these synthetic insecticides, several adverse effects have been reported resulting from their misuse (Lengai, *et al*., 2000). These include; human poisoning, destruction of natural enemies, insecticide resistance, crop pollination problem due to honey bee losses, domestic animal poisoning, contaminated livestock products, fish and wildlife losses (Grzywacz and Leavett, 2012). The ever-increasing problems associated with synthetic insecticides have synergized keen interest in the use of plant products as bio-insecticides. Botanicals are relatively safe, non-persistent, eco-friendlier and readily available (Dayan *et al.,* 2009). This study was therefore conducted to identify major arthropod pests of groundnut sown at Umudike, Abia State, Nigeria and to evaluate the effectiveness of the plant extracts and the synthetic insecticide (cypermethrin) in the control of insect pests of groundnut.

## Materials and Methods

The experiment was conducted at the Eastern farm of Michael Okpara University of Agriculture, Umudike, to determine the efficacy of selected leave extracts against cowpea pests. Umudike is located on latitude $5^0 29'$N and longitude $7^0$ $33'$E. The average annual rainfall is 2177mm and temperatures ranges from 29°C to 31°C, with relative humidity of 50-90% in the rain-forest ecological zone of Southeast Nigeria (NRCRI, 2019). The experimental site was cleared, pegged and ridges made manually using hoes and shovels. Each ridge had a dimension of 1.2m x 0.75m, with furrows of 1m in between, giving plot size of 10m x 5.25m = $52.5M^2$. The variety used in this study was Mbaise local and obtained from the National Agricultural Seed Council, NRCRI premises, Umudike. Organic manure (cured poultry droppings) was applied on each of the ridges and incorporated into the soil at a rate of 2kg per ridge before planting.

***Agronomic practices*:** The Groundnut seeds were sown at three seeds per hole on $13^{th}$ July, 2019 at a planting distance of 30cm, and later thinned to two plants per stand after plant emergence. Seeds that failed to germinate were supplied 4 days after planting. Weeding was done at 3WAP, 6WAP and 9WAP, with the use of hoes and hand pulling. At maturity, groundnuts were harvested and the pod weight (gram) determined using a sensitive balance. The treatments consist of leaf extracts of Gmelina (*Gmelina arborea),* Bitter leaf (*Vernonia amygdalina)* and Pawpaw (*Carica papaya)*. Cypermethrin; a synthetic insecticide was purchased at an agro-chemical store in Umuahia, Abia State, and the plant material; *C. papaya, G. arborea, V. amygdalina*, leaves were collected from Umudike environment.

***Preparation and application of the biopesticides***: Cold extraction method (Harborne, 1973) was used for the extraction of the plant leaves. The crude extracts were prepared by first of all sterilizing plant leaves in 1% Sodium hypochlorite (NaOCl) for 1 minute, washed 3 times in distilled water, and air dried to a very low moisture level to preserve. Two hundred gram (200g) leaves were separately weighed into a wooden mortar and pestle for pounding (Opara *et al*., 2013). The mixture was allowed to stand overnight, and then strained through double folds of sterile cheese cloth, into separately labelled clean bucket to obtain a homogeneous substance that was used for spraying. The aqueous solutions were taken to the field for spraying using a 500ml hand sprayer and applied on the plants till runoff, five times at weekly intervals. This was done early in the mornings between 6:00am - 7:00am and Cypermethrin (12.5% E.C) applied at 2mls/plot.

***Pest sampling*:** Insect pests were collected with a sweep net, cellophane bags and sample bottles. Others were hand-picked using hand gloves and plastic forceps. Samplings were carried out at 4WAP, 6WAP, 8WAP and 10WAP. These were done 2 days after each spray. Collected insects were stored with chloroform and later identified in the laboratory using taxonomic key, picture chart and lens.

***Data collection***: Data were also collected on the following growth parameters:

***Insect population count*:** Assessment of the population of insect was done by visual counting on the 4 randomly tagged plant of each plot, using sweep nets. These were done 2 days after each spray, between 6:30am and 7:30am.

***Height of the plant*:** The height of the plant was measured with a meter rule from the soil level to the tip of plant, on the 4 randomly tagged plant of each plot.

***Number of branches***: The number of branches was obtained by visual counting of the number of branches on the 4 randomly tagged plant of each plot.

***Number of leaves***: The number of leaves was obtained by visual counting of the number of leaves on the 4 randomly tagged plant of each plot.

***Leave damage assessment***: Number of damaged leaves was determined by counting and recording of the number of leaves damaged by insects. Leaf damage data were recorded at 4, 6, 8, and 10WAP.
This was calculated thus;

$$\frac{\text{Total number of leaves damage}}{\text{Total number of leaves}} \times 100$$

***Weight of pods***: These was done after the pod from each plot were harvested, washed to remove soil and then weighed in the laboratory, using weighing balance of 0.01g sensitivity.

***Experimental Design and Statistical analyses***
The design was Randomized Complete Block Design (RCBD) with five treatments and three replicates. Data collected were subjected to analysis of variance using Genstat statistical package and significant means were separated by Fisher's Least Significant Difference (FLSD), at 5% level of significance.

**Results and Discussion**
The effect of the plant extracts and cypermethrin on field pests of groundnut at Umudike is presented in Table 1. The identified pest populations infesting groundnut in the field at 4 and 6 WAP were *Empoasca kerri*, *Spodoptera litura*, *Tetranychus urticea* and *Oedaleus nigerianensis*. At 4 WAP, their populations were not significantly different among the treatments. Whereas, at 6 WAP, Cypermethrin treated plots recorded the least insect population, and significantly ($P \leq 0.05$) lower than those treated with plant extracts. The plots treated with *V. amygdalina* among the plant extracts recorded the lowest insect population. Arthropod population were *E. kerri* (3.33), *S. litura* (2.67), *T. urticea* (2.67), and *O. nigeriensis* (1.67), followed by plots treated with *G. arborea* and the control had the highest number of pests; *E. kerri* (6.00), *S. litura* (3.67), *T. urticea* (4.00) and *O. nigeriensis* (4.00).

Table 2 presents the effect of selected plant extracts on arthropod pests infesting groundnut at Umudike. Results showed that at 8 WAP, Cypermethrin and the plant extracts were significantly different ($P<0.05$) from the untreated control, except for *T. urticae* and *O. nigeriensis* where the treatments types had no significant effect on the population of the pests. The least count was on the Cypermethrin treated plot, followed by *G.arborea* treated plot which recorded a low arthropod population of *E. kerri* (2.67), *S. litura* (2.00), *T. urticea* (2.33), *O. nigeriensis* (1.13), followed by plots treated with *V. amygdlina*. The untreated plots had the highest number of pests at 8 and 10 WAP. For the 10 WAP, after the synthetic treated plots, *V. amygdalina* treated plot had the lowest number of insects; *E. kerri* (2.33), *S. litura* (1.67), *T. urticea* (1.33), *O.nigeriensis* (4.00), followed by *Gmelina arborea* treated plot which recorded *E. kerri* (2.67), *S. litura* (1.67), *T. urticea* (2.00), *O. nigeriensis* (3.33), while the untreated plot had the highest number.

Table 3 shows the effects of plant extracts and Cypermethrin insecticide on the height of the Groundnut plant at 4, 6, 8, and 10 WAP. The result shows that among the plant extracts plots treated with *V. amygdalina* produced the highest height of the plant (26.33, 36.92, 40.775 and 58.283), followed by plots treated with *C. papaya* (25.73, 36.52, 40.625, and 50.500) and the untreated plots recorded the least in height (24.92, 36.53, 39.800 and 50.108), followed by plots treated with *G. arborea* (25.43, 36.43, 40.325, and 52.358) at 4, 6, 8, and 10 WAP respectively. The synthetic (Cypermethrin) recorded the highest in all the treatments (26.33, 36.92, 40.775 and 58.283) at 4, 6, 8, and 10 WAP respectively. There were significant ($P<0.05$) differences on the height of the plant.

Table 4 shows the effect of plant extracts and synthetic insecticide on number of branches at 4, 6, 8, and 8 WAP. The result obtained showed that, plots treated with *V. amygdalina* among the plant extracts recorded the highest number of branches (3.083, 3.333, 4.917 and 5.917) and the control plots recorded the list number of branches (3.083, 3.250, 4.833 and 5.833) at 4, 6, 8, and 10WAP respectively, followed by plots treated with *G. arborea* (3.00, 3.10, 4.92, 5.92) in that order. The synthetic Cypermethrin had the highest number of branches (3.17, 3.42, 5.087, and 6.00) in all the treatments at 4, 6, 8, and 10 WAP respectively. The result shows that all plant extract and synthetic were not significantly different.

The effect of plant extracts and synthetic insecticide on number of leaves at 4, 6, 8, and 10 WAP is shown in Table 5. The result of the study indicates that the plots treated with *V. amygdalina* had the highest number of leaves (282.6, 297.1, 413.25 and 417.9) among the plant extracts at 4, 6, 8, and 10 WAP respectively, and the untreated plots had the least number of leaves (278.4, 294.2, 336.92 and 354.2) at 4, 6, 8 and 10 WAP also. The synthetic insecticide (Cypermethrin) had the highest number of leaves in all the treatments (286.0, 302.0, 420.25 and 481.4), also at 4, 6, 8, and 10 WAP respectively. There were significant ($P<0.05$) differences recorded in the number of leaves based on insecticide types, except at 6WAP, which was not significantly different.

Table 6 shows the effect of plant extracts and Cypermethrin insecticide on number of damaged leaves at 4, 6, 8, and 10 WAP respectively. Leaves damaged assessment showed that, plots treated with *V. amygdalina* had the lowest number of damaged leaves (9.09, 10.99, 8.96 and 9.53), followed by plots treated with *C. papaya* (13.61, 12.53, 11.08 and 9.98) and untreated control plots recorded the highest (14.02, 16.44, 14.95 and 14.14) number of damaged leaves at 4, 6, 8, and 10 WAP respectively. The Cypermethrin had the lowest number of damaged leaves in all the treatments (6.42, 8.43, 7.38 and 6.58) at 4, 6, 8 and 10 WAP respectively.

Table 7 shows the effects of plant extracts and Cypermethrin insecticide on weight of pods. The data regarding pods weight of groundnut revealed that all the treatments were significantly different on pod weight over untreated control. The result shows that among the plant extracts, plots treated with *V. amygdalina* had the highest pod weight (80.1), followed by plots treated with *G. arborea* (77.6) and plots with *C. papaya* (73.5). However, the lowest was untreated control (66.0) and the synthetic (Cypermethrin) had the highest (88.5) pod weight in all the treatments.

This study shows that the three plant extracts (*C. papaya, G. arborea* and *V. amygdalina)* had insecticidal activity against insect pests of Groundnut. From the experiment, the identified insects' pests of groundnut in Umudike, Abia State were *E. kerri*, *S. litura*, *T. urtisea* and *O. nigerianensis*. The results indicate that the extracts of the three plant species exhibited moderate level of insecticidal activity in effectively reducing insect pest population and proved significantly different from the untreated control at 5% probability level. This finding was validated by Emeasor and Nwosu (2018) that the plant extracts of *V. amygdalina*, *G. arborea* and *C. papaya* demonstrated potent insecticidal properties against insect pest.

The plant extracts of *V. amygdalina* and *C. papaya* leaves proved to be the most effective among the plant extracts in reduction of number of insect pests up to the 10 WAP. The result confirmed the previous work by Emeasor and Nwosu (2018) who reported that extract of *V. amygdalina* leaves was the most effective in reducing the insect pest infestation among the plant extracts. Onunkun, (2012), also confirmed that the leaves extract of *V. amygdalina* possess insecticidal properties. The plant extract reduced the insect pests up to the seventh day after application.

The use of plants, plant material or crude plant extracts for the protection of crops and stored products from insect pests have been recorded as one of the oldest crop protection methods (Thacker, 2002). Several authors have shown the efficacy of different plant materials as biopesticides for the control of different pest species. Cashew plant extracts have been found to be effective against post-flowering insect pests of cowpea (Oparaeke *et al.,* 2005; Amatobi 2000). Neem, West African black pepper, garlic bulb, African nutmeg, and *Lippia adoensis* Hoschst, have been reported to be effective against some crop pest species (Jackai and Oyediran 1991; Scott and McKibben 1978; Olaifa *et al*.,1987; Oparaeke *et al*., 2000). Okech *et al*. (1997) in a field trial, observed that *Tephrosia volgelii* aqueous extract effectively reduced maize stalk borer (*Chilo partellus* Swinhoe) numbers and damage symptoms and improved grain yield.

In this study, Cypermethrin proved to be the most effective in all the treatments. The high effectiveness of Cypermethrin compared to *V. amygdalina*, *C. papaya* and *G. arborea* could also be associated with its standardized active ingredient formulations that have a "knockdown" effect on pests immediately on exposure, like all Pyrethroids do (Hills and Waller, 1988), whereas, the low efficiency of the plant extracts could be among other reasons, due to lack of the "knockdown" effect and rapid breakdown (non-persistence). The plant materials reduced population of insect pest mainly due to contact toxicity and acting upon the nervous system of the insects. The effectiveness of the synthetic insecticide is a confirmation of the report of Brooke and Hines (1999), that chemical insecticides have been the primary control agent of agricultural pests.

On the yield and yield components of Groundnut, the present investigation shows that, the control plots recorded the lowest in plant height. The plant heights of the Groundnut treated with various plant extracts were significantly different from the control. Similar observations were recorded for the number of Leaves, except at 6WAP, which was not significant and for number of branches. The weight of Groundnut pods treated with the various plant extracts and Cypermethrin were significantly higher than for the control.

**Conclusion**

The results of this studyt revealed that plant extracts from leaves o*f V. amygdalina*, *C. Papaya*, *G. arborea* have biopesticidal activity against some arthropod pests of groundnut. The study also showed that yield and yield parameters were significantly higher in extract treated plots than in the control plots. These plant extracts can be a suitable alternative to synthetic pesticides for arthropod pest management. Farmers adopting the use of plant derived pesticide will help alleviate growing public concerns regarding the effects of synthetic pesticides on human health and environmental impact, and these plants derived pesticides are easily assessable, friendly to environment, relatively cheap and easy to apply by non-professionals for enhanced groundnut production in Nigeria.

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**Table 1: Effect of Different Plant Extracts and Synthetic Insecticide on Field Insect Pests of Groundnut at 4 and 6 WAP**

| Treatment | 4 WAP | | | | 6 WAP | | | |
|---|---|---|---|---|---|---|---|---|
| | **EK** | **SL** | **TU** | **ON** | **EK** | **SL** | **TU** | **ON** |
| ***Carica papaya*** | 8.00 | 4.00 | 4.33 | 2.33 | 3.67 | 2.33 | 3.00 | 1.33 |
| | (2.91) | (2.11) | (2.18) | (1.40) | (2.04) | (1.68) | (1.86) | (1.68) |
| ***Gmelina arborea*** | 7.67 | 3.33 | 4.33 | 2.00 | 5.00 | 2.67 | 3.33 | 2.33 |
| | (2.85) | (1.95) | (2.18) | (1.43) | (2.34) | ()1.77 | (1.95) | (1.54) |
| ***Vernonia*** | 7.67 | 3.67 | 3.00 | 2.00 | 3.33 | 2.67 | 2.67 | 1.67 |
| ***amygdalina*** | (2.85) | (2.04) | (1.86) | (1.35) | (1.95) | (1.77) | (1.770 | (1.29) |
| **Cypermethrin** | 7.67 | 4.00 | 4.00 | 2.00 | 2.67 | 2.00 | 2.00 | 1.33 |
| | (2.85) | (2.11) | (2.11) | (1.40) | (1.77) | (1.58) | (1.58) | (1.16) |
| **Control** | 6.67 | 3.00 | 3.00 | 3.33 | 6.00 | 3.67 | 4.00 | 4.00 |
| | (2.66) | (1.86) | (1.86) | (1.82) | (2.52) | (2.04) | (2.11) | (2.11) |
| **Mean** | 7.53 | 3.60 | 3.73 | 2.33 | 4.13 | 2.67 | 3.00 | 2.13 |
| **LSD 0.05** | NS | NS | NS | NS | 2.78 | 1.06 | 0.88 | 0.97 |

***EK: Empoasca kerri (Leaf hopper); SL: Spodotera liturara (To bacco Caterpillar); TU: Tetranychus urticae (Spider mite); ON: Oedaleus nigeriensis (Nigerian grasshoppers); WAP: Weeks After Planting. Data in parenthesis are square root transformed data***

**Table 2: Effect of different Plant extracts and synthetic ins ecticide on field insect pests of Groundnut a t 8 and 10 WAP**

| Treatment | 8 WAP | | | | 10 WAP | | | |
|---|---|---|---|---|---|---|---|---|
| | **EK** | **SL** | **TU** | **ON** | **EK** | **SL** | **TU** | **ON** |
| ***Carica papaya*** | 3.33 | 2.67 | 2.00 | 3.00 | 2.67 | 2.00 | 2.00 | 3.33 |
| | (1.95) | (1.77) | (1.56) | (1.73) | (1.77) | (1.58) | (1.58) | (1.82) |
| ***Gmelina arborea*** | 2.67 | 2.00 | 2.33 | 1.13 | 2.67 | 1.67 | 2.00 | 3.33 |
| | (1.77) | (1.58) | (1.68) | (1.16) | (1.77) | (146) | (1.56) | (1.95) |
| ***Vernonia*** | 3.00 | 2.00 | 1.33 | 2.61 | 2.33 | 1.67 | 1.33 | 4.00 |
| ***amygdalina*** | (1.87) | (1.58) | (1.34) | (1.61) | (1.68) | (1.46) | (1.34) | (1.97) |
| **Cypermethrin** | 1.33 | 1.33 | 1.33 | 1.00 | 1.00 | 1.00 | 1.00 | 1.67 |
| | (1.34) | (1.34) | (1.34) | (1.02) | (1.02) | (1.02) | (1.02) | (1.29) |
| **Control** | 7.00 | 4.00 | 3.67 | 2.61 | 8.33 | 5.00 | 4.67 | 3.67 |
| | (2.71) | (2.12) | (2.04) | (1.59) | (2.97) | (2.33) | (2.27) | (1.89) |
| **Mean** | 3.47 | 2.40 | 2.13 | 2.13 | 3.40 | 2.00 | 2.20 | 3.20 |
| **LSD 0.05** | 2.443 | 0.6431 | NS | NS | 1.002 | 1.031 | 1.060 | 2.13 |

***EK: Empoasca kerri (Leaf hopper); SL: Spodotera liturara (Tobacco Caterpillar); TU: Tetranychus urticae (Spider mite); ON: Oedaleus nigeriensis (Nigerian grasshoppers); WAP: Weeks After Planting. Data in parenthesis are square root transformed data***

Table 3: Effect of Plant extracts and synthetic insecticide on height of the plant

| Treatment | HP | HP | HP | HP |
|---|---|---|---|---|
| | **4WAP** | **6WAP** | **8WAP** | **10WAP** |
| ***Carica papaya*** | 25.73 | 36.52 | 40.625 | 54.500 |
| ***Gmelina arborea*** | 25.43 | 36.42 | 40.325 | 52.358 |
| ***Vernonia amygdalina*** | 26.33 | 36.92 | 40.775 | 58.283 |
| **Cypermethrin** | 26.03 | 38.07 | 46.325 | 60.350 |
| **Control** | 24.92 | 36.53 | 39.800 | 50.108 |
| **Mean** | **25.69** | **36.89** | **41.570** | **55.120** |
| **LSD(0.05)** | **0.970** | **0.817** | **0.5725** | **0.3645** |

*HP: Height of Plant; WAP: Week After Planting*

**Table 4: Effect of Plant extracts and synthetic in secticide on Number of branches at 4, 6, 8 and 10 WAP**

| Treatment | Number of Branches | | | |
|---|---|---|---|---|
| | **4WAP** | **6WAP** | **8WAP** | **10WAP** |
| ***Carica papaya*** | 3.083 | 3.250 | 4.917 | 5.917 |
| ***Gmelina arborea*** | 3.000 | 3.100 | 4.917 | 5.917 |
| ***Vernonia amygdalina*** | 3.083 | 3.333 | 4.917 | 5.917 |
| ***Cypermetrin*** | 3.167 | 3.417 | 5.087 | 6.000 |
| **Control** | 3.083 | 3.250 | 4.833 | 5.833 |
| **Mean** | **3.083** | **3.270** | **4.633** | **5.917** |
| **LSD(0.05)** | **NS** | **NS** | **NS** | **NS** |

*NB: Number of Branches; WAP: Week After Planting*

**Table 5: Effect of Plant extracts and synthetic insecticide on Number of leaves at 4, 6, 8 and 10 WAP**

| Treatment | Number of leaves | | | |
|---|---|---|---|---|
| | **4WAP** | **6WAP** | **8WAP** | **10WAP** |
| ***Carica papaya*** | 231.9 | 294.1 | 349.33 | 390.8 |
| ***Gmelina arborea*** | 277.3 | 294.8 | 340.50 | 361.1 |
| ***Vernonia armygdalina*** | 282.6 | 297.1 | 413.25 | 417.9 |
| ***Cypermetrin*** | 286.0 | 302.0 | 420.25 | 481.4 |
| **Control** | 278.4 | 294.2 | 336.92 | 354.2 |
| **Mean** | **271.2** | **296.4** | **372.05** | **401.1** |
| **LSD 0.05** | **66.36** | **NS** | **5.502** | **48.21** |

*NL: Number of leaves; WAP: Week After Planting*

**Table 6: Effect of Plant extracts and synthetic insecticide on Leaves damaged at 4, 6, 8 and 10 WAP**

| Treatment | Leaves damaged | | | |
|---|---|---|---|---|
| | **4WAP** | **6WAP** | **8WAP** | **10WAP** |
| ***Carica papaya*** | 13.61 | 12.53 | 11.08 | 9.98 |
| ***Gmelina arborea*** | 11.79 | 13.48 | 13.61 | 13.31 |
| ***Vernonia amygdalina*** | 9.09 | 10.99 | 8.96 | 9.53 |
| ***Cypermethrin*** | 6.42 | 8.43 | 7.38 | 6.58 |
| **Control** | 14.02 | 16.44 | 14.95 | 14.14 |
| **Mean** | **10.99** | **12.37** | **11.19** | **10.71** |
| **LSD(0.05)** | **4.398** | **1.428** | **1.416** | **1.222** |

*LD: Leaves Damaged; WAP: Weeks After Planting*

**Table 7: Effect of Plant extracts and synthetic insecticide on weight (t/ha) of pods**

| Treatment | WP(t/ha) |
|---|---|
| ***Carica papaya*** | 73.5 |
| ***Gmelina arborea*** | 77.6 |
| ***Vernonia amygdalina*** | 80.1 |
| ***Cypermethrin*** | 88.5 |
| **Control** | 66.0 |
| **Mean** | **77.1** |
| **LSD(0.05)** | **8.68** |

**WP: Weight of Pods**