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# Comparative Toxicity of Botanical and Synthetic Insecticides Against major Field Insect Pests of Cowpea *(Vigna unquiculata( L) Walp)*

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## ABSTRACT

*Field experiment was conducted during the major raining season of 2006 to evaluate the effectiveness of two plant extracts – Tephrosia vogelii and Petiveria alliacea applied as insecticides singly and as a mixture of the two in ratio 1:1 at three major insect pests – Maruca vitrata (Tab), Megalurothrips sjostedti (try) and Ripotortus dentipes (Fab). Unsprayed and synthetic insecticide (Decis) treated plots were included for comparison. Application of the extracts irrespective of concentrations, significantly suppressed insect pests population, reduced pod damage and increased grain quality compared with control. However, the mixture of the extracts at 20 % concentration competes favourably with synthetic insecticide (Decis). The result further demonstrated that, the effectiveness of the extracts as insecticide was dose-dependent.*

**Key words**: Decis, *T. vogelii*, *P. allaicea*, dose, concentration.

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## INTRODUCTION

Cowpea *(Vigna unguiculata( L). Walp*) is an important grain legume throughout the tropics and, covering Asia, Africa, central and south America, as well as parts of Southern Europe (Singh; *el at* 1997). The largest production is in Africa with Nigeria and Niger accounts for 87% of worlds cowpea harvest (23). In Nigeria, cowpea is grown mainly for human as well as for animal food. It is cultivated either as monocrops or in mixed cropping situations with other crops, especially cereals.

The major constraint in the cultivation of cowpea is insect pests attack which has been observed to have caused up to 70% grain yield loss (4). Among the insect pests of cowpea, post-flowering insects such as *Meglurothrips sjostedti Tryborn, Maruca vitrata, Fabricious Clavigralla tomentoscollis* Stat and *Riptortus dentipes* Fab (14) have been implicated to have caused major economic lost. The larvae of *Maruca testulalis* have been implicated to have caused serious economic damages to both flowers and pods of cowpea. This can result to 70% yield loss (20). Both Adult and nymph cause destruction to shoots, flower buds and pollen of cowpea, damage done after 42 days from planting can responsible for significant yield loss (NR 1, 1996). The same author also reported that *Riptortus dentipes* feed on both green pods of cowpea which result to seed deformation, drying, abortion and pod shriveling.

Insect pests of cowpea have mainly been controlled with synthetic insecticides (15, 1). Most insecticidal compounds fall within four main classes - organophosphates, organochlorines. carbamates and pyrethroids. As a result of the problems of pesticide resistance and negative effects on non-target organisms including man and the environment, organochlorine has been reportedly banned in developed countries. This resurcitated the idea of botanical insecticide as a promising alternative to pest control. Botanical insecticides are naturally occurring chemical extracted from plants which break down readily in the soil and are not stored in plant or animal tissue. Often their effect are not long lasting as those of synthetic pesticides (11). Botanical insecticides are generally pest – specific and are relatively harmless to non-target organisms. They are biodegradable and harmless to the environment. Also, the possibility of insect developing resistance to botanical insecticide is less likely (25).

Over 2000 species of plants are known to have possessed insecticidal activities (21,11) despite this only a few have been scientifically evaluated.

*Petiveria alliacea* which is commonly known as Anamu belongs to the family phtolaccacea (9, 16). (13) reported several biological compounds in the root of *P.alliacea* which include: benzalhyde ,dibenzyltrisulfide , cis and trans-stibene *e.t.c* of which dibenzyltrisulfide is insecticidal compound. Laboratory and field tests have shown the effectiveness of this plant extract against armyworm, leaf-cutting, ants, whiteflies and the three stages of moqiutoes ( 3). Fish bean (*Tephnosia vogelii*) which has been listed among plants that posses insecticidal properties (12) contains rotenoids (18) of which the leaves contain the highest concentrations (Merck, 1996). Rotenone is both stomach and contact poison, useful against sucking and biting insects (27). *T.vogelii* extracts have been reported to be effective in the control of ticks, lice and flies on animals (18). Also, formulation of *T.vogelii* + locust lotion was observed to be effective as Lambdacyalothrin in the control of insect pests of Okra in the field (2). *Caryedon serratus* of groundnut was effectively controlled by *T.vogelii* (7). In addition, *T.vogelii* was observed to have had negative effect on the fecundity of *Tribolium casteaneum* (6).

This study was therefore conducted to determine the efficacy of plant extracts on *Maruca vitrata*, *Megalurothrips sjostedti* and *Riptortus dentipes* infesting cowpea on the field.

## MATERIALS AND METHODS

### 3.1 Study Site

The field experiment was conducted at Ladoke Akintola University of Technology (LAUTECH) Teaching and Research Farm, Ogbomoso, Nigeria ( longitude $4^0 30^1$E and latitude $10^0 5^1$N). The region climate could be described as hot humid tropical falls in Southern Guinea Savanna of

Nigeria with a mean temperature of 27$^0$C and annual rainfall of 1400mm.It is marked with dry and wet seasons, characterized by a bi-modal rainfall pattern with peaks in July and September.

### 3.2 Preparation of Botanicals

The plant species screened for insecticidal properties were *T.vogelii* and *P. alliacea.* The two plants were collected from Botanical Garden of Teaching and Research Farm LAUTECH, Ogbomoso. Fresh leaves and roots of the two plants were harvested at full maturity. In order to prepare extract from each of them, Five hundred grammes (500g) each of fresh leaves of *T. vogelii* and root of *P. alliacea* were crushed separately in a mortar with pestle. The crushed plant parts were put in a separate plastic buckets containing one litre of water. These were allowed to settle overnight and the aqueous suspension was filtered through Muslin cloth. The filtrate then served as stock solution for the experiment. The extract from each plant was diluted to various (5, 10 and 20 %) concentrations meaning that 5, 10 and 20% each was collected separately from 1000ml of the stock solution. However, 5% was equavelent to 50ml, 10% was equivalent to 100ml while 20% was 250ml of the stock solution. The unsprayed plots and synthetic insecticide (Decis) treated at 0.8 L / ha were included for comparison. Each of the concentrations both synthetic and botanical insecticides was diluted with 1000ml of water to achieve the same spraying volume.

### 3.3 Experimental Design and Field Layout

The experimental site which occupied 0.6 hectare of land was ploughed and harrowed once. Thirty-six plots were demarcated and arranged in a randomized complete block design with three replications of twelve treatment combinations. Each plot had five rows. The plot size was 3 m x 3 m with 1 m x 2 m gaps between adjacent plots and blocks.

The test crop was Ife Brown cowpea variety. This was chosen because it is highly susceptible to insects attack. The seeds were obtained from IITA Ibadan. Planting was done in 2006 cropping season, two to three seeds were dropped per stand and thinning was done one week after planting to achieve one plant per stand. The crop was spaced out at 30 cm x 60 cm. Manual weeding was done fortnightly.

### 3.4 Treatment Application

Application of treatment, which was on weekly basis was done by spraying each plot very early in the morning using appropriate concentration of the extracts and the synthetic insecticide as stated in section 3.2 above. Treatment application commenced, 35 days after planting. Early morning application was observed to prevent photodecomposition of the extracts. This was in line with method used by (24, 22). However, Decis was applied two weeks after planting to prevent pre-flowering insect pests.

### 3.5 DATA COLLECTION

Estimation of population densities of nymphs of *Megalurothrips sjostedtii* and larvae of *Maruca vitrata* were done by randomly picking five flowers per plot at 50 % flowering. The flowers were placed in a glass vials containing 30 % Alcohol. The flowers were opened-up, the insects found were counted. This was done a day after each treatment.

Population densities of *Riptortus dentipes* were done after each weekly treatment, beginning from four weeks after planting, this was done a day after each treatment.
The visual counting of the insects was based on three inner rows of each plot and was done in the early hours of the day when they were relatively inactive.

At full ripening, 30 pods were picked randomly from the middle rows in each plot. The pods were observed and rated for twisting, stunting infection, constriction and shriveling were used as an index of pod damage. Thereafter, the pods were split opened and seeds contained extracted. The seed were cleaned, air-dried and weighed for grain yield determination. The result was expressed as grain yield per hectare. A hundred grains were picked randomly from seeds. Wrinkled grains and those showing feeding punctures from 100 grains were used to expressed grain quality (22).

### 3.6. DATA ANALYSIS

Data collected were subjected to analysis of variance (ANOVA) using Randomised Complete Block Design (R C B) as reported by (10). Significant means were compared using Duncans Multiple Range test (DMRT) at 5% probability level.

## RESULTS

Table 1 shows effect of insecticide treatments on *R. dentipes.* Application of botanical at lowest concentration (5% v/v) gave significant results when compared to unsprayed. But among the least concentrations, combination of the two plant extracts had highest insecticidal activity against *R. dentipes*. The efficacy of botanical insecticides at highest concentration (20% v/v) was comparable with synthetic insecticide (Decis) at $2^{nd}$, $3^{rd}$ and $4^{th}$ week after treatment thought highest population of *R. dentipes* was observed from the single application of *T. vogelii* and *P. alliacea* at 20% concentration.

All the botanical insecticides, irrespective of concentration exhibited high significant insecticidal compared with untreated plots. Also, effectiveness of the combination of the plant extracts at 10% concentrations was comparable with single application of each extracts at highest concentrations (20% v/v).

Table 2 reveals the effect of botanical insecticides on *M. vitrata.* There were no significant differences between botanical insecticides and synthetic insecticides. However, highest number of *M. vitrata* was observed from the plants treated with the least concentration (5% v/v) followed by 10% concentration, except the plants treated with combination of the plant extracts at 10% concentration of the plant extracts at 10% concentration which had the same number of *M. vitrata* with single application of the plant extracts at 20% v/v. Irrespective of concentration level, botanical insecticide effectively controlled *M. vitrata* compared with untreated plants.

Table 3 shows effect of botanical treatments on *C. tomentosicollis*. Higher number of *C. tomentoscollis* was observed at $1^{st}$ and $2^{nd}$ week after treatment. There was no significant difference between the single applications of plant extracts at 20% concentration and combination of the extracts. However, all the botanical insecticides regardless of the concentration were effective compared with unsprayed plants.

With reference to grain yield, there were significant different among the botanical insecticides with combination of plant extracts which had highest grain yield followed by single application of the extracts at 20% concentration. However, all the botanical treated plants resulted into higher yield than untreated plants (control) (Fig 1). Pods were protected against insect infestations with botanical treated plants compared with untreated plants with significant difference among the botanical insecticides. there was significant difference among the botanical insecticides(Fig 2). Among the botanical insecticides combination of plant extracts at 20% resulted to good grain quality than the others (fig 3). However, no significant difference was observed from the single application of the extracts at 20% and combination of the extracts at 10% concentration (Fig 3).

**Table 1: Mean number of *R. dentipes* in response to weekly application of plant extracts**

| | Weeks after treatment | | | |
|---|---|---|---|---|
| Treatment | 1 | 2 | 3 | 4 |
| Control | 2.34a | 2.33a | 2.00a | 1.45a |
| Decis | 0.45d | 0.22b | 0.00c | 0.00b |
| T.v (5%) | 1.44b | 1.56a | 1.00b | 0.45b |
| T.v (10%) | 1.11bc | 0.56a | 0.45bc | 0.22b |
| T.v (20%) | 0.78cd | 0.56b | 0.22c | 0.00b |
| P.a (5%) | 0.89bcd | 0.56b | 0.45bc | 0.22b |
| P.a (10%) | 0.89bcd | 0.45b | 0.45bc | 0.22b |
| P.a (20%) | 0.67cd | 0.44b | 0.22c | 0.00b |
| T.v+Pa(5%) | 0.56cd | 0.67b | 0.45bc | 0.33b |
| T.v+Pa(10%) | 0.56cd | 0.33b | 0.22c | 0.00b |
| T.v+Pa(20%) | 0.45d | 0.22b | 0.00c | 0.00b |

*Mean having the same alphabet (s) in a column are not significantly different ($p<0.05$ )*
*T.v = T.vogelii; P.a = P. aliaea*

**Table 2: Mean number of *M. vitrata* (nymphs) in response to weekly application of plant extracts**

| | Weeks after treatment | | | |
|---|---|---|---|---|
| Treatment | 1 | 2 | 3 | 4 |
| Control | 4.33a | 3.67a | 2.33a | 2.33a |
| Decis | 0.33b | 0.33b | 0.00b | 0.00b |
| T.v (5%) | 1.33b | 1.33b | 1.67b | 0.67b |
| T.v (10%) | 0.67b | 0.67b | 0.33b | 0.00b |
| T.v (20%) | 0.67b | 0.33b | 0.00b | 0.00b |
| P.a (5%) | 1.67b | 1.33b | 1.00b | 0.67b |
| P.a (10%) | 0.67b | 0.67b | 0.67b | 0.00b |
| P.a (20%) | 0.67b | 0.67b | 0.00b | 0.00b |
| T.v+Pa (5%) | 1.33b | 0.67b | 0.67b | 0.33b |
| T.v+Pa (10%) | 0.67b | 0.67b | 0.33b | 0.00b |
| T.v+Pa (20%) | 0.67b | 0.33b | 0.00b | 0.00b |

*Means having the same letter of aphabet in a column are not significantly different ($p<0.05$ )*

**Table 3: Mean number of *C. tomentosicollis* in response to weekly application of plant extracts**

| | Weeks after treatment | | | |
|---|---|---|---|---|
| Treatment | 1 | 2 | 3 | 4 |
| Control | 2.00a | 1.78a | 1.45a | 1.45a |
| Decis | 0. 78ab | 0.33b | 0.00b | 0.00c |
| T.v (5%) | 1.67ab | 1.40ab | 0.87ab | 0. 67c |
| T.v (10%) | 1.22ab | 1.22ab | 0.89ab | 0.44bc |
| T.v (20%) | 0.89ab | 0.89ab | 0.44b | 0.00c |
| P.a (5%) | 1.44ab | 1.11ab | 0.89ab | 0.89ab |
| P.a (10%) | 1.33ab | 0.78ab | 0.67ab | 0.44bc |
| P.a (20%) | 1.00ab | 0.89ab | 0.56ab | 0.00c |
| T.v+Pa (5%) | 1.00ab | 1.11ab | 0.56ab | 0.22bc |
| T.v+Pa (10%) | 1.00ab | 0.56b | 0.44b | 0.1000c |
| T.v+Pa (20%) | 0.88ab | 0.56b | 0.00b | 0.00c |

*Mean having the same letter of aphabet in a column are not significantly different (p<0.05)*

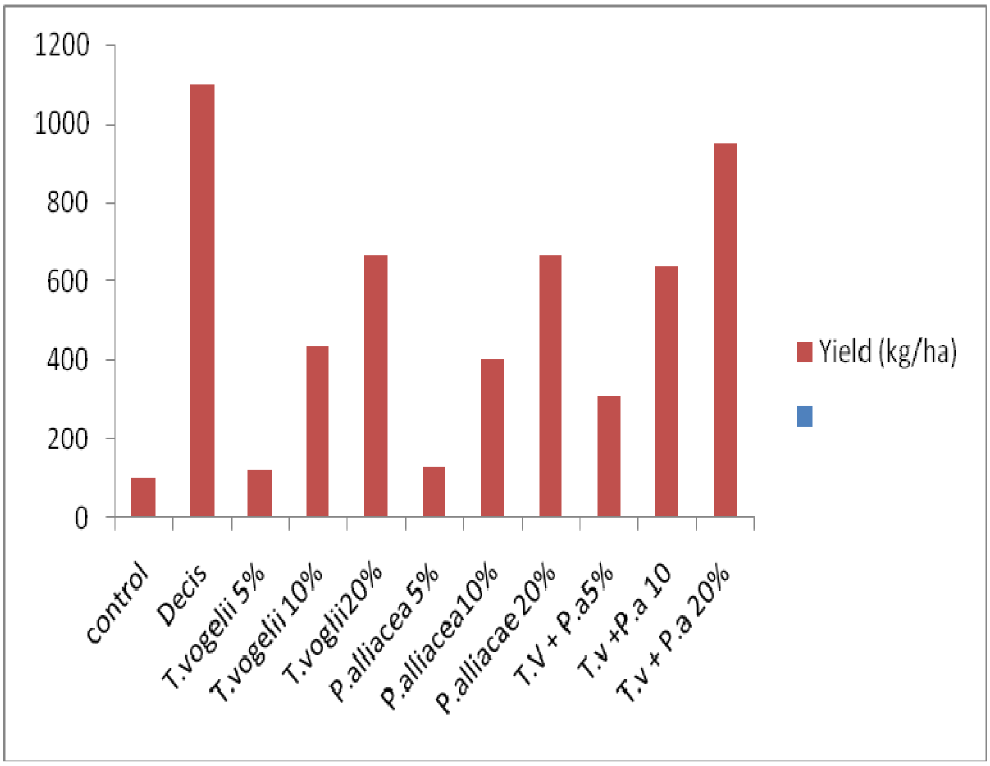


**Fig: 1 Effect of plant extract on grain yield**

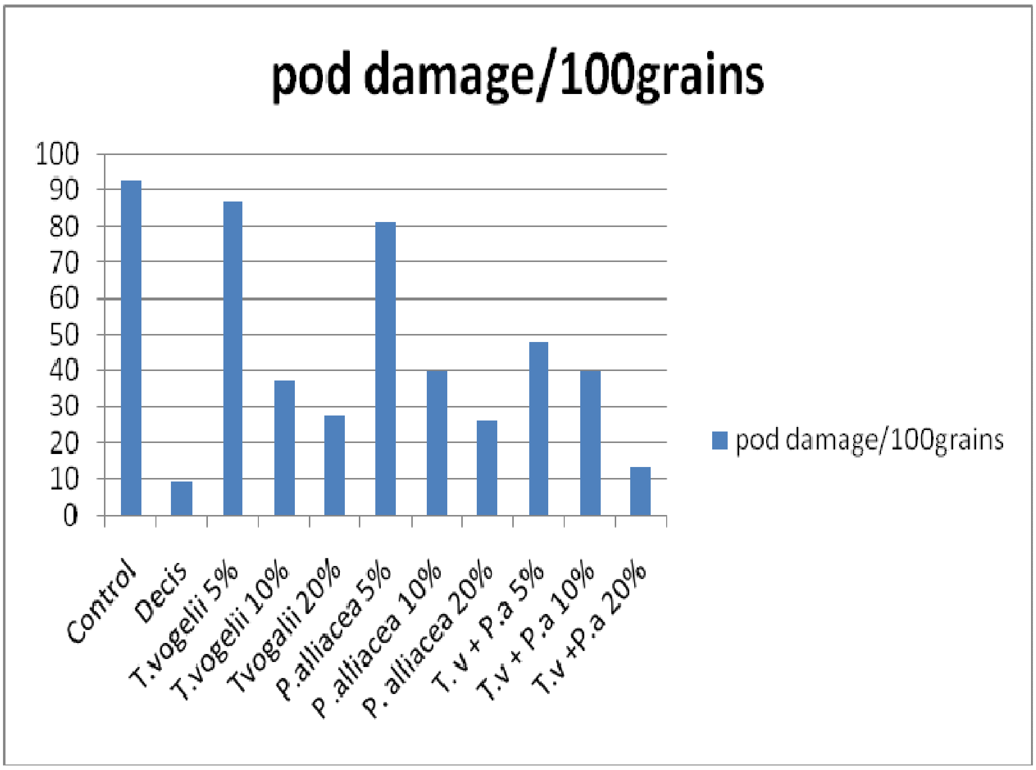


**Fig: 2 Effect of plant extract on pod damage**

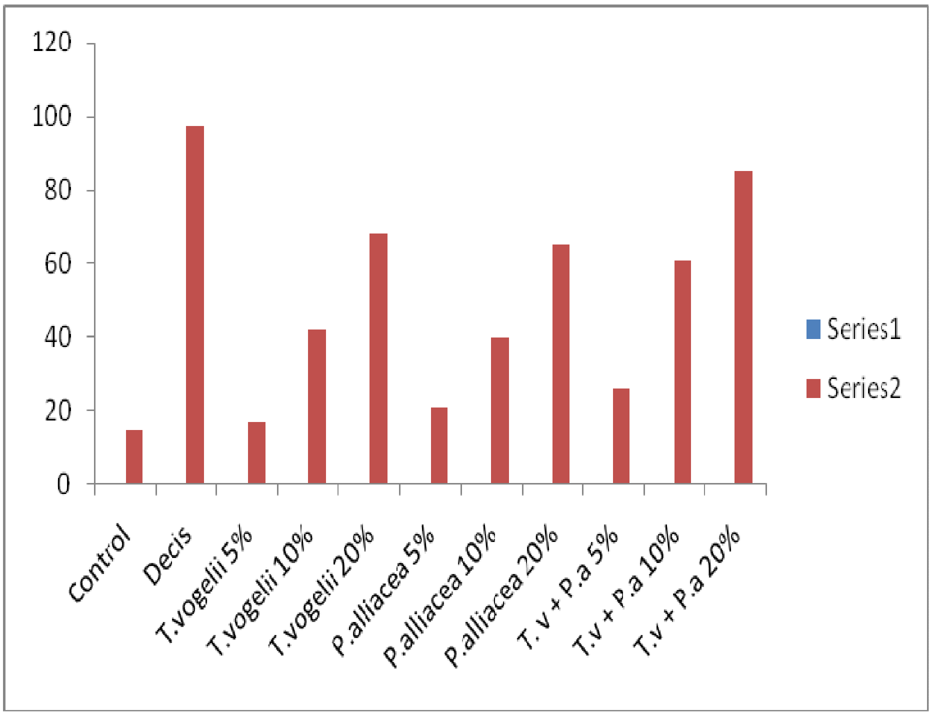


**Fig: 3 Effect of plant extract on cowpea grian quality**

## DISCUSSION

Pesticide application (both synthetic and botanical) have been reported to have controlled insect infestations and increased the yield of cowpea to a reasonable level (4). This result indicates the effectiveness of botanical insecticides at different concentrations (5, 10 and 20 %). It was observed that application of botanical insecticide at least concentration exhibited insecticidal activity compared to untreated plants. However, application of *T. vogelii* and *P. alliacea* at 20% concentration proved to be more effective against the three observed insects – *R. dentipes, M. sjostedti* and *M. vitrata* when compared with others tested concentrations. But the efficacy was low as compared with synthetic insecticide (Decis). This may be due to the fact that the active ingredient in Decis (Delthametrin) is more environmentally stable than any known botanical insecticide. This observation was in line with earlier reports by (5) where synthetic insecticides were reported to be more effective than botanical insecticides when both were applied under the field condition.

The response of these insects to different levels of concentrations can be associated with the ability of each concentration to withstand photo-decomposition of the extracts. This may suggest that the rate of decomposition of the plant extracts depends on the quantity or dosage applied. The implication of this finding is that effectiveness of these plant extracts depends on the level of concentration, so to effectively control these major insects, application of the extracts at 20% concentration will be the preferred. This is in agreement with (6) that effectiveness of botanical insecticides is dose-dependent.

Among the six roteniods which occur naturally from *T. vogelii*, rotenone was found to be the most insecticidal which acts as either a contact or stomach poison (25). Also, Dibenzyltrisuifide isolated from *P. allicea* was reported to be insecticidal compound (17). The result of this experiment shows that the combination of the two active ingredients was significantly effective as synthetic insecticide (Decis) in controlling the populations of the target insects below the economic threshold level. Also, the lowest population of the target insects observed from the plants treated with the combination of the two plant extracts at 10% and 20% concentrations compared with the single application of each plant extracts at 20% concentration was another obvious evidence of the combining effect of the two active ingredients. This support the earlier work by (1) who reported that combination of crude *T. vogelii* extracts with locust lotion was effective as Lamdacyalothrin in controlling field insect pests of cowpea.

Doubtless, the yield is the ultimate goal of the farmers and therefore, the quantity and quality of the harvested farm produce will depend on the soil fertility and insect pests infestation levels (8). High yields were obtained from synthetic insecticides, closely followed by plots treated with plant extracts at 20% concentrations while the plots treated with plant extracts at 5% concentration and untreated plots had least yields respectively. And also, good grain quality were obtained from the plots treated with both synthetic and botanical insecticide at 20% concentrations compare with those that were treated with the least concentration and untreated plants. This experiment suggests that the two plants used as insecticide effectively reduced the level of insect infestations which consequently lead to high yield. Also, the two active ingredients can be said to have successfully reduced the feeding activities and oviposition rates of the target insects, which might eventually lead to their mortality or migratory ability to their wide host. However, slow acting effect of these two plant extracts as insecticides was observed during the active fruiting stage of the tested plants, this might have been connected with lack of adequate yields as obtained from plants treated with synthetic insecticide. This suggests the mode of action of these plants to be repellant. The result concurs with earlier observation raised by (11) that the delayed effect is one of the major problems of botanical insecticides.

Although adequate yield was not obtained from botanical treated plant but the two plants exhibited high insecticidal activities. Single application of the two plant extracts at 20% concentrations demonstrated the ultimate concentrations to be used. However, where the two plants are available, the combination of the two extracts at either 10% or 20% concentration should be used so as to obtain a reasonable high yield. These findings appreciate important of traditional knowledge in science through the control of major insects of cowpea. Apart from this, the use of these plants is cost effective, and environmental safety is guaranteed. However, these plants could be used in developing countries especially in poverty ridden societies. The results obtained from this study suggest that the studied plant species can be investigated for their bioefficacy on insect pests associated with other crops.

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