EFFECT OF LAMBDA-CYHALOTHRIN AND DIMETHOATE ON THE GROWTH RESPONSE OF COWPEA PLANTS AND THE SURROUNDING SOIL

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Abstract

Insecticides are used widely to control insect pests affecting cowpea and their residues are often deposited in the soil. This may impact the physico-chemical characteristics of the soil and the plant health. This study was designed to investigate the growth response of cowpea treated with lambda-cyhalothrin and dimethoate and the insecticides influence on the physico-chemical characteristics of the soil. Three cowpea seeds were planted per polyethylene bag containing top soil, and later thinned to two plants. The insecticides were assayed singly or combined. The insecticides were applied at the pre-flowering (30th day), flowering (50th day) and at podding (70th day) stages of cowpea growth. The physico-chemical parameters of treated soils were assayed. Treated soils with lambda-cyhalothrin and dimethoate and the control were slightly acidic with pH varying from 5.78 to 6.55. Soil organic matter and soil nutrients such as nitrogen, phosphorous, potassium and sodium had lowest values in untreated soil; they had highest values in soil treated with combined insecticides. Lambda-cyhalothrin and dimethoate treatments elicited diverse response from the cowpea plant. Generally, there were slight increase in the vegetative parameters, yield and pod dimensions of treated plants when compared with the control. These insecticides also increased the root nodules, root length and dry weight of cowpea at different concentrations. The combination of these insecticides had positive effect on cowpea without adverse influence on the yield and as well as the soil physicochemical properties.

Keywords: Cowpea, lambdacyhalothrin, dimethoate, yield, soil

1.0 Introduction

Cowpea (*Vigna unguiculata* (L.) Walpers) is a food and animal feed crop grown in the semi-arid tropics covering Africa, Asia, United States and Central and South America. It has the useful ability to fix atmospheric nitrogen through its root nodules, and it grows well in poor soils with more than 85% sand and with less than 0.2% organic matter and low levels of phosphorus (Singh et al. 2003). Most cowpeas are grown on the African continent, particularly in Nigeria and Niger which account for about 66% of world cowpea production (FAOSTAT, 2013). Cowpea is the most economically important indigenous African legume crop (Langyintuo et al. 2003). The menace of insect pests such as *Maruca vitrata* (F.) has hampered the production of this essential legume. *Maruca* alone can cause yield loss ranging from 20%-80% (Singh et al., 1990). It is not feasible to grow cowpea commercially with the use of insecticides sprays (Ndiso et al., 2017). Chemical control of destructive organisms of cowpea plants is an established measure (Abudulai et al., 2001). Pyrethroids, including lambda-cyhalothrin, disrupt the normal functioning of the nervous system in organisms such as mosquitoes and spiders (WHO, 1990). Lambda-cyhalothrin was found very effective against *M. vitrata* (Amit et al. 2016). Likewise dimethoate is an organophosphate insecticide that is used worldwide in agriculture and urban areas due to its high efficacy and rapid environmental degradation. Dimethoate can be applied to many crops such as fruit, vegetables and grains for pest control. It has been used to control a wide range of insects which includes *M. vitrata* (Mirajkar and Pope 2005). Dimethoate is highly soluble in water and has low soil persistence.

The presence of certain functional groups such as -OH, -NH₂, -NHR, -CO.NH₂, -COOR and -NR₃, in the molecular structure of pesticides has hasten adsorption, especially on the soil humus which subsequently may affect plant growth (Misra and Mani 1994). Inappropriate use of insecticides may leave residues on the plants and the environment which could be lethal to the plants growth and the surrounding soil (Konlan et al., 2016). The physico-chemical parameters of a soil vary when treated with insecticides (Wafa et al. 2017). The analyzed physico-chemical parameters "carbon, phosphorous, and nitrogen" showed a big variability according to the nature of the pesticide and the used doses (Wafa Tahar et al. 2017). Most of the tested physico-chemical parameters were higher in the treated soils with pesticides (Wafa Tahar et al. 2017). The values vary according to the nature of the insecticide and the doses used. Jackai and Adalla (1997) reported that cowpea yield increased when treated with insecticides and unprotected plots had the lowest yields. Ndiso et al. (2017) noted that the number of pods per plant was significantly higher in insecticide sprayed plots than in unsprayed plots for all the cowpea varieties tested. According to Ahmed et al., (2014), insecticide sprays effectively protected cowpea pods from damage by insects, thus escalating the grain yield. Nwadinigwe (2010) reported that insecticide treatments increased some vegetative parameters, such as plant height and diameter of the plant. It was also observed that insecticide stimulates growth parameters such as root length, pod length, number of pods

and stem, hence, improves seedlings as well as the yield obtained (Obidola et al., 2019). When chemical pest control management is used effectively and appropriately it increases cowpea yield significantly (Sastawa et al., 2014). Lambda-cyhalothrin and dimethoate insecticides are used widely to control a variety of insects affecting cowpea and their residue are often deposited in the soil. There is need to know the influence of lambda-cyhalothrin and dimethoate on cowpea plants and the surrounding soil so as to suggest alternative insecticides that will not have adverse effect on the cowpea plants and the surrounding soil. This study was designed to investigate the influence of lambda-cyhalothrin and dimethoate on the growth response of cowpea and also to determine the effect of these insecticides on physico-chemical characteristics of the soil samples.

2.0 Experimental

Collection and Procurement of Experimental Materials

Soil samples (top soil) were collected behind the School of Sciences in the Federal University of Technology, Akure, Nigeria using soil auger at the depths of 15-20cm into sterile polyethylene bags. Cowpea seeds *V. unguiculata* (variety 'oloyin') was obtained at Araromi market in Akure, Nigeria. The insecticides used, lambda-cyhalothrin and dimethoate were purchased from pesticide sales store in Akure.

Physicochemical Analysis of the Soil

Soil sample used for this experiment was analyzed (before which serves as the control and after insecticide treatment) to determine its physicochemical characteristics according to the methods of AOAC (1990); Carter (1992) and Centeri et al. (2015). The clay, silt and sand content of the soil were determined. Other parameters determined include pH, % Carbon (according to Pendzhi et al. 2018), calcium, potassium, magnesium, sodium, phosphorous and total nitrogen content. The soil organic matter (SOM) was also determined (Carter 1992).

Exposure of Cowpea Plants to Insecticides' Treatment

Soil sample (5kg) was weighed and dispensed into polyethylene bags and 500ml of water was added. Cowpea seeds (three seeds per bag) were planted at a depth of 5cm to ensure proper stand establishment. After germination, all seedlings were thinned to two per bag to avoid overcrowding. The plants were watered regularly to maintain a good soil moisture condition.

Insecticides were applied using a hand sprayer at the pre-flowering (30th day), flowering (50th day) and at podding (70th day) stages of cowpea growth (Ajeigbe et al. 2012). The experimental design was complete randomized design with 3 replicates. The experimental concentrations of each insecticide and their combinations are outlined on (Table 1) (Ajeigbe et al. 2012). The rationale behind the experimental design in Table 1 is to know the side effect the individual and combined insecticides can have on the cowpea plants and the surrounding soil when used for the control of insects. Forty millilitres (40ml) of each insecticide (or combination) concentration was applied

to each experimental unit. Harvesting was done at the 90th day after planting of cowpea.

Measurement of Growth and Yield Parameters

The growth parameters that were monitored include plant height (cm), diameter (cm), number of leaves per plant, number of root nodules, root length (cm) and plant dry weight (g). Height measurement (cm) was taken from the soil level to the tip of the upper most leaf. Stem diameter was taken at the middle part of the stem using a thread and a meter rule. The plants were washed and cleaned to remove traces of soil before oven drying at 70°C for 48 hours to determine their dry weights (Aikins and Afuakwa 2008). The root nodules were counted after the cowpea plants were harvested at the 90th day (Nkaa et al. 2014). The root lengths of the plants were measured using a thread and a meter rule.

The yield parameters monitored include number of cowpea pods per plant and pods weight (g) per plant. Pod fresh weight per plant was obtained by weighing all the pods plucked from a plant using Metler's weighing balance.

Statistical Analysis

All experiments were carried out in triplicates. Data obtained were subjected to analysis of variance (ANOVA) and means were separated by New Duncan's Multiple Range Test. Statistical Package for Social Science (SPSS) version 22 was used for the data analysis. Differences were considered significant at $p < 0.05$.

Table 1: The experimental concentrations of each insecticide and their combinations.

Code	Concentration (ml/L of water)
C ₀ D ₀	0.0ml of Lambda-cyhalothrin + 0.0ml of Dimethoate (Control)
C ₁ D ₀	4.2ml of Lambda-cyhalothrin
C ₂ D ₀	12.5ml of Lambda-cyhalothrin
C ₃ D ₀	37.5ml of Lambda-cyhalothrin
C ₀ D ₁	4.2ml of Dimethoate
C ₁ D ₁	4.2ml of Lambda-cyhalothrin + 4.2 of Dimethoate
C ₂ D ₁	12.5ml of Lambda-cyhalothrin + 4.2 of Dimethoate
C ₃ D ₁	37.5ml of Lambda-cyhalothrin + 4.2ml of Dimethoate
C ₀ D ₂	12.5ml of Dimethoate
C ₁ D ₂	4.2ml of Lambda-cyhalothrin + 12.5ml of Dimethoate
C ₂ D ₂	12.5ml of Lambda-cyhalothrin + 12.5ml of Dimethoate
C ₃ D ₂	37.5ml of lambda-cyhalothrin + 12.5ml of Dimethoate
C ₀ D ₃	37.5ml of Dimethoate
C ₁ D ₃	4.2ml of Lambda-cyhalothrin + 37.5ml of Dimethoate
C ₂ D ₃	12.5ml of Lambda-cyhalothrin + 37.5ml of Dimethoate
C ₃ D ₃	37.5ml of Lambda-cyhalothrin + 37.5ml of Dimethoate

3.0 Results and Discussion

The effect of lambda-cyhalothrin and dimethoate on the physicochemical characteristics of soil

The soil used in planting of cowpea in this study is humus soil. The soil (treated and untreated with lambda-cyhalothrin and dimethoate) were slightly acidic with pH varying from 5.78 to 6.55 as shown in Table 2. The values vary according to the nature of the insecticide and concentration. Most of the tested parameters were higher in the soils treated with the combination of the insecticides. There were variations in values of Mg from 1.26 to 1.38cmol/kg. Treatment with dimethoate only (C₀D₁) had the lowest value of magnesium. However, the highest value of Mg was observed in treatments with combined insecticides (C₃D₃ and C₃D₁). For the soil organic matter (SOM), it was observed that the control (C₀D₀) had the lowest SOM while this parameter increased in soil with the applied insecticides and their combination at different concentrations, however C₃D₃ produced the highest value of (SOM). Soil nutrients like nitrogen, phosphorous, potassium and sodium had lowest values in untreated soil. However, these parameters had significantly higher ($P < 0.05$) values in insecticides treated soils at different concentrations when compared with the control. Hence it can be deduced from this study that these insecticides treatments at different concentrations increased the soil nutrients. This is similar to the study reported by Das and Mukherjee (2000) that the mineralization rate of organic carbon in soils treated with different insecticides, like organophosphate and pyrethroid groups of insecticides was higher compared to the control. Rangaswamy and Venkateswarly (1993) also found similar results. Tu (1997) who reported that organophosphate insecticides, diazinon, dursban and zinophos had no deleterious effect on the production of phosphorous, nitrogen and other soil nutrients. Another observation made in some cases is that the breakdown of certain insecticides, organophosphate, pyrethroids and carbonates leads to improved availability of plant nutrients like sodium in soil thus favourably affecting the crop yield (Prashar and Shah, 2016). The increase in nutrients of soils treated with these insecticides can also be as a result of some biological transformation such as the biodegradation of the insecticides which favours mineralization of soil organic matter for plants nutrient and their production (Das and Mukherjee 2000). Volodymyr et al. (2018) reported that insecticides especially the highly water-soluble types are less persistent in the environment, and are most likely to biodegrade quickly. For this reason, they are not likely to be accumulated in the soil for a long period of time thereby reducing the toxicity of these insecticide concentrations in the soil. The analyzed physico-chemical parameters "carbon, phosphorous, and nitrogen" showed a big variability according to the nature of the pesticide and the used doses (Wafa Tahar et al. 2017). Most of the tested parameters are higher in the treated soils with pesticides.

Vegetative and yield parameters of cowpea plants treated with lambda-cyhalothrin and dimethoate

The numbers of leaves from 30 to 50 days on the cowpea plant increased with the addition of the insecticides at different concentrations. It was observed at the 50th day of germination that the

number of leaves increased with increase in dimethoate concentration applied to the cowpea seedlings (Table 3). This means that the insecticides did not inhibit photosynthesis and protein synthesis in the leaf cells (Volodymyr et al., 2018). Leaf defoliation was observed from 60 to 90 days in all the treatments. Some of the insecticide treatments had a positive impact on the plant height, they increased the plant height (Table 4). Both insecticides increased the plant height at different treatments which include C2D0, C3D1, C0D2, C2D2, C1D3 and C2D3; the plant height of these treatments were not significantly different from each other after the 90th day of growth. However, the highest plant height (66.60cm) was recorded in the treatment with lambda-cyhalothrin (C2D0). This is similar to previous reports that insecticide treatment increased plant height (Nwadinigwe, 2010; Nzenwa and Ononuju 2011). The diameters of cowpea seedlings were not significantly different across all the treatments used at the 90th day (Table 5). Diameter of 0.90cm was recorded as the highest for both single and combined insecticides treatments. This is an indication that the insecticides at different concentrations did not decrease the stem diameter of cowpea plant in this study. Nwadinigwe (2010) reported that all insecticide treatment increased the stem diameter. In the same vein, number of root nodules -increased alongside with the application of insecticide treatments at different concentrations (Figure 1). Cowpea seedlings treated with combined insecticides (C1D2 and C3D3) had the highest number of root nodules.

This is in agreement with Sartaj *et al.* (2010) who reported that improvement on root nodules was noted with different insecticide concentrations. The Nitrogen fixation and nodulation were unaffected by the tested insecticides at different concentrations after the 90th day. Nitrogen can be supplied to crops by biological nitrogen fixation which is important in sustainable agricultural production (Bohlool et al. 1992). Root length increased slightly with different concentrations of insecticides treatments when compared with the control (C₀D₀) (Figure 2). Treatment with C₃D₂ and C₀D₃ produced the longest root length showing that dimethoate causes more increase in root length. This is similar to the results of Obidola et al. (2019) who reported that there was increase in root length after the application of insecticide treatments. These insecticides probably did not have adverse effects on the micronutrient transport system and the plasma membrane of the root cells of cowpea (Kopittke et al. 2011).

Application of single and combined insecticides significantly increased the dry weight and number of pods of cowpea when compared with the control (C₀D₀) (Figure 3 and 4). Treatment C₀D₂ of dimethoate elicited the highest plant weight while the highest number of pods was recorded with combined insecticides treatment C₂D₂. The number of pods produced by the treatments were significantly different ($P < 0.05$) from the control. Sartaj et al. (2010) observed that different insecticide concentrations increased the plant weight and the yield of cowpea. Jackai and Adalla (1997) reported that cowpea yield increased when treated with dimethoate and unprotected plots had the lowest yields. Ndiso et al. (2017) also reported that the number of pods per plant was significantly higher in insecticide sprayed plots than in unsprayed plots for all the cowpea varieties tested. Both insecticides increased pods weight at lower and higher concentrations when combined as

seen in Figure 5. Treatments C₂D₀, C₂D₁, C₂D₂, and C₃D₃ produced higher pods weight. However, the highest pods weight was recorded with treatment

C₂D₂ at the 90th day. This shows that the combination of both lambda-cyhalothrin and dimethoate at 12.5ml/L of water might produce more pods in cowpea plants when applied. The results of vegetative parameters in this study shows that lamb-cyhalothrin and dimethoate caused the cowpea plant to increase in height, stem diameter, number of leaves, root length, number of root nodules and dry weight of the plant. Results of yield parameters showed more pods were produced by these insecticides treatments at different concentrations than the control. Spiers et al. (2008) found that diverse insecticides including abamectin, bifenthrin (pyrethroid), cyhalothrin and spinosad, did not cause damage to gerbera plant, even when applied at 4x the recommended rate. Kusi et al. (2019) also reported that to maintain high grain yields, there will be the need to at least apply two or three rounds of insecticide sprays. The present results showed that lambda-cyhalothrin and dimethoate and their combination may possess growth regulating properties. This is in agreement with the results observed by Nwadinigwe (2010) and Oyewale et al. (2014) that insecticides increased plant's growth. Some fungicides and insecticides may act as plant growth regulators, in addition to their function as fungicides and insecticides (Gupta et al. 2004). Leaf anatomy is an important feature for internal water balance of plants and the anatomical characteristics may change due to the application of growth regulators (Kishorekumar et al. 2006). Among the key findings in this study is that the use of lambda-cyhalothrin and dimethoate have positive impact on cowpea plant productivity. The result of Oyewale and Bamaiyi (2013) shows that proper timing of two times insecticide applications (at flowering and again at podding stages) could produce as good cowpea crop as four times insecticide applications. This would be advantageous from the perspectives of lower costs and environmental pollution (Ajeigbe et al. 2012).

The differences in cowpea plant response to the different insecticide concentrations could be attributed to the presence of the active principle(s) or compound(s) such as alkaloids and glucosides in the plant itself (Nzenwa and Ononuju 2011). Some other factors that can influence plant response to different insecticide concentrations include plant age, method and timing of insecticide application, evaporation of insecticide and some environmental factors such as pH, UV light, temperature (Schmolke et al. 2010); they influence solubility, volatility and chemical activity of insecticides (Volodymyr et al. 2018). This might have probably influenced the low toxicity of these insecticides on the cowpea plant even at higher concentrations. There is need for further study especially in the area of insecticide concentrations that could cause significant damage to cowpea.

Table 2: Physicochemical characteristics of soil treated with insecticides at different concentrations and combination.

Treatments	Treatments Physicochemical parameters							
	Physicochemical parameters							
	pH	SOM(%)	N(%)	P(mg/kg)	K(cmol/kg)	Na(cmol/kg)	Mg(cmol/kg)	Ca(mol/kg)
C ₀ D ₀	6.49±0.01 ^h	2.93±0.01 ^a	0.77±0.00 ^a	0.96±0.01 ^a	0.75±0.00 ^a	0.77±0.01 ^a	1.34±0.00 ^d	1.97±0.00 ^g
C ₁ D ₀	6.54±0.01 ^{jk}	3.57±0.00 ^b	1.11±0.01 ^b	2.23±0.00 ^b	0.97±0.01 ^b	0.88±0.00 ^b	1.28±0.01 ^b	1.38±0.01 ^b
C ₂ D ₀	6.50±0.01 ^{hi*}	4.31±0.01 ^e	1.16±0.01 ^e	2.33±0.01 ^d	1.24±0.01 ^e	1.16±0.01 ^e	1.32±0.01 ^c	1.98±0.01 ^{g*}
C ₃ D ₀	6.52±0.01 ^{ij}	4.64±0.01 ^h	1.25±0.00 ^g	2.43±0.00 ^g	1.38±0.01 ^g	1.36±0.01 ⁱ	1.35±0.00 ^e	2.21±0.01 ⁱ
C ₀ D ₁	6.51±0.01 ^{hi*}	3.58±0.00 ^b	1.12±0.01 ^b	2.23±0.01 ^b	0.98±0.01 ^b	0.93±0.00 ^c	1.26±0.01 ^a	1.36±0.01 ^a
C ₁ D ₁	5.95±0.01 ^d	3.81±0.00 ^c	1.14±0.00 ^c	2.31±0.01 ^c	1.14±0.01 ^c	1.12±0.00 ^d	1.32±0.01 ^c	1.40±0.01 ^c
C ₂ D ₁	6.45±0.00 ^g	4.42±0.00 ^f	1.16±0.00 ^e	2.38±0.00 ^e	1.25±0.00 ^e	1.20±0.00 ^g	1.35±0.01 ^e	1.95±0.01 ^f
C ₃ D ₁	5.83±0.01 ^b	4.68±0.01 ⁱ	1.26±0.00 ^h	2.47±0.01 ^h	1.41±0.01 ^h	1.37±0.01 ⁱ	1.38±0.01 ^g	2.14±0.01 ^h
C ₀ D ₂	6.46±0.01 ^g	4.26±0.01 ^d	1.14±0.00 ^c	2.31±0.00 ^c	1.18±0.00 ^d	1.13±0.01 ^d	1.28±0.01 ^b	1.86±0.00 ^d
C ₁ D ₂	5.78±0.00 ^a	4.31±0.01 ^e	1.15±0.00 ^d	2.34±0.01 ^d	1.25±0.01 ^e	1.14±0.00 ^e	1.32±0.00 ^c	1.88±0.00 ^e
C ₂ D ₂	6.50±0.00 ^{hi*}	4.42±0.00 ^f	1.18±0.01 ^f	2.38±0.00 ^e	1.30±0.01 ^f	1.18±0.01 ^f	1.34±0.00 ^{d*}	1.97±0.00 ^{g*}
C ₃ D ₂	6.55±0.01 ^k	4.75±0.01 ^j	1.32±0.00 ^k	2.48±0.01 ^h	1.44±0.01 ⁱ	1.42±0.00 ^k	1.37±0.01 ^f	2.13±0.01 ⁱ
C ₀ D ₃	6.42±0.01 ^f	4.51±0.01 ^g	1.24±0.00 ^g	2.38±0.00 ^e	1.37±0.00 ^g	1.33±0.01 ^h	1.32±0.00 ^c	1.87±0.01 ^{de}
C ₁ D ₃	5.86±0.00 ^c	4.62±0.00 ^h	1.27±0.00 ⁱ	2.41±0.00 ^f	1.41±0.01 ^h	1.37±0.01 ⁱ	1.33±0.01 ^c	1.97±0.01 ^{g*}
C ₂ D ₃	6.37±0.01 ^e	4.73±0.01 ^j	1.31±0.01 ^j	2.46±0.00 ^h	1.55±0.01 ^j	1.38±0.01 ^j	1.37±0.01 ^f	2.14±0.01 ^h
C ₃ D ₃	6.44±0.01 ^g	4.78±0.01 ^k	1.38±0.00 ^k	2.56±0.00 ⁱ	1.61±0.01 ^k	1.41±0.01 ^k	1.38±0.01 ^g	2.31±0.01 ^j

Values with the same superscript letter(s) along the same column are not significantly different (P>0.05)

(*) Indicates values not significantly different from the control

Key: C₀D₀ = control (0.00ml/L of cyhalothrin and 0.00ml/L of dimethoate), C₁D₀ = 4.2ml/L of cyhalothrin, C₂D₀ = 12.5ml/L of cyhalothrin, C₃D₀ = 37.5ml/L of cyhalothrin, C₀D₁ = 4.2ml/L of dimethoate, C₀D₂ = 12.5ml/L of dimethoate, C₀D₃ = 37.5ml/L of dimethoate, C₁D₁ = 4.2ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₂D₁ = 12.5ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₃D₁ = 37.5ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₁D₂ = 4.2ml/L of cyhalothrin and 12.5ml/L of dimethoate, C₂D₂ = 12.5ml/L of cyhalothrin and 12.5ml/L of dimethoate, C₃D₂ = 37.5ml/L of cyhalothrin and 12.5ml/L of dimethoate, C₁D₃ = 4.2ml/L of cyhalothrin and 37.5ml/L of dimethoate, C₂D₃ = 12.5ml/L of cyhalothrin and 37.5ml/L of dimethoate, C₃D₃ = 37.5ml/L of cyhalothrin and 37.5ml/L of dimethoate, SOM=soil organic matter.

Table 3: Number of leaves on insecticides treated cowpea seedlings at different days.

Treatments	Number of Leaves at Different Days of Seedling's Growth								
	10 days	20 days	30 days	40 days	50 days	60 days	70 days	80 days	90 days
C ₀ D ₀	5.00±0.00 _a	11.00±0.00 _{ab} _c	26.00±0.00 _{def}	56.66±1.67 _{def}	58.00±2.51 _{cde}	58.66±2.33 _{bc} _d	52.00±1.52 _{cd}	46.00±1.00 _b _c	37.66±0.33 _{cde}
C ₁ D ₀	5.00±0.00 _{a*}	12.00±1.00 _{bc} _{d*}	21.00±1.00 _{abc}	52.66±0.33 _{abcd} _*	54.33±1.20 _{abc} _*	53.66±0.88 _{ab*}	45.66±2.40 _a	39.66±1.85 _a	31.00±1.73 _{ab}
C ₂ D ₀	5.00±0.00 _{a*}	11.00±0.00 _{ab} _{c*}	26.00±3.00 _{def} _*	53.00±1.52 _{abcd} _*	55.66±1.20 _{abc} _{d*}	55.66±1.20 _{ab*}	48.00±0.57 _{ab} _{c*}	41.66±0.67 _a	35.33±1.85 _{bcd} _*
C ₃ D ₀	5.00±0.00 _{a*}	13.00±1.00 _{cd*}	25.00±1.00 _{cde} _*	56.00±0.57 _{cdef} _*	58.33±2.02 _{cde} _*	58.33±2.02 _{bc} _{d*}	50.66±1.20 _{bc} _*	45.33±0.67 _b _{c*}	39.33±0.33 _{def} _*
C ₀ D ₁	5.00±0.00 _{a*}	10.00±1.00 _{ab} _*	27.00±1.00 _{def} _*	55.33±1.45 _{bcd} _{e*}	55.33±1.45 _{abc} _{d*}	54.33±0.66 _{ab*}	46.00±1.52 _a	39.66±2.02 _a	30.66±1.45 _{ab}
C ₁ D ₁	5.00±0.00 _{a*}	11.00±1.73 _{ab} _{c*}	25.00±1.00 _{cde} _*	58.00±1.73 _{f*}	60.00±1.00 _{def} _*	58.66±1.20 _{bc} _{d*}	52.00±1.15 _{cd} _*	46.00±2.30 _b _{c*}	39.33±2.02 _{def} _*
C ₂ D ₁	5.00±0.00 _{a*}	11.00±0.00 _{ab} _{c*}	18.00±1.00 _a	55.00±1.15 _{bcd} _{e*}	55.00±1.15 _{abc} _{d*}	56.66±1.85 _{ab} _*	48.33±0.66 _{ab} _{c*}	42.33±0.33 _{ab*}	33.33±0.88 _{abc} _*
C ₃ D ₁	5.00±0.00 _{a*}	14.00±0.00 _{d*}	23.00±3.00 _{bcd} _*	51.33±1.20 _{bc}	51.33±1.20 _a	52.00±1.00 _a	44.66±1.20 _a	39.33±0.88 _a	30.00±1.73 _a
C ₀ D ₂	5.00±0.00 _{a*}	11.00±0.00 _{ab} _{c*}	20.00±1.73 _{ab}	53.33±2.60 _{abcd} _{e*}	54.00±2.64 _{abc} _*	55.00±1.73 _{ab*}	49.00±1.15 _{ab} _{c*}	42.66±1.85 _{ab*}	36.33±2.72 _{cde} _*
C ₁ D ₂	5.00±0.00 _{a*}	11.00±1.73 _{ab} _{c*}	30.00±1.00 _{f*}	57.33±0.66 _{ef*}	60.66±0.67 _{def} _*	62.33±1.45 _{cd} _*	55.66±0.88 _{ef}	50.66±0.88 _d	40.66±0.33 _{ef*}
C ₂ D ₂	5.00±0.00 _{a*}	9.00±1.00 _{a*}	25.00±1.00 _{cde} _*	53.66±0.88 _{abcd} _{e*}	57.33±0.67 _{bcd} _{e*}	57.33±2.67 _{ab} _{c*}	51.33±2.02 _{bc} _*	45.66±1.85 _b _{c*}	36.66±0.88 _{cde} _*
C ₃ D ₂	5.00±0.00 _{a*}	10.00±1.00 _{ab*}	25.00±2.00 _{cde} _*	55.33±0.33 _{bcd} _{e*}	55.33±0.33 _{abc} _{d*}	55.33±0.33 _{ab*}	47.66±0.88 _{ab} _{c*}	41.00±1.15 _{ab*}	34.66±1.85 _{abc} _{d*}
C ₀ D ₃	5.00±0.00 _{a*}	11.00±0.00 _{ab} _{c*}	20.33±0.33 _{abc} _*	56.00±0.57 _{cdef} _*	63.33±2.40 _f	63.33±2.40 _{d*}	57.33±1.76 _e	50.66±0.88 _d	43.33±1.33 _f
C ₁ D ₃	5.00±0.00 _{a*}	11.00±0.00 _{ab} _{c*}	22.66±0.33 _{abc} _{d*}	52.00±1.52 _{abcd} _*	52.66±1.20 _{ab}	53.33±0.88 _{ab} _*	47.00±1.52 _{ab} _{c*}	39.33±0.66 _a	30.00±0.57 _a
C ₂ D ₃	5.00±0.00 _{a*}	11.00±0.00 _{ab} _{c*}	24.00±1.00 _{bcd} _{e*}	50.33±0.88 _a	51.66±1.33 _a	52.66±2.02 _a	45.33±0.66 _a	39.66±1.20 _a	31.00±2.08 _{ab}
C ₃ D ₃	5.00±0.00 _{a*}	13.00±1.00 _{cd} _*	28.00±1.00 _{ef*}	58.66±0.88 _{f*}	61.66±0.88 _{ef*}	62.66±1.76 _{cd} _*	55.66±0.88 _{de} _*	49.33±0.63 _c _{d*}	41.00±0.57 _{ef*}

Data are presented as Mean±S.E (n=3). Values with the same superscript letter(s) along the same column are not significantly different (P>0.05).

(*) Indicates values not significantly different from the control

Key: C₀D₀ = control (0.00ml/L of cyhalothrin and 0.00ml/L of dimethoate), C₁D₀ = 4.2ml/L of cyhalothrin, C₂D₀ = 12.5ml/L of cyhalothrin, C₃D₀ = 37.5ml/L of cyhalothrin, C₀D₁ = 4.2ml/L of dimethoate, C₀D₂ = 12.5ml/L of dimethoate, C₀D₃ = 37.5ml/L of dimethoate, C₁D₁ = 4.2ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₂D₁ = 12.5ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₃D₁ = 37.5ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₁D₂ = 4.2ml/L of cyhalothrin and 12.5ml/L of dimethoate = 16.7ml/L, C₂D₂ = 12.5ml/L of cyhalothrin and 12.5ml/L of dimethoate = 25ml/L, C₃D₂ = 37.5ml/L of cyhalothrin and 12.5ml/L of dimethoate, C₁D₃ = 4.2ml/L of cyhalothrin and 37.5ml/L of dimethoate, C₂D₃ = 12.5ml/L of cyhalothrin and 37.5ml/L of dimethoate, C₃D₃ = 37.5ml/L of cyhalothrin and 37.5ml/L of dimethoate.

Table 4: Plant height (cm) of insecticides treated cowpea seedlings at different days.

Treatments	Plant Height (cm) at Different Days of Seedlings' Growth								
	10 days	20 days	30 days	40 days	50 days	60 days	70 days	80 days	90 days
C ₀ D ₀	11.36±0.29 _a	24.66±0.92 _a	41.66±0.16 _{ab}	55.66±0.71 _a	58.53±2.71 _{abc}	59.56±1.04 _{ab}	60.63±1.15 _{abcd}	60.90±1.09 _a	61.00±1.01 _{ab}
C ₁ D ₀	11.43±0.29 _{a*}	22.16±1.69 _a	42.26±0.69 _{ab}	56.36±1.36 _a	58.93±2.80 _{abc}	59.86±1.67 _{ab}	60.90±1.95 _{abcd}	61.03±2.00 _a	61.16±1.90 _{ab}
C ₂ D ₀	10.76±0.21 _{a*}	24.23±1.39 _a	46.86±2.26 _e	61.83±1.63 _d	64.43±2.22 _{e*}	65.20±1.5 _e	66.20±1.04 _f	66.43±1.21 _d	66.60±1.17 _e
C ₃ D ₀	10.66±0.16 _{a*}	23.86±1.21 _a	41.83±0.55 _{ab}	56.03±1.24 _a	57.20±1.30 _{abc}	58.06±1.05 _{ab}	59.13±0.92 _{abcd}	59.30±0.92 _{ab*}	59.40±1.00 _{ab}
C ₀ D ₁	11.66±0.60 _{a*}	22.80±1.00 _a	40.33±0.80 _{ab}	54.66±1.76 _a	56.43±1.37 _{abc}	57.36±1.7 _{a*}	58.13±1.62 _{abc}	58.20±1.62 _{ab*}	58.33±1.72 _{ab*}
C ₁ D ₁	11.56±0.69 _{a*}	23.26±0.99 _a	39.93±0.88 _{ab}	54.26±1.07 _a	55.43±0.76 _{ab*}	56.66±0.94 _{a*}	57.60±0.46 _{a*}	57.73±0.58 _{a*}	57.80±0.57 _{a*}
C ₂ D ₁	11.50±0.81 _{a*}	22.13±0.92 _a	40.73±0.56 _{ab}	54.66±1.17 _a	57.46±1.71 _{abc}	58.20±1.38 _{ab}	58.93±1.43 _{abc}	59.06±1.48 _{ab*}	59.06±1.48 _{ab*}
C ₃ D ₁	11.33±1.09 _{a*}	23.00±0.76 _a	43.43±0.80 _{bc}	58.56±1.20 _b	61.60±1.73 _{abc}	62.26±1.27 _{ab}	63.13±0.97 _{bcde}	63.36±0.93 _b	63.43±0.95 _{bc}
C ₀ D ₂	11.83±0.24 _{a*}	23.00±1.40 _a	45.50±0.88 _{de}	59.53±1.63 _b	62.73±2.40 _{abc}	63.80±1.82 _{bc}	64.73±1.33 _{bcdf}	65.03±1.18 _{cd*}	65.03±1.18 _{de}
C ₁ D ₂	10.80±0.36 _{a*}	23.56±2.13 _a	40.86±0.75 _{ab}	54.33±0.97 _a	56.03±1.00 _{abc}	57.13±0.76 _{b*}	59.40±0.92 _{abc}	59.56±0.98 _{ab*}	59.66±1.06 _{ab}
C ₂ D ₂	12.16±0.44 _{a*}	20.56±1.14 _a	46.33±1.55 _e	60.36±2.20 _c	63.43±3.00 _{de*}	64.33±2.55 _{cd}	65.20±2.03 _{de*}	65.50±1.18 _{cd*}	65.63±1.70 _{de}
C ₃ D ₂	10.66±0.60 _{a*}	25.43±2.12 _b	41.50±0.81 _{ab}	55.23±1.40 _a	58.40±1.98 _{abc}	59.66±3.82 _{ab}	60.60±1.33 _{abcd}	60.86±2.28 _a	60.96±2.34 _{ab}
C ₀ D ₃	11.26±0.81 _{a*}	24.73±1.14 _a	42.03±0.77 _{ab}	56.03±1.56 _a	58.96±2.31 _{abc}	59.86±1.40 _{ab}	60.96±0.92 _{abcd}	61.16±1.58 _a	61.30±1.59 _{ab}
C ₁ D ₃	11.96±0.72 _{a*}	27.06±1.13 _c	44.96±2.72 _{cd}	58.80±3.44 _b	61.90±4.21 _{abc}	62.70±1.59 _{ab}	63.36±2.03 _{cdef}	63.50±3.48 _b	64.30±3.02 _{cd}
C ₂ D ₃	10.90±0.21 _{a*}	27.13±0.75 _c	46.23±0.64 _e	60.20±1.24 _c	62.93±1.84 _{abc}	63.83±0.58 _{bc}	65.03±0.33 _{ef*}	65.36±0.74 _d	65.70±0.73 _{de*}
C ₃ D ₃	12.56±0.38 _{a*}	21.43±1.44 _a	39.40±0.55 _{a*}	52.80±0.92 _a	55.86±1.84 _{ab*}	56.83±0.56 _{a*}	57.66±1.04 _{a*}	57.83±1.06 _a	58.03±0.90 _{a*}

Data are presented as Mean±S.E (n=3). Values with the same superscript letter(s) along the same column are not significantly different (P>0.05).

(*) Indicates values not significantly different from the control

Key: C₀D₀ = control (0.00ml/L of cyhalothrin and 0.00ml/L of dimethoate), C₁D₀ = 4.2ml/L of cyhalothrin, C₂D₀ = 12.5ml/L of cyhalothrin, C₃D₀ = 37.5ml/L of cyhalothrin, C₀D₁ = 4.2ml/L of dimethoate, C₀D₂ = 12.5ml/L of dimethoate, C₀D₃ = 37.5ml/L of dimethoate, C₁D₁ = 4.2ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₂D₁ = 12.5ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₃D₁ = 37.5ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₁D₂ = 4.2ml/L of cyhalothrin and 12.5ml/L of dimethoate, C₂D₂ = 12.5ml/L of cyhalothrin and 12.5ml/L of dimethoate, C₃D₂ = 37.5ml/L of cyhalothrin and 12.5ml/L of dimethoate, C₁D₃ = 4.2ml/L of cyhalothrin and 37.5ml/L of dimethoate, C₂D₃ = 12.5ml/L of cyhalothrin and 37.5ml/L of dimethoate, C₃D₃ = 37.5ml/L of cyhalothrin and 37.5ml/L of dimethoate.

Table 5: Diameter (cm) of insecticide treated cowpea seedlings at different days.

Treatments	Diameter (cm) at Different Days of Seedlings' Growth								
	10 days	20 days	30 days	40 days	50 days	60 days	70 days	80 days	90 days
C ₀ D ₀	0.36±0.03 _{ab}	0.53±0.03 ^c	0.66±0.03 _{ab}	0.76±0.03 _{ab}	0.76±0.03 _{ab}	0.86±0.03 ^{bc}	0.86±0.03 _{ab}	0.86±0.03 _{ab}	0.86±0.03 _{ab}
C ₁ D ₀	0.33±0.03 _{ab*}	0.43±0.03 _{ab*}	0.63±0.03 _{ab*}	0.73±0.03 _{ab*}	0.73±0.03 _{ab*}	0.76±0.03 _{ab*}	0.83±0.03 _{ab*}	0.86±0.03 _{ab*}	0.86±0.03 _{ab*}
C ₂ D ₀	0.30±0.00 ^{a*}	0.50±0.00 ^{bc*}	0.66±0.03 _{ab*}	0.76±0.03 _{ab*}	0.76±0.03 _{ab*}	0.76±0.03 _{ab*}	0.76±0.03 ^{a*}	0.80±0.00 ^{a*}	0.80±0.00 ^{a*}
C ₃ D ₀	0.30±0.00 ^{a*}	0.50±0.00 ^{bc*}	0.63±0.03 _{ab*}	0.73±0.03 _{ab*}	0.73±0.03 _{ab*}	0.76±0.03 _{ab*}	0.80±0.00 _{ab*}	0.90±0.00 _{b*}	0.90±0.00 _{b*}
C ₀ D ₁	0.40±0.00 _{b*}	0.50±0.00 ^{bc*}	0.70±0.00 _{b*}	0.80±0.00 _{b*}	0.80±0.00 _{b*}	0.86±0.03 ^{bc*}	0.90±0.00 _{ab*}	0.90±0.00 _{b*}	0.90±0.00 _{b*}
C ₁ D ₁	0.33±0.03 _{ab*}	0.50±0.00 ^{bc*}	0.63±0.03 _{ab*}	0.73±0.03 _{ab*}	0.73±0.03 _{ab*}	0.80±0.05 ^{abc*}	0.80±0.05 _{ab*}	0.83±0.03 _{ab*}	0.86±0.03 _{ab*}
C ₂ D ₁	0.40±0.00 _{b*}	0.50±0.00 ^{bc*}	0.60±0.00 ^{a*}	0.70±0.00 ^{a*}	0.70±0.00 ^{a*}	0.80±0.00 ^{abc*}	0.80±0.00 _{ab*}	0.80±0.00 ^{a*}	0.80±0.00 ^{a*}
C ₃ D ₁	0.36±0.03 _{ab*}	0.46±0.03 ^{abc*}	0.63±0.03 _{ab*}	0.73±0.03 _{ab*}	0.73±0.03 _{ab*}	0.76±0.03 _{ab*}	0.80±0.00 _{ab*}	0.83±0.03 _{ab*}	0.86±0.03 _{ab*}
C ₀ D ₂	0.40±0.00 _{b*}	0.40±0.00 ^a	0.63±0.03 _{ab*}	0.73±0.03 _{ab*}	0.73±0.03 _{ab*}	0.73±0.03 ^a	0.83±0.03 _{ab*}	0.90±0.00 _{b*}	0.90±0.00 _{b*}
C ₁ D ₂	0.30±0.00 ^{a*}	0.46±0.03 ^{abc*}	0.70±0.00 _{b*}	0.80±0.00 _{b*}	0.80±0.00 _{b*}	0.90±0.00 ^{c*}	0.90±0.00 _{b*}	0.90±0.00 _{b*}	0.90±0.00 _{b*}
C ₂ D ₂	0.36±0.03 _{ab*}	0.43±0.03 _{ab}	0.66±0.03 _{ab*}	0.76±0.03 _{ab*}	0.76±0.03 _{ab*}	0.80±0.05 ^{abc*}	0.80±0.05 _{ab*}	0.83±0.03 _{ab*}	0.83±0.03 _{ab*}
C ₃ D ₂	0.36±0.03 _{ab*}	0.46±0.03 ^{abc*}	0.66±0.03 _{ab*}	0.76±0.03 _{ab*}	0.76±0.03 _{ab*}	0.86±0.03 ^{bc*}	0.90±0.00 _{b*}	0.90±0.00 _{b*}	0.90±0.00 _{b*}
C ₀ D ₃	0.33±0.03 _{ab*}	0.50±0.00 ^{bc*}	0.70±0.00 _{b*}	0.80±0.00 _{b*}	0.80±0.00 _{b*}	0.80±0.00 ^{abc*}	0.80±0.00 _{ab*}	0.80±0.00 ^{a*}	0.83±0.03 _{ab*}
C ₁ D ₃	0.36±0.03 _{ab*}	0.46±0.03 ^{abc*}	0.66±0.03 _{ab*}	0.76±0.03 _{ab*}	0.76±0.03 _{ab*}	0.80±0.05 ^{abc*}	0.80±0.05 _{ab*}	0.83±0.03 _{ab*}	0.83±0.03 _{ab*}
C ₂ D ₃	0.33±0.03 _{ab*}	0.43±0.03 _{ab}	0.66±0.03 _{ab*}	0.76±0.03 _{ab*}	0.80±0.00 _{b*}	0.76±0.03 _{ab*}	0.80±0.00 _{ab*}	0.80±0.00 ^{a*}	0.83±0.03 _{ab*}
C ₃ D ₃	0.33±0.03 _{ab*}	0.50±0.00 ^{bc*}	0.63±0.03 _{ab*}	0.73±0.03 _{ab*}	0.73±0.03 _{ab*}	0.76±0.03 _{ab*}	0.83±0.00 _{ab*}	0.83±0.06 _{ab*}	0.86±0.03 _{ab*}

Data are presented as Mean±S.E (n=3). Values with the same superscript letter(s) along the same column are not significantly different (P>0.05).

(*) Indicates values not significantly different from the control

Key: C₀D₀ = control (0.00ml/L of cyhalothrin and 0.00ml/L of dimethoate), C₁D₀ = 4.2ml/L of cyhalothrin, C₂D₀ = 12.5ml/L of cyhalothrin, C₃D₀ = 37.5ml/L of cyhalothrin, C₀D₁ = 4.2ml/L of dimethoate, C₀D₂ = 12.5ml/L of dimethoate, C₀D₃ = 37.5ml/L of dimethoate, C₁D₁ = 4.2ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₂D₁ = 12.5ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₃D₁ = 37.5ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₁D₂ = 4.2ml/L of cyhalothrin and 12.5ml/L of dimethoate, C₂D₂ = 12.5ml/L of cyhalothrin and 12.5ml/L of dimethoate, C₃D₂ = 37.5ml/L of cyhalothrin and 12.5ml/L of dimethoate, C₁D₃ = 4.2ml/L of cyhalothrin and 37.5ml/L of dimethoate, C₂D₃ = 12.5ml/L of cyhalothrin and 37.5ml/L of dimethoate, C₃D₃ = 37.5ml/L of cyhalothrin and 37.5ml/L of dimethoate.

Figure 1: Number of root nodules on insecticides treated cowpea at harvest on the 90th day.

Key: C₀D₀ = control (0.00ml/L of cyhalothrin and 0.00ml/L of dimethoate), C₁D₀ = 4.2ml/L of cyhalothrin, C₂D₀ = 12.5ml/L of cyhalothrin, C₃D₀ = 37.5ml/L of cyhalothrin, C₀D₁ = 4.2ml/L of dimethoate, C₀D₂ = 12.5ml/L of dimethoate, C₀D₃ = 37.5ml/L of dimethoate, C₁D₁ = 4.2ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₂D₁ = 12.5ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₃D₁ = 37.5ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₁D₂ = 4.2ml/L of cyhalothrin and 12.5ml/L of dimethoate, C₂D₂ = 12.5ml/L of cyhalothrin and 12.5ml/L of dimethoate, C₃D₂ = 37.5ml/L of cyhalothrin and 12.5ml/L of dimethoate, C₁D₃ = 4.2ml/L of cyhalothrin and 37.5ml/L of dimethoate, C₂D₃ = 12.5ml/L of cyhalothrin and 37.5ml/L of dimethoate, C₃D₃ = 37.5ml/L of cyhalothrin and 37.5ml/L of dimethoate.

Figure 2: Root length (cm) of insecticides treated cowpea at harvest on the 90th day.

Key: C₀D₀ = control (0.00ml/L of cyhalothrin and 0.00ml/L of dimethoate), C₁D₀ = 4.2ml/L of cyhalothrin, C₂D₀ = 12.5ml/L of cyhalothrin, C₃D₀ = 37.5ml/L of cyhalothrin, C₀D₁ = 4.2ml/L of dimethoate, C₀D₂ = 12.5ml/L of dimethoate, C₀D₃ = 37.5ml/L of dimethoate, C₁D₁ = 4.2ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₂D₁ = 12.5ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₃D₁ = 37.5ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₁D₂ = 4.2ml/L of cyhalothrin and 12.5ml/L of dimethoate, C₂D₂ = 12.5ml/L of cyhalothrin and 12.5ml/L of dimethoate, C₃D₂ = 37.5ml/L of cyhalothrin and 12.5ml/L of dimethoate, C₁D₃ = 4.2ml/L of cyhalothrin and 37.5ml/L of dimethoate, C₂D₃ = 12.5ml/L of cyhalothrin and 37.5ml/L of dimethoate, C₃D₃ = 37.5ml/L of cyhalothrin and 37.5ml/L of dimethoate.

Figure 3: Dry weight (g) of insecticides treated cowpea at harvest on the 90th day.

Key: C₀D₀ = control (0.00ml/L of cyhalothrin and 0.00ml/L of dimethoate), C₁D₀ = 4.2ml/L of cyhalothrin, C₂D₀ = 12.5ml/L of cyhalothrin, C₃D₀ = 37.5ml/L of cyhalothrin, C₀D₁ = 4.2ml/L of dimethoate, C₀D₂ = 12.5ml/L of dimethoate, C₀D₃ = 37.5ml/L of dimethoate, C₁D₁ = 4.2ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₂D₁ = 12.5ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₃D₁ = 37.5ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₁D₂ = 4.2ml/L of cyhalothrin and 12.5ml/L of dimethoate, C₂D₂ = 12.5ml/L of cyhalothrin and 12.5ml/L of dimethoate, C₃D₂ = 37.5ml/L of cyhalothrin and 12.5ml/L of dimethoate, C₁D₃ = 4.2ml/L of cyhalothrin and 37.5ml/L of dimethoate, C₂D₃ = 12.5ml/L of cyhalothrin and 37.5ml/L of dimethoate, C₃D₃ = 37.5ml/L of cyhalothrin and 37.5ml/L of dimethoate.

Figure 4: Number of pods on insecticides treated cowpea at harvest on the 90th day.

Key: C₀D₀ = control (0.00ml/L of cyhalothrin and 0.00ml/L of dimethoate), C₁D₀ = 4.2ml/L of cyhalothrin, C₂D₀ = 12.5ml/L of cyhalothrin, C₃D₀ = 37.5ml/L of cyhalothrin, C₀D₁ = 4.2ml/L of dimethoate, C₀D₂ = 12.5ml/L of dimethoate, C₀D₃ = 37.5ml/L of dimethoate, C₁D₁ = 4.2ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₂D₁ = 12.5ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₃D₁ = 37.5ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₁D₂ = 4.2ml/L of cyhalothrin and 12.5ml/L of dimethoate, C₂D₂ = 12.5ml/L of cyhalothrin and 12.5ml/L of dimethoate, C₃D₂ = 37.5ml/L of cyhalothrin and 12.5ml/L of dimethoate, C₁D₃ = 4.2ml/L of cyhalothrin and 37.5ml/L of dimethoate, C₂D₃ = 12.5ml/L of cyhalothrin and 37.5ml/L of dimethoate, C₃D₃ = 37.5ml/L of cyhalothrin and 37.5ml/L of dimethoate.

Figure 5: Pods weight (g) of insecticides treated cowpea at harvest on the 90th day.

Key: C₀D₀ = control (0.00ml/L of cyhalothrin and 0.00ml/L of dimethoate), C₁D₀ = 4.2ml/L of cyhalothrin, C₂D₀ = 12.5ml/L of cyhalothrin, C₃D₀ = 37.5ml/L of cyhalothrin, C₀D₁ = 4.2ml/L of dimethoate, C₀D₂ = 12.5ml/L of dimethoate, C₀D₃ = 37.5ml/L of dimethoate, C₁D₁ = 4.2ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₂D₁ = 12.5ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₃D₁ = 37.5ml/L of cyhalothrin and 4.2ml/L of dimethoate, C₁D₂ = 4.2ml/L of cyhalothrin and 12.5ml/L of dimethoate, C₂D₂ = 12.5ml/L of cyhalothrin and 12.5ml/L of dimethoate, C₃D₂ = 37.5ml/L of cyhalothrin and 12.5ml/L of dimethoate, C₁D₃ = 4.2ml/L of cyhalothrin and 37.5ml/L of dimethoate, C₂D₃ = 12.5ml/L of cyhalothrin and 37.5ml/L of dimethoate, C₃D₃ = 37.5ml/L of cyhalothrin and 37.5ml/L of dimethoate.

Conclusion

The effect of these insecticides treatment showed that there was increase in the soil nutrients when compared with the control. Lambda-cyhalothrin and dimethoate used as single or combined treatments at different concentrations in the present investigation had no adverse effects on the yield of cowpea plants. More work needs to be carried out to determine the toxicological effect of the insecticide concentrations and their combination on both plant and animal including human.

Declaration of Conflict of Interests

All Authors have declared that there is no conflict of interest

Authors' Contributions

Conception: [OBO, EFO]

Design: [OBO, EEA, EFO GOA]

Execution: [OBO]

Interpretation: [OBO, EEA, EFO GOA]

Writing the paper: [OBO, EEA, EFO GOA]

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