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Nutrient Release Pattern from Compost Supplemented with Jatropha Cake on Alfisol of Ilorin, Nigeria

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Author's contribution

Author AAO conceived, designed the experiments, performed the experiments, analyzed the data, contributed reagents, materials, analysis tools and wrote the paper.

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ABSTRACT

The mineralization of nutrients from compost supplemented with Jatropha cake was examined on an Alfisol of Ilorin, Nigeria with a view to determining its potential for fertility improvement.
Two kilogram soil (0-15 cm depth) was weighed into plastic pots, replicated three times and arranged in a completely randomized design. Compost Aleshinloye Grade B (un-amended compost) augmented with jatropha cake in different proportions was applied at the rate of 10 t /ha to each pot. The soil in the pot was incubated with the following treatments: AJ (30% Aleshinloye Grade B + 70% Jatropha cake), BJ (40% Aleshinloye Grade B + 60% Jatropha cake), CJ (50% Aleshinloye Grade B + 50% Jatropha cake), DJ (60% Aleshinloye Grade B + 40% Jatropha cake) including control (CO). At the end of 0, 3, 6, 9, and 12 weeks, the incubated soil were sampled and analyzed for pH, N, P, K, OC, Ca, NH_4-N and NO_3-N contents. Data collected were subjected to ANOVA and cluster analysis.
The results of Incubation of fertilizers applied increased soil pH. At 12 weeks, higher value (0.57cmol/kg) was obtained from mineralized exchangeable K by DJ treated soil. CJ significantly increased (*P*=.05) OC, NO_3-N, NH_4-N, total N and P.
Thus the result of this finding suggests that 10 t /ha CJ (50% Aleshinloye Grade B + 50% Jatropha cake) significantly increased the N and P.

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1. INTRODUCTION

Jatropha curcas serves as a good source of alternative energy, since it produces the seed oils that can be used as a biodiesel. The high oil contents resided in Jatropha seed made it applicable for scientists to research for this biodiesel aspect [1,2,3]. The oil extraction from Jatropha seed resulted in a massive amount of the seedcake. In practicality, 4 kilograms of fresh Jatropha seeds can yield only 1 kilogram of Jatropha oils. Therefore, this creates a large amount of solid waste left after an oil extraction. The *Jatropha curcas* seedcake contained up to 58% of crude protein by weight [4] The percentages of nitrogen (N), phosphorous (P), and potassium (K) were 3.2-4.5%, 1.4-2.1%, and 1.2-1.7%, respectively [5] The presences of these elements were recognized as the organic nutrients sources that are even higher than that of chicken or cow manure [4].

The increasing cost of inorganic fertilizers in West Africa, particularly Nigeria, has necessitated investigation into the use of organic wastes or residues for soil improvement. The soils of the Nigerian Guinea Savanna are predominantly Alfisol. These soils are inherently low in organic matter (OM), cation exchange capacity (CEC), deficient in Nitrogen (N) and phosphorus (P) and are largely coarse textured. This low level of organic matter has made the Savanna soil susceptible to major chemical, physical and biological limitations which reduce crop yields [6].

Farmers are in the habit of improving soil fertility through the addition of mineral fertilizers but the use of the fertilizer has not solved the problem of nutrient deficiencies. Organic fertilizers represent a source of nutrient for plants [7] since their decomposition is responsible for nutrient release; moreover seed cake of *J. curcas* is rich in protein [8] and therefore can be an excellent source of N for plant. Therefore, there is a need to find alternative supplementary sources of nutrients for soil fertility management. Rates of decomposition and mineralization for various organic materials that are potential sources of nutrients for plant growth are seldom known [9]. Understanding the rate by which Jatropha cake supplemented with compost released plant nutrients to the soil will be a guide to the fertilizer recommendation to avoid its over or underutilization by farmers. Most arable crops complete their vegetative and reproductive cycles within three months of planting. Thus, predicting the amount of plant available N, P, and K produced by compost enriched with Jatropha in the soils is necessary for proper plant nutrition also, its effect on the chemical properties on Alfisol of Ilorin have not been adequately documented. The aim of this investigation was to evaluate the different mineralization rates of compost supplemented with Jatropha cake and changes in soil chemical properties induced by this organic fertilizer.

2. MATERIALS AND METHODS

The experimental soil for this study was a surface layer of a sandy loam collected from Teaching and Research Farm, Kwara State University, Malete, Ilorin, Nigeria. The farm extends from latitude 8°71' N and longitude 4°44' E. The climate is characterized by distinct wet and dry seasons with a mean annual temperature that ranges from 25-28.9°C. In addition, the annual mean rainfall is about 1,150 m, exhibiting a double maximal pattern between April and October of every year. The Kwara State University land area forms part of the South Western sector of Nigerian basement complex, a zone of basement reactivation and plutonism during the Pan-African urogeny [10].

Soil samples were collected at 0–15 cm, air dried, and screened through a 2-mm sieve. The particle-size distribution was analysed by the hydrometer method and consisted of 75.8% sand, 13.4% silt, and 10.8% clay.

Two kilograms of soil screened to pass through a 2-mm sieve were weighed into polyethylene pots with tight-fitting lids. The soil in the pot was incubated with following treatments;

1. Control (CO)
2. 30% Aleshinloye Grade B + 70% Jatropha cake (AJ)
3. 40% Aleshinloye Grade B + 60% Jatropha cake (BJ)
4. 50% Aleshinloye Grade B + 50% Jatropha cake (CJ)
5. 60% Aleshinloye Grade B + 40% Jatropha cake (DJ)

All the treatments were applied at the rate of 10 t/ha. The fertilizer treatments were thoroughly mixed with the soil. The pot was brought to 60% of the water-holding capacity (WHC) of the soil.

The WHC of the soil was determined by weighing 100 g of soil into a pre-weighed perforated plastic cup lined with cotton wool. The soil in the pot was saturated with water until it drained freely from the cup. The saturated soil was allowed to stay for 24 hours to allow drainage until all gravitational water from the soil is removed. When free drainage had completely ceased, the pots were reweighed. The difference between the moist soil and oven-dry soil was considered to be the WHC of the soil expressed gravimetrically. The lid was placed in a slightly slanted position on the pot to allow for aerobic conditions. The treatment applications were replicated three times and left on a laboratory bench at 25+38℃. The experiment was laid out in a completely randomized design. The chemical composition of Jatropha cake and Aleshinloye Grade B used in the study is given in Table 1. Aleshinloye Grade B (un-amended compost) is produced from Aleshinloye fertilizer plant, Ibadan, Oyo State Nigeria. The soil in the pot was stirred and rehomogenized once every 2 weeks to simulate the regular soil. At 3, 6, 9 and 12 weeks, the soil–fertilizer mixture was spread on a clean polyethylene paper, mixed, and rehomogenized, and the soil aggregates were crushed by hand. Fifty-gram subsamples were taken, spread out to dry, and rescreened through a 2-mm sieve for chemical analysis.

Table 1. Physical and chemical properties of soil before incubation

Parameters	Soil test value
pH (H_2O)	6.7
Org.C (gk/g)	6.84
Total N (g/kg)	3.1
P (mg/kg)	9.3
Exchangeable bases cmol/kg	
Mg	4.54
Ca	19.8
Na	0.78
K	1.52
Extractable micronutrients	
Cu	3.69
Fe	229.0
Mn	124.0
Zn	1.24
Textural class %	
Sand	75.8
Silt	13.4
Clay	10.8

2.1 Soil Analysis

Soil pH was determined in water 1:2 soil: water ratio with a glass electrode pH Meter. The cation exchange capacity (CEC) was determined by the neutral 1.0 M ammonium acetate saturation method as described by [11]. The exchangeable cations were displaced with the same neutral 1.0 M NH_4OAc. Calcium in the extracts was determined by atomic absorption spectrophotometry, whereas K was determined by flame photometry. The NH_4-N and NO_3-N in the soil were extracted with 2 M KCl, and the extracts were distilled over 2% boric acid with two or three drops of mixed indicator (methyl red bromocresol green) until 30 cm^3 of the distillate were collected to determine NH_4-N. To the same extract in the distillation flask, 1 gram of Devarda alloy was added, and it was distilled over another 2% boric acid with the mixed indicator to determine NO_3-N. The distillates were titrated with 0.025 N sulphuric acid (H_2SO_4) to determine NH_4-N and NO_3-N following the procedure described by [12]. The OC in the soil was determined by the Walkey-Black method [13].

2.2 Statistical Analysis

The effect of Aleshinloye Grade B supplemented with Jatropha cake application rates on soil chemical properties after 12 weeks of incubation were determined by ANOVA, and mean separation was achieved by Duncan's Multiple Range Test (DMRT) at 5% probability level. A hierarchical cluster analysis was done using each soil's chemical and fertilizer treatments, according to average linkage clustering method in PAST 2.08 [14]

3. RESULTS AND DISCUSSION

3.1 Physico-Chemical Characteristics of the Soil

The physico-chemical properties of soil use prior to incubation are presented in Table 1. The soil class was sandy loam and slightly acidic with pH of 6.7. The pH of most agricultural soils in tropics has been reported to range from 5.0 to 6.8 [15]. Organic matter content was 6.84 g/kg compared with critical level for optimum crop production given as 30 g/kg [16]. The organic matter was below the range for tropical soils used for crop production. The available P was 9.3 mg/kg, indicating that it was low compared with the critical level which range from 10–15 mg/kg [17]. This shows that the soil needs amendment for crop optimum production. The total nitrogen was 3.1 g/kg indicating that it was higher than the critical level which ranges from 0.01 to 1.20 g/kg, [18] for tropical agricultural soils. Calcium content was 19.8 cmol/kg, compared with the critical level; given as 2.6 cmol/kg [16]. Therefore the soil needs amendment for crop optimum production. Exchangeable sodium was 0.78 cmol/kg compared with the critical level of Na which ranges from 0.48 to 0.94 cmol/kg which means it was higher than the critical level for the tropical soils. Exchangeable magnesium was 4.54 cmol/kg. The level of magnesium was higher compared to critical level for tropical soils (0.15 cmol/kg). Exchangeable potassium 1.52 cmol/kg was higher than the critical level of 0.2 cmol/kg [19].This level of potassium needs no amendment for optimum crop production.

3.2 Chemical Properties of Fertilizer Material Prior To Incubation

The chemical properties of fertilizer used as treatment prior to incubation are shown in Table 2. The analysis showed that total N in Aleshinloye Grade B is 11.7 g/kg, Jatropha cake 43.1 g/kg. K in Aleshinloye Grade B (2.09 g/kg) and Jatropha cake (2.2 g/kg). Ca in Aleshinloye Grade B 23.4 g/kg and Jatropha cake 0.3 g/kg. Mg in Aleshinloye Grade B is 2.4 g/kg, and Jatropha cake 8.39 g/kg. K in Grade B is 20.9 g/kg and Jatropha cake 2.2 g/kg. P in Aleshinloye Grade B is 7.6 g/kg while Jatropha cake is 0.7 g/Kg.

Table 2. Chemical composition of Aleshinloye Grade B and Jatropha cake

Nutrient element (g/kg)	Concentration of grade B fertilizer	Jatropha cake
Total N	11.7	34.1
Ca	23.4	0.3
Mg	2.4	8.39
K	20.9	2.2
Mn	106.67	0.01
Na	29.61	0.08
Fe	8195.39	2.1
Cu	16.98	0.02
P	7.6	0.7
Zn	19.9	0.08

3.3 Soil pH

The pH values of some fertilizer treated soil were low in the 3rd week of incubation but the values increased thereafter with increase in length of incubation. Table 3 shows that changes in pH were not pronounced among the fertilizer nutrients sources. Nevertheless, some significant difference existed among the four incubation period for each of the 5 treatments. At each period of pH determination, the values for the organic material treated soils were significantly higher than for the control (*P*=.05). The higher pH observed for the organic materials over the control was probably influenced by the mineralization and subsequent release of nutrients from the organic wastes [20].

3.4 Available P

Table 4 indicates the changes in available P at the various incubation periods for each of the five fertilizer nutrient sources. It was obvious that control had the lowest values compared to those of AJ, BJ, CJ and DJ. The quantity of P released by AJ, BJ, CJ and DJ in the 3 weeks, were significantly *P*=.05) higher compared to the control (Table 4). The increase in the P value in the treatment C (50% Aleshinloye Grade B + 50% Jatropha cake) was as a result of the availability of P which is mostly derived from soil organic matter [21]. In the sixth week, the P released in BJ was significantly higher than in the AJ, CJ, DJ and the control, while in the nine weeks, CJ was significantly different when compared with the previous weeks of incubation. However, the increase or decrease in the amounts of P released at the twelve weeks compared to the nineth week was marginal, which showed that the P mineralization had attained stability. The values of P released by the CJ, BJ and DJ were significantly higher than in AJ. There was an increase in P released at the 12th weeks over the 6th and 9th weeks with organic materials especially BJ and CJ having significantly (*P*=.05) higher amounts of K compared with the DJ, AJ and control.

3.5 Exchangeable K

The Exchangeable K released from organic fertilizer application from 3 to 12 weeks of incubation is shown in Table 5. Where AJ was applied, K released was highest at three weeks of incubation. After the sixth weeks of incubation, K released was the highest where DJ was applied. However, K released in the absolute control treatments was decreased. After the nine and twelve weeks of incubation K released in DJ were significantly different from other fertilizer treatments. The increase in K values from DJ in the sixth week may probably be due to the fact that greater levels of decomposition have taken place in the media.

Table 3. Change in pH during incubation of organic materials

	Weeks of incubation			
Treatments	**3**	**6**	**9**	**12**
CO	6.8c	6.5d	6.6d	6.7d
AJ	8.0b	8.1b	7.9b	7.8b
BJ	8.1a	8.2a	8.0a	7.7c
CJ	8.1a	7.9c	7.9b	7.8b
DJ	8.1a	7.9c	7.7c	7.9a

Means followed by the same letters within a column are not significantly different at (P=.05)
Legend
CO- Control (Zero addition), AJ -30% Aleshinloye Grade B + 70% Jatropha cake
BJ - 40% Aleshinloye Grade B + 60% Jatropha cake, CJ - 50% Aleshinloye Grade B + 50% Jatropha cake
DJ- 60% Aleshinloye Grade B + 40% Jatropha cake

Table 4. Effect of organic fertilizer materials on P release (mg/kg) over twelve weeks of incubation

	Weeks of incubation			
Treatments	**3**	**6**	**9**	**12**
CO	12.20e	10.11e	11.53e	12.21e
AJ	19.86c	19.06d	17.69d	13.72d
BJ	19.06d	28.33a	27.07b	29.70b
CJ	22.84b	21.81c	32.45a	37.36a
DJ	40.45a	26.50b	24.89c	21.3c

Means followed by the same letters within a column are not significantly different at (P=.05)
Legend
CO- Control (Zero addition), AJ -30% Aleshinloye Grade B + 70% Jatropha cake
BJ - 40% Aleshinloye Grade B + 60% Jatropha cake, CJ - 50% Aleshinloye Grade B + 50% Jatropha cake
DJ- 60% Aleshinloye Grade B + 40% Jatropha cake

Table 5. Potassium (g/kg) released by organic materials over twelve weeks of incubation

	Weeks of incubation			
Treatments	**3**	**6**	**9**	**12**
CO	0.25e	0.20e	0.23e	0.25e
AJ	0.56a	0.50b	0.48b	0.49b
BJ	0.43c	0.49c	0.36d	0.32d
CJ	0.37d	0.43d	0.40c	0.39c
DJ	0.46b	0.51a	0.53a	0.57a

Means followed by the same letters within a column are not significantly different at (P=.05)
Legend
CO- Control (Zero addition), AJ -30% Aleshinloye Grade B + 70% Jatropha cake
BJ - 40% Aleshinloye Grade B + 60% Jatropha cake, CJ - 50% Aleshinloye Grade B + 50% Jatropha cake
DJ- 60% Aleshinloye Grade B + 40% Jatropha cake

3.6 Total N

Total N released by the fertilizer treated soils was significantly (*P*=.05) higher than for the control (Table 6). Total N released from added organic matter was highest for CJ amended soils throughout the incubation period (3 to 12 weeks) compared to other treatments and the control. The N mineralized in compost supplemented with jatropha cake amended soil and control ranged from 0.022 to 0.126 g/kg during incubation period. On 6^{th} and 9th week, there was no significant change in N released from AJ, BJ, CJ and DJ treated soil, but thereafter, release of total N was significantly decreased from 9^{th} week to 12^{th} weeks in BJ treated soil and control soil resulted in N immobilization.

Table 6. N (g/kg) mineralized by organic materials over twelve weeks of incubation

	Weeks of incubation			
Treatments	**3**	**6**	**9**	**12**
CO	0.022e	0.096a	0.029e	0.022e
AJ	0.055c	0.051c	0.051c	0.055c
BJ	0.033d	0.081b	0.081b	0.033d
CJ	0.126a	0.096a	0.096a	0.126a
DJ	0.033d	0.049d	0.049d	0.077b

Means followed by the same letters within a column are not significantly different at (P=.05)
Legend
CO- Control (Zero addition), AJ -30% Aleshinloye Grade B + 70% Jatropha cake
BJ - 40% Aleshinloye Grade B + 60% Jatropha cake, CJ - 50% Aleshinloye Grade B + 50% Jatropha cake
DJ- 60% Aleshinloye Grade B + 40% Jatropha cake

3.7 Exchangeable Ca

The Exchangeable Ca released by the soils amended with organic fertilizers AJ, BJ, CJ and DJ were significantly (*P*=.05) higher than the control (Table 7). The increasing exchangeable Ca in all the treatments could have come from mineralization of compost supplemented with Jatropha cake, because there was significant difference between the control and other fertilizers amended soil. At the 9^{th} and 12^{th} week, exchangeable Ca was significantly higher in AJ amended soil than BJ, CJ, DJ and control. It is possible that the bulk of the increase in the concentration of exchangeable Ca was due to mineralization of compost Grade B in the soil. The Aleshinloye Grade B used in the study contained 23.4 g/kg Ca while Jatropha cake is 0.3 g/kg, suggesting that combination of the two organic fertilizers will be a good source of Ca in the soil.

3.8 Soil NH_4-N and NO_3-N

The NO_3–N released by the soils amended with organic fertilizers were significantly (*P*=.05) higher than the control (Table 8). The difference was between 26-45 % over the control after three weeks incubation. NO_3-N released by DJ treated soils was significantly ($p<0.05$) higher than that of AJ, BJ, CJ and control. At the sixth weeks, NO_3-N generated by soils treated with AJ, BJ, CJ and DJ were higher than for control by a range of 48 – 51.4 %. At twelve weeks, NO_3–N released by the soils amended with CJ was significantly higher than all other treatments including control. At three weeks of incubation, the NH_4-N content produced by DJ was highest compared to other treatments. At the sixth weeks, the results showed that AJ, BJ, CJ and control resulted to increase in the amount of NH_4-N released compared to the preceding weeks, whereas DJ gave decreased values. The NH_4-N generated by fertilizers treated soils were between 28.3 – 52.6% higher than for control. At the end of nineth weeks the NH_4-N generated decreased across the AJ and DJ treated soils, whereas BJ, CJ and control gave decreased values. At twelfth weeks, the higher quantity of NH_4-N was generated by soil amended with CJ. More importantly NO_3- N in the organic material treated soils indicated that the organic wastes could readily supply the N need of arable crops. However, rational use of the organic wastes is needed to checkmate excess release of NO_3-N that could be detrimental to the environment through underground water pollution [22].

3.9 Soil Organic Carbon Content

The result indicates that organic fertilizer application initially increased soil organic carbon content of amended soils (Table 9). Organic carbon content was found to be 14.71 % higher in treatment AJ (30% Aleshinloye Grade B + 70% Jatropha cake), 10.47% in fertilizer treatment BJ (40% Aleshinloye Grade B + 60% Jatropha cake) and 18.67% in treatment CJ (50% Aleshinloye Grade B + 50% Jatropha cake) over the initial value (6.84 g/kg) after 6 weeks of incubation. After 3 weeks, organic carbon content decreased significantly (*P* =.05) in control. Significant differences were found among different periods of incubation when Aleshinloye Grade B in combination with Jatropha cake applied in different proportion. At the end of the incubation, the organic carbon was highest for treatment CJ and followed by values for DJ, AJ, BJ and least in control. The change in organic carbon amount was 25.3% less in soils where no manure added at 12 weeks of its first incubation period (3 weeks). The highest amount of soil organic carbon at the beginning of the incubation was indicative of a larger pool of the less resistant fractions that were available to be broken down and recycled, thus resulting in lower contents remaining at the end incubation. Similar results was observes by [23].

Table 7. Calcium (g/kg) released by organic materials over twelve weeks of incubation

	Weeks of incubation			
Treatments	**3**	**6**	**9**	**12**
CO	1.40e	1.65e	2.40e	2.60e
AJ	2.85a	3.55a	3.74a	3.90a
BJ	2.28c	2.96d	3.15c	3.36c
CJ	2.64b	3.04c	3.37b	3.86b
DJ	2.23d	3.18b	280d	2.96d

Means followed by the same letters within a column are not significantly different at (P=.05)
Legend
CO- Control (Zero addition), AJ -30% Aleshinloye Grade B + 70% Jatropha cake
BJ - 40% Aleshinloye Grade B + 60% Jatropha cake, CJ - 50% Aleshinloye Grade B + 50% Jatropha cake
DJ- 60% Aleshinloye Grade B + 40% Jatropha cake

Table 8. Effect of organic fertilizer materials on NO_3- N and NH_4-N released over twelve weeks of incubation

	Weeks							
	3	**6**	**9**	**12**	**3**	**6**	**9**	**12**
	NO_3- N				**NH_4-N**			
Treatments								
CO	0.58d	0.72e	0.58e	0.56e	1.00d	2.02e	2.35e	1.57e
AJ	1.06b	1.52a	0.87c	0.94c	2.98b	4.27a	2.45c	2.64c
BJ	1.06b	1.33c	1.38b	0.72d	1.63c	3.47c	3.88b	2.44d
CJ	0.89c	1.48b	1.64a	2.15a	2.98b	4.16b	4.61a	6.04a
DJ	1.09a	1.20d	0.84d	1.31b	3.06a	2.82d	2.36d	3.68b

Means followed by the same letters within a column are not significantly different at (P=.05)
Legend
CO- Control (Zero addition), AJ -30% Aleshinloye Grade B + 70% Jatropha cake
BJ - 40% Aleshinloye Grade B + 60% Jatropha cake, CJ -50% Aleshinloye Grade B + 50% Jatropha cake
DJ- 60% Aleshinloye Grade B + 40% Jatropha cake

3.10 Hierarchical Cluster Analysis

Hierarchical cluster analysis (HCA) was applied to the data to investigate if the nutrient released was critical. The dendrogram displayed in Fig. 1 shows the composts supplemented with jatropha cake at different rates which are comparable (similar) and non–comparable (non-similar) based on the nutrient released. Samples that are related or similar are contained within clusters. The lower the Euclidian distances between the samples the more similar the samples are [24,25]. From the dendrogram in Fig. 1 the characteristics used included pH, P, K, N, Ca, NO_3-N, NH4-N and Org.C. From the dendrogram in Fig.1 CJP (50% Aleshinloye Grade B + 50% Jatropha cake and Phosphorus) and $CJNH_4$-N (50% Aleshinloye Grade B + 50% Jatropha cake and NH_4-N) had their linkage greater than that of other cluster. There was a distinct relationship between one cluster and other cluster in this analysis.

Table 9. Organic carbon (g/kg) released by organic materials over twelve weeks of incubation

	Weeks of incubation			
Treatments	**3**	**6**	**9**	**12**
CO	3.21e	2.98e	3.0e	2.56e
AJ	5.73d	8.02b	4.59d	5.0c
BJ	8.08a	7.64c	7.65b	3.06d
CJ	5.75c	8.41a	9.17a	12.22a
DJ	6.11b	3.82d	4.60c	7.26b

Means followed by the same letters within a column are not significantly different at (P=.05)
Legend
CO- Control (Zero addition), AJ -30% Aleshinloye Grade B + 70% Jatropha cake
BJ - 40% Aleshinloye Grade B + 60% Jatropha cake, CJ - 50% Aleshinloye Grade B + 50% Jatropha cake
DJ- 60% Aleshinloye Grade B + 40% Jatropha cake

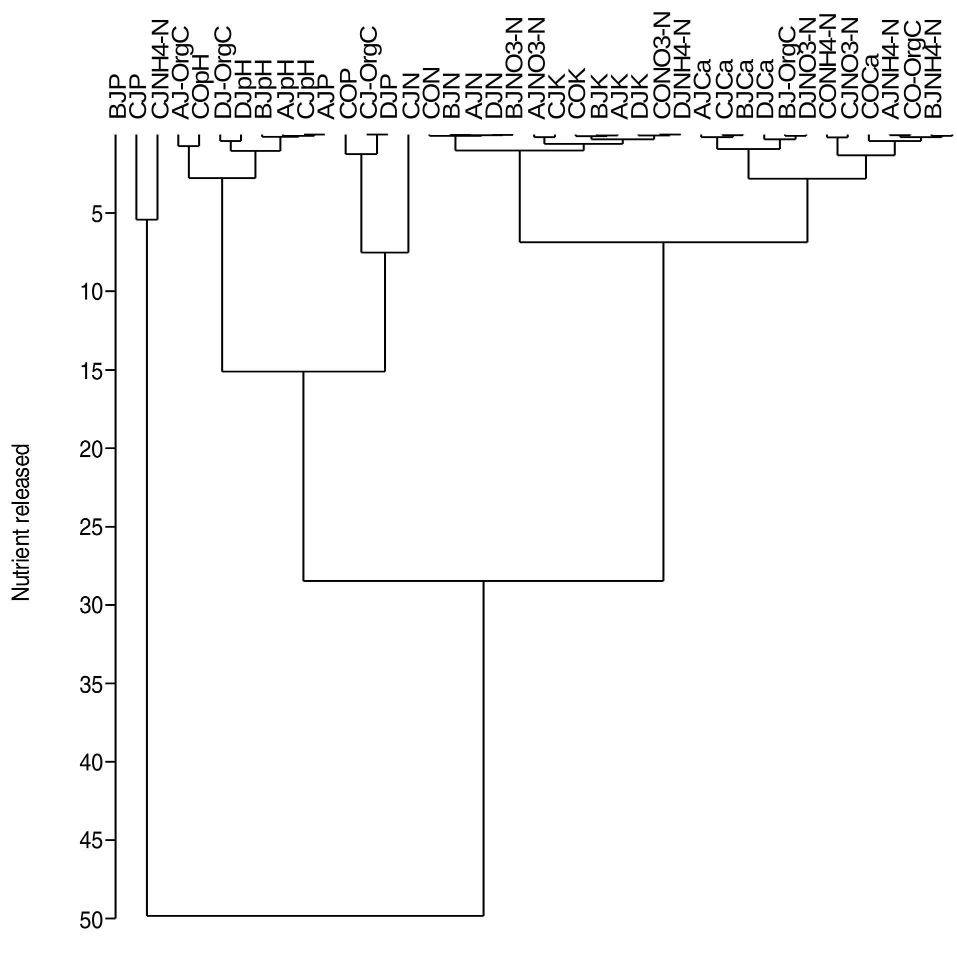

Fig. 1. Dendrogram showing the clustering of the nutrient released by the fertilizer treatments at 12 weeks

3.11 Discussion

Mineralization rates observed in laboratory may not depict the true rates taking place under field condition [26,27] however, this mineralization study will provide meaningful information on potential of compost supplemented with jatropha cake intended to be used for amendment in crop production system for supply of nutrient. The observation that the compost generally increased soil pH compared with the control is in tandem with the reports of previous workers [28,29]. The soil pH changes observed may be due to nitrogen transformations and release of metal cations as the organic residues decompose [30]. There are several different mechanisms that have been suggested to explain the initial rise in soil pH when organic amendments are applied to soils. These include oxidation of organic- acid anions present in the decomposing residues, ammonification of residue organic N, specific adsorption of organic molecules produced during residue decomposition and reduction reactions induced by anaerobiosis [31].

The N mineralization pattern of the compost amended with jatropha cake closely reflected the differences in their chemical composition. Immobilization of N took place in all the amended soil which occurred at sixth and nineth week until 12 weeks respectively, although, there was a net mineralization of N in organic compost amended soil (Table 6). Mineralization and immobilization occur simultaneously when organic residues are incorporated to soil [32]. Highest N release was observed in CJ (50% Aleshinloye Grade B + 50% Jatropha cake) amended soil followed by DJ, AJ, BJ and control soil which could be attributed to the fact that cake had higher N (34.1 g/kg).

Application of CJ (50% Aleshinloye Grade B + 50% Jatropha cake) increased soil available P compared with the control. This is an indication that organic materials generally contain significant quantities of P which is mineralized during decomposition of the organic residues and orthophosphate is released into the soil solution [31]. A number of studies have demonstrated that addition of organic amendments to soils can significantly increase the availability of P to plants and decrease the P adsorption capacity of soils [32,33]. There was marked reduction in P adsorption capacity of a soil previously treated with AJ (30% Aleshinloye Grade B + 70% Jatropha cake) and DJ (60% Aleshinloye Grade B + 40% jatropha cake). The reduced P adsorption and increased P availability following applications of organic amendments to soils is thought to be the cumulative result of several mechanisms [34]. These include release of inorganic P from decaying residues, blockage of P adsorption sites by organic molecules released from the residues, a rise in soil pH during decomposition and complexation of soluble Al and Fe by organic molecules [31,35].

The compost amended with jatropha cake released significant amounts of K that are somewhat deficient in most savanna soils under continuous cultivation [36]. These results corroborated with the works of [4,37] who reported that jatropha cake contained high concentrations of K that are even higher than that of chicken or cow manure. However, from the 6^{th} to 9^{th} week, the concentration of K declined sharply in soil treated with AJ, BJ and CJ whereas the concentrations of calcium increased markedly. It was speculated that the decrease in exchangeable K could have been engendered by its displacement from the exchange sites by Ca, as would be predicted by cation exchange theory of preferential adsorption of divalent to monovalent cations in soil colloids [38].

The pattern of organic carbon mineralization differed for compost supplemented with jatropha cakes. AJ (30% Aleshinloye Grade B + 70% Jatropha cake) and CJ (50% Aleshinloye Grade B + 50% Jatropha cake) amended soil showed an initially fast mineralization followed slowly which reflect the mineralization of organic carbon with varying quality composition of organic materials.

The highest amount of soil organic carbon at the beginning of the incubation was indicative of a larger pool of the less resistant fractions that were available to be broken down and recycled, thus resulting in lower contents remaining at the end incubation. Similar results was observes by [39]. From several studies it has been found that the addition of organic residues increases the soil organic carbon level initially and with the course of time organic carbon content decreases in soil up to a certain period [40,23]. The higher NO_3-N recorded in the soil treated with CJ (50% Aleshinloye Grade B + 50% Jatropha cake) at 12 weeks might be as a result of rapid conversion by microbial activities in the soil [41]. This is in support of [42] who found that application of compost mineralization resulted in increased soil NO3-N. Mineralization rates of NH_4-N increased at all weeks of incubation with the soil treated with CJ. The release of NH4-N in the soil may guarantee plant N use efficiency [43]. This is in support of [44,45] who indicate that increase in NH_4-N results from ammonification of easily mineralizable organic N.

4. CONCLUSION

The organic fertilizer (50% Aleshinloye Grade B + 50% Jatropha cake) used in this study mineralized quite rapidly on Alfisol to improve N, P and organic carbon of the soil. The real benefit seems to be in the supply of N. The amount of N mineralized from 10 t/ha application rate used in this study can supply sufficient N as to drastically reduce inorganic N fertilizer requirements. Similarly, AJ (30% Aleshinloye Grade B + 70% Jatropha cake) can provide a substantial supply of K and, to some extent Ca to the soil to meet crop requirements.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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