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ORIGINAL ARTICLE

Effect of Cocoa Pod Husk Ash and Goat Dung on Nutrient Content and Growth Performance of Cashew (Anacardium Occidentale)

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Adejobi, K.B., Famaye, A.O., Adeniyi, D.O., Orisajo, S.B. and Adeyemi, E.A.: Effect of Cocoa Pod Husk Ash and Goat Dung on Nutrient Content and Growth Performance of Cashew (Anacardium Occidentale)

ABSTRACT

The effect of different levels of cocoa pod husk ash and goat dung on nutrient uptake and growth performance of cashew (Anacardium occidentale) seedlings was investigated at Ibadan in the rain forest zone of Nigeria. The organic fertilizer treatments; cocoa pod husk ash(CPHA) and goat dung(GD) were applied at 6.5g of CPHA (5t/ha), 25g of GD (20t/ha) 12.5g of GD +6.5g of CPHA (10+5t/ha) 18.75g of GD + 6.5g of CPHA (15t+6.5t/ha), 25g of GD + 6.5g of CPHA (20t+5t/ha) 6.5g of GD+6.5g of CPHA (5t+5t/ha), 0.6g of urea (400kg/ha), per 2.5 kg of soil filled poly bag. The results showed that these organic fertilizers increased significantly ($p<0.05$) the growth parameters (plant height, stem diameter, leaf area leaf number, number of branch, root and shoot length, root and shoot dry weight and root and shoot fresh weight), soil and leaf N, P, K, Ca, Mg, Na soil pH and organic matter (O.M) compared to the control treatment. 20 t/ha of GD + 5 tons/ha of CPHA treatment had the highest values of cashew seedlings performance compared to 5t/ha CPHA, 20t/ha GD, 400kg / ha urea, and the control treatment respectively. For instance, combined application of 20t/ha of GD +5t/ha of CPHA increased the plant height, number of leaf, leaf area, stem diameter, number of branch, root and shoot length, fresh and dry root weight,fresh and dry shoot weight of cashew seedlings by 45%, 29%, 12%, 52%, 59%,34%, 32%, 14%, 14%, 33% and 17% respectively compared to sole application of 20 tons/ha of GD. When compared with urea fertilizer application, 20t/ha GD+5t/ha CPHA treatment also increased the plant height, number of leaf, leaf area, stem diameter, number of branch, root and shoot length, dry and fresh root weight, dry and fresh shoot weight of cashew seeding by 25%, 28% 9%,46%,59%,19%,18%,32%,14%,6% and 13% respectively. For leaf chemical composition of cashew seedlings, 20t/ha GD and 5t CPHA increased leaf N, P, K, Mg, Ca and Na by 57%, 22%, 27%,28%, 50%, and 56% respectively compared with the control. When compared with urea fertilizer treatment, 20t/ha of GD + 5 t/ ha of CPHA increased the leaf N, P, K, Mg and Ca by 18%,56%, 10% 12% and 20%, respectively. However, urea fertilizer increased leaf N, K, and Ca by 48%, 19%, and 38% compared to control treatment. For soil chemical composition, 20t/ha GD 5t/ha CPHA manure also increased the soil pH, OC, OM, N,P, K, Na, Mg and Ca by 18%,26%, 29%, 50%, 80%, 43%, 30%, 14%, and 9% respectively compared to urea fertilizer treatment. However, 20%t/ha GD + 5t/ha CPHA (25g GD+6.5g CPHA) was the most effective treatment in improving cashew seedlings performance, soil and leaf mineral composition. Therefore it could be recommended to cashew farmers.

Key words: Cashew, cocoa pod husk ash, goat dung, nutrient uptake, growth.

Introduction

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The cashew (Anacardium occidentale) is a native of central and South America. Cashew is now grown in many parts of the world where its growth is not limited by cold. It is an important commodity crop with great potential as foreign exchange earner and source of industrial raw materials with the prospect of becoming a major commercial tree crop in Nigeria. Cashew is grown for its nuts and pseudo-apple from which products such as cashew juice, wine vinegar, jams chocolate, cashew nut shell liquid (CNSL) and cooking oil are made [20]. Cashew is produce in almost 32countries of the world and it annual world production is about 400,000 tonnes and more than 50 percent of this production comes from South Asia and Eastern Africa, especially India and Tanzania. Nigeria produces 186,000 metric tonnes of nuts per year representing 9.0% of the world production this making Nigeria the 4th largest producing country in the world after Vietnam, India and Brazil [8].

Cashew is grown in many soil types of the savanna zones of Nigeria. It is less selective and demanding in terms of soil types and fertility requirement compared with other plantation crops [20]. Cashew as a result of its wide adaptation is often grown in very poor soil and this has affected its survival and establishment in most fields. In many cashew plantations, the establishment could be as low as 45%, while in acute situation it could be less.

Information concerning nutritional requirements of cashew is very scarce, this can be due to an earlier suggestion that cashew must be modest in it nutritional demand since it is found to be productive on soil too poor and dry for other crop [20]. The use of NPK fertilizer for cashew nutrition had been established (Lefebure 1970;23]. The wide spread deficiency of N,P, K and other macro nutrients in Nigeria soil, constitutes a serious limiting factor in the production of major food and fibre crop [9,6]. These macro nutrient deficiency is often corrected through the use of inorganic fertilizers, application of most these inorganic fertilizers on along term basis often lead to reduction in pH and exchangeable bases thus making them unavailable to crops and the productivity of crop decline [27]. In addition, the problem of affordability of the chemical fertilizer to farmers farmer and other attendant problems of fertilizer procurement and distribution make the use of cocoa pod husk ash and goat dung a viable option [21]. The use of organic fertilizer to grow tree crops, especially cocoa, coffee and oil palm has been reported by various workers [5,11]. Application of compost improve the biological activities of the soil and has a direct impact on the sustainability of soil health [15].

Intensive use of some of these plant and animal wastes such as cocoa pod husk ash and goat dung had not been extended to cashew production.

Therefore the objectives of this study are to:

1. Determine the influence of combine effect and sore application of cocoa pod husk ash and goat dung on growth performance of cashew seedlings in the nursery.
2. Determine the leaf nutrients of cashew seedlings and soil chemical composition as influenced by the organic amendments.

Materials and methods

The trial was conducted between September 2009 to February 2010 in Ibadan in the rain- forest zone of South Western Nigeria. The site was located at Cocoa Research Institute of Nigeria (CRIN). Ibadan, the capital of Oyo State is located on latitude 070 10E and longitude 030 52E on the humid tropical and rainforest zone of Nigeria. The rainfall is between 1200 - 1500mm per annum, with average temperature of 30.1oC.

Soil Sampling and Analysis Before Planting:

Soil samples were randomly collected from 0-15cm depth on the site, mixed thoroughly and the bulk sample was taken to the laboratory, air dried and sieved to pass through a 2mm screen for chemical analysis. The soil pH was read on the pH meter. Organic matter was determined by the wet oxidation method [25]. Soil P was extracted by the bray p1 extracted and measured by the Murphy blue coloration and determine on a spectronic 20 at 882um [14]. Soil K, ca and mg were extracted with imnh4 OAC, Ph was determined with flame photometer; Mg was determined with an atomic absorption spectrophotometer. The total N was determined by the Microkjedahl Method [7].

Processing of the Organic Residues Used for the Experiment:

The cocoa pod husk was obtained from crop processing unit Cocoa Research Institute of Nigeria; Ibadan. The CPHA was sun dried for 3 weeks then burn to ashes. After cooling, the ash collected was bagged and kept in dry place ready for application. While goat manure was obtained from nearby pen in Akure Nigeria, the manure was air dried for a week under the shade.

Chemical Analysis of the Organic Materials Used:

Two grammes (2g) each of the organic material used were analyzed.

The nitrogen content was determined by Kjedahi method (Jackson, 1964) while the determination of other nutrient such as P, K, Ca and Mg was done using the wet digestion method based on 25-5-5mc

of HNO3 - H2S04 - HClO4 acids (AOAC 1970). The K and Ca nutrient were read on flame photometer while Mg was read on atomic absorption spectrometer. The P content was developed into a yellow coloration with vanado molybdate solution and read on spectronic 20 at 442 um. The organic carbon (%) was determined by wet oxidation method through chronic acid digestion (Walkey and Black 1934).

Collection of Cashew Nut:

Disease free cashew nut was collected from cashew plantation; in Cocoa Research Institute of Nigeria (CRIN) Ibadan. The variety of the cashew nut was Brazilian large - Oro selection (10 - 12g in size). The nuts were dried and viability viability testing done by immersing them in sugar solution (0.68kg sugar in 4.5 liters of water) to identify the viable and high density nut for the study.

Nursery Establishment:

The bulk soil taken from (0-15 cm depth) was sieved to remove stones and plant debris and 2.5 kg of the sieved soil was placed into a polythene bag (25cm x 13 cm) in 2009. There were 7 treatments. The rate of application were 5t/ha CPHA, 5t/ha CPHA + 5t/ha GD, 5t/ha CPHA + 10t/ha GD, 5t/ha CPHA + 15t/ha GD, 5t/ha CPHA + 20t/ha GD, 20t/ha GD, 400kg/ha urea and the control (no treatment).

Two (2) cashew nuts were sown per polythene bag arranged in complete randomized block design (RCBD) and replicated three times. The parameters such as plant height, leaf area, stem diameter and number of branch were recorded from 4 week after planting (WAT). Growth parameters were measured every four - week until 20 week after planting. Hand weeding was done at 3 week after planting and repeated at 6, 9, 12 and 16 weeks.

At 24 weeks after planting in the nursery the seedlings were carefully removed from the polythene bags for the measurement of fresh root and shoot weights, root length and shoot length. Then, they were oven - dried and both dried root and shoot weight were taken before finally analyzed for N, P, K, Ca and Mg contents.

At the time of taking the shoot weight, soil samples were taken from each poly bag and air dried and sieved for analysis of soil N, P, K, Ca, Mg, pH and OM as described earlier.

Statistical Analysis:

The growth data collected were analyzed using ANOVA. The treatment means were compared using Duncan's multiple range test (P=0.05).

Results:

The soil chemical properties before planting are presented in Table 1. Base on the established critical level of soils in south west Nigeria, the soil was acidic with pH.5.26 and low in organic matter compared to the critical level of 3% organic matter [4].

The total nitrogen (0.43g/kg) is far less than 1g/kg which is considered optional for most crops (sobulo and Osiname,1973). While the available P is less than 10mg/kg P critical level [4]. The exchangeable K (0.12), Ca (0.10) and Mg (0.13mmol/kg) were lower than 0.20cmol/kg critical levels considered as adequate for crops (Folorunso et. al., 2000). The soil textural class is sandy loam and it is classified as Oniganbari soil series which is equivalent to Alfison (Isohyperthermic Oxic Paleustaif) [24].

The chemical analysis of the Organic fertilizer materials used for growing cashew seedling is presented in Table 2. Goat dung manure had the highest valves of N, P, and Mg compared to cocoa pod husk ash. While cocoa pod husk had the highest values of pH, C/N, K, Na, and Ca contents compared to Goat dung manure.

There were significant increases ($p< 0.05$) in the plant height, stem diameter, leaf area, leaf number, number of branch, root and shoot length, root and shoot fresh weight, root and shoot dry weight (kg) under different organic fertilizers compared to the control treatment (Table 3).

20t/ha of GD+5t/ha of CPHA treatment had the highest values of plant height, leaf area, stem diameter, number of leaf, number of branch, root and shoot length, root and shoot fresh weight, root and shoot dry weight of cashew seedling compared to 5t/ha CPHA alone, 20t/ha GD alone, 400kg/ha urea, and the control treatment respectively.

For instance, combined application of 20t/ha of GD+5t/ha of CPHA increased the plant height, number of leaf, leaf area, stem diameter, number of branch root and shoot length, dry and fresh root weight, dry and fresh shoot of cashew seedlings by 38%, 14%, 21%, 56%, 59%, 34%, 34%, 14%, 14%, 17%, 33%, respectively compared to sole application of 20t/ha of GD.

When compared with urea fertilizer application, 20t/ha GD + 5t/ha CPHA treatment also increased the plant height, number of leaf, leaf area, stem diameter, number of branch, root and shoot length, dry and fresh root weight, dry and fresh shoot weight of cashew seedlings by 25%, 28%, 9%, 46%, 59%, 19%, 18%, 32%, 14%, 6%, and 13% respectively.

All the treatment had better value of growth parameter of cashew seeding than that of control. There were significant increases ($p<0.05$) in leaf N, P, K, Ca and Na of cashew seedlings compared to control treatment. Among the organic fertilizer treatments, 20t/ha of GD + 5t/ha CPHA had the highest values of leaf N, P, K, Mg and Ca while 20t of GD alone and 5t/ ha of GD + 5t/ha of CPHA also

had the highest value of leaf Na and K. respectively compared with urea fertilizer treatment, 20t/ha of GD + 5t/ha of CPHA increased the leaf N, P,K, Mg, and Ca by 18%,56% 10%,12% 20%, respectively. However, urea fertilizer increased leaf N, K, and Ca by 48% 19%, and 38% compared to control treatment.

There were significant increase ($p<0.05$) in soil pH, N, P ,K, Ca, Mg, OC, and OM compared to the control treatments under different organic fertilizer treatment (table 5) 20t/ha of GD treatment alone had the highest value of soil pH, OC, OM, and N, while combined 20t/ha GD + 5t/ha CPHA also had the highest values of soil P and K compared to others. For example, 20tons.ha GD manure increased the soil pH, OC, OM, and P by 13%, 0.3%,42%, 58%, and 6% compared to urea fertilizer treatment, 20tons/haGD increased soil Ph, OC, OM, N, P, K, Na, Mg, and Ca by 19%, 42%,42%, 56%,4% 20% 23% 29% and 28% respectively.

Table 1: Pre - study Analysis of the Physicochemical Characteristics of the Planting Soil.

Soil Properties	Value
Physical Properties	
Sand	642.02g/kg
Silt	136.56g/kg
Clay	139.55g/kg
Textural Class	Sand loam
Water Holding Capacity	36.70%
Chemical Properties	
Soil pH (H20) 1:1	5.26
Organic Carbon	2.73g/kg
Organic Matter	0.55%
Total Nitrogen %	0.43g/kg
Available Phosphorous	2.00mg/kg
Exchangeable basis	
K+	0.12mmol/kg
Ca++	0.10mmol/kg
Na+	0.13mmol/kg
Mg++	2.80mmol/kg
Mn++	0.03mmol/kg
Exchangeable acidity	
Al+++	0.23mmol/kg
H+	0.12mmol/kg
ECEC	5.14mmol/kg

Table 2: Chemical Analysis of Organic Fertilizer used for the Experiment.

Treatment	pH (H20)	C/N Ratio	N %	P mg/kg	K mg/L	Na mg/L	Mg mg/L	Ca mg/kg
*GD	6.38	62.00	1.26	40.36	2.29	1.67	1.90	3.40
*CPHA	7.21	95.00	1.02	16.26	5.01	3.06	1.80	3.60

Values are average of three replicates. *GD (Goat Dung). *CPHA (Cocoa Pod Husk Ash)

Table 3: Effect of different levels of CPHA on growth parameters of cashew seedlings in the nursery.

Treatment	Plant height (cm)	Number of leaf	Leaf area (cm)	Stem diameter	Number of Branch	Root length (cm)	Shoot length (cm)
5t/ha CPHA	37.43b	26.46ab	73.76bc	0.81b	1.60bc	16.12c	18.60c
20t/ha GD	33.42b	21.66bc	81.96bc	0.89b	1.46bc	15.33c	17.34c
10t/ha GD + 5t/ha CPHA	40.98b	26.73ab	77.40bc	0.83b	1.93bc	16.33c	18.72c
15t/ha GD + 5t/ha CPHA	42.74b	26.46ab	82.65bc	1.09ab	2.75ab	16.00c	18.21c
20t/ha GD + 5t/ha CPHA	60.85a	30.6a	92.84a	1.85a	3.53a	23.33a	25.66a
5t/ha GD + 5 t/ha CPHA	40.98b	24.0bc	71.24bc	0.90ab	2.60ab	16.66c	18.90c
400kg/ha Urea	45.34ab	21.93bc	84.69ab	1.00ab	1.46bc	19.00b	21.02b
No treatment (control)	33.42b	18.0c	64.59c	0.81b	0.93c	12.33c	14.33c

Treatment means within each column followed by the same letter are not significantly different from each other using Duncan Multiple Range Test at 5% level.

Table 4: The yield parameter of cashew seedlings 24 weeks after planting under different level of cocoa pod husk ash and goat dung

manure application.

Treatment	Fresh Root Weight (g)	Dry Root Weight (g)	Fresh Shoot Weight (g)	Dry Shoot Weight (g)
5t/ha CPHA	24.66a	6.00b	43.00c	16.33g
20t/ha GD	23.33b	6.33c	46.00c	22.66c
10t/ha GD + 5t/ha CPHA	24.00b	6.00b	34.66c	15.00c
15t/ha GD + 5 t/ha CPHA	25.66a	8.33b	42.00c	17.66c
20t/ha GD + 5 t/ha CPHA	27.00a	7.33a	68.66a	27.33a
5t/ha GD + 5 t/ha CPHA	23.16b	5.00b	43.00c	16.33b
400kg/ha Urea	23.16b	5.00b	60.00b	25.66a
No treatment (control)	23.33b	5.33b	39.66c	14.66d

Treatment means within each column followed by the same letter are not significantly different from each other using Duncan Multiple Range Text at 5% level.

Table 5: The leaf chemical composition under different level of GD + CPHA.

Treatment	N %	P mg/kg	K mg/100g	Mg mg/l	Ca mg/100g	Na mg/l
5t/ha CPHA	4.4b	15.8b	7.3f	4.3a	15.2b	3.8c
20t/ha GD	4.1bc	9.4d	13.3b	2.4d	12.0d	4.9a
10t/ha GD + 5t/ha CPHA	4.0c	5.5a	9.7c	2.4d	8.0g	3..8c
15 t/ha GD + 5 t/ha CPHA	2.4d	8.8a	6.8g	2.4fd	9.4f	3.3d
20t/ha GD + 5 t/ha CPHA	5.1a	18.8a	8.3d	2.5d	16.0a	3.9c
5t/ha GD + 5 t/ha CPHA	3.9c	5.2g	14.5a	4.3d	11.2e	2.7e
400kg/ha Urea	4.2bc	8.3e	7.5e	3.8b	12.8c	3.9c
No treatment (control)	2.2e	14.7c	6.1h	3.8b	8.0g	4.7b

Treatment means within each column followed by the same letter are not significantly different from each other using Duncan Multiple Range Test at 5% level.

Table 6: Soil Chemical Analysis after Experiment under different levels of GD and CPHA.

Treatment	Soil pH (H20)1.1	Organic Carbon (OC) g/kg	Organic Matter (OM) %	N %	P mg/kg	K mg/l	Na mg/l	Mg mg/l	Ca mg/l
5t/ha CPHA	5.89b	2.98a	2.96a	0.20a	4.71d	1.53b	1.08b	2.60a	4.70b
20t/ha GD	6.80a	2.99a	5.12a	0.48a	5.01c	0.70cd	0.78c	1.70c	4.00c
10t/ha GD + 5t/ha CPHA	5.83b	2.41b	4.16a	0.41a	23.8a	1.75b	1.16b	1.30d	3.70cd
15t/ha GD + 5t/ha CPHA	5.93ab	1.80d	3.10a	0.24a	22.05b	2.27a	1.53a	2.30b	5.90a
20t/ha GD + 5t/ha CPHA	6.74a	2.34b	4.03a	0.40a	23.80a	0.98c	0.86c	1.40d	3.20de
5t/ha GD + 5t/ha CPHA	5.78b	1.99c	3.43a	0.36a	1.93e	0.97c	0.93bc	1.70c	3.30de
400kg/ha Urea	5.50c	1.72d	2.97a	0.20a	4.83d	0.56de	0.60d	1.20d	2.90e
Control	5.16c	1.67d	2.87a	0.12a	1.25f	0.45e	0.51d	1.30d	2.10f

Treatment means within each column followed by the same letter are not significantly different from each other using Duncan Multiple Range Text at 5% level

Discussion:

General increase in growth parameters such as plant height, leaf area, stem diameter, number of leaf number of branch, root and shoot length, fresh root and shoot weight, dry root and shoot weight of cashew seedlings could be adduced to the nutrient contents of the organic fertilizers used which encouraged better seedling growth. This finding that the manure improved soil nutrients content is consistent with earlier finding of Adeniyan and Ojeniyi [3] and Moyin -jesu [10] who reported that organic manure supported crop growth performance and increased crop yield.

Combined application of 20t/ha of GD + 5t/ha of CPHA gave the best performance on the growth moderate least and soil fertility and this could be as a result of its high value of N, P, K, and moderate Ca and Mg. this finding also agreed with Odedina *et. al.,* [19] who reported that goat dung when used as fertilizer, it improves soil fertility and vegetable yield.

The value reported for soil pH before the experiment was acidic but the application of cocoa pod husk ash increased the soil pH to a near neutral level.

This could be due to the fact that cocoa pod husk ash was naturally rich in K, Ca, and Mg which created a liming effect in soil and stability of the soil buffering capacity. The observation agreed with the work of Adeiran *et. al.*, [2] and Moyin - jesu [12] who stated the use of ash along with urea would serve to control soil acidity problem that arise with respective use of urea. Again, soil pH had been reported to influence nutrient availability and update by crops [1] Goat dung and cocoa pod husk ash Complement each other to improve both the performance of cashew seedling and soil fertility than urea application. This finding agreed with that of Obi and Ofondiru [18] who reported that the continuous use of mineral fertilizers such as NPK, urea and ammonium sulphate had let to degradation of soil physical quantities and low soil organic matter level. The least values recorded for the soil, growth and leaf parameter of cashew seedling under the control treatment could be attributed to the initial poor soil fertility status and continuous cultivation of the land without replenishing with organic fertilizer. This observation agreed with that of Woomer and Muchena [26] who reported that continuous productivity of tropical soil is associated with maintenance of improvement of soil physical characteristics which can be further improved by applying organic fertilizer.

Conclusion and Recommendation:

The combined and sole application of organic fertilizers such as goat dung and cocoa pod husk ash increased significantly the soil and leaf N,P,K,Ca, Mg, soil pH and O.M, plant height, stem diameter, number of leaf, leaf area, root and shoot length, fresh root and shoot weight, dry root and shoot weight of cashew seedling. It is therefore recommended that goat dung be applied at 20t/ha with cocoa pod husk ash at 5tons.ha (25g + 6.5g/2.5kg of soil) was the most effective fertilizer material for improving the nutrient availability and ensuring sustainable cultivation of cashew seedling on a commercial basis.

This recommendation corroborate with the fact that inorganic fertilizer are becoming too expensive to purchase by small scale formers of cashew seedlings. Besides, these organic fertilizers appear to have a strong, lasting beneficial effect on the soil properties and could be environmentally friendly.

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