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Comparative effects of organic and inorganic soil amendments on the growth of cashew nut (*Anacardium occidentale l.)* seedlings

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This experiment was established to investigate the comparative effect of organic and inorganic soil amendments on the growth of cashew seedlings. Cashew nuts were planted in potting medium filled with well drained loamy soil and placed in a screenhouse. Cashew seeds with 8 to 9 g weight were selected and viability test was carried out using Tetrazolium test (TZ) viability test to ascertain how viable the seeds were before sown in a potting medium. After two weeks of germination, amended with the following treatments at various levels; NPK 15:15:15, composted cow dung, composted poultry dropping, sunshine organo-mineral, pig manure and control (No fertilizer). Complete randomized design (CRD) was used for the experimental layout with three replicates. Agronomic parameters in the study include; stem girth, plant height, number of leaves, leaf length and width. Cashew seedlings were more responsive to the animal sourced fertilizers (organic manure) compared to the inorganic (NPK 15, 15, 15) and control (No fertilizer). Composted poultry droppings fertilizer (PDF) showed higher significant differences on stem girth, plant height and cow dung gave significant difference on number of leaves from 2 to 8 weeks of growth after treatments application, sunshine organomineral and composted poultry droppings fertilizer gave higher significant differences at 8 weeks on leaf length and width respectively.

Key words: Cashew nut (*Anacardium occidentale L.)*, seedlings, organo-mineral, soil amendments.

INTRODUCTION

Cashew tree, *Anacardium occidentale*, belongs to the Anacardiaceae family of plants which also includes the mango, pistachio, and poison ivy. A medium-sized, spreading evergreen tree native to Brazil, but now grown widely in the tropics for its edible nuts and the oil contained in the shells. The fruit consists of a fleshy, red or yellow, termed the *apple*, at the end of which is borne a hard-shelled, kidney-shaped nut. Although, cashew trees are spread throughout the tropics, commercial production is centered in India, which handles 90% of the world trade. The cashew tree grows with minimum of attention and is easily cultivated. Cashew nuts are edible when roasted and used extensively in the confectionery and baking trade. The cashew nuts shell liquid is a

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valuable by-product, containing 90% anacardic acid and 10% cardol, and is used in the varnish and plastic industries. The cashew nuts and apples are astringent for eating without being processed, but when processed may be used for jams, chutney, pickles, and wine. It is a nut crop of considerable economic importance to Nigeria.

Unlike most fruits where the seed is found inside the flesh, the cashew seed hangs from the bottom of the cashew apple. Although, fresh cashew fruit (apple) is not only edible but delicious. Cashew apples begin to ferment as soon as they are picked and will barely last 24 h. Cashew apples are highly prized in their growing locale, where they are sometimes found canned in jams, or used to make liquors. The cashew tree is a tropical ever-green, resistant to drought unexacting soil. The tree has extensive root systems, which helps it to tolerate a wide range of moisture levels and soil types. Cashew nut processing allows for the development of an important by-product, which can increase its added value. The liquid inside the shell represents 15 percent of the gross weight and has some attractive possible medicinal and industrial uses. Cashew Nut Shell Liquid (CNSL) is one of the few natural resins that is highly heat resistant and is used in braking systems and in paint manufacture. It contains a compound known as *anacardium*, which is used to treat dermatological disorders. Successful cashew cultivation depends on the selection of the best varieties suited to agro climatic condition.

. Cashew is becoming one of the most important cash crops for farmers in Nigeria where there is a great potential for increased production for the local and export market (Olife et al., 2013). Cashew has assumed greater importance due to its special qualities and consumer preference that resulted from its good taste, supplement of plant protein in human diet and as supplement for soybeans in livestock mashes (Ojewola et al., 2004). Africa accounts for about 36% of world cashew production and Nigeria is the world's 6th largest producer of cashew, with annual production of about 120,000 tonnes (FAO, 2000). Prior to this, production was relatively static at 25,000 tonnes over a 25 year period from 1965. As in the case of other developing countries, Nigeria has recognized the potential economic value of cashew and has made a concerted effort to improve production of the crop (Olife et al., 2013).

Cashew is usually planted as mono-crop in plantations for the nuts that have pleasant taste and flavor when roasted (Yahaya, 2003). Generally, the fleshy part of the whole fruit is eaten raw or the apple juice is being extracted, bottled and sold, while jam and jelly are produced from the pulp following juice extraction and the pulp is a useful ingredient in livestock feedstuff (Yahaya et al., 2010). This research came up due to low usage of fertilizers (inorganic) to fruit crops such as cashew, either at the seedling stage or fruiting stage and the reason may be due to high cost and scarcity of inorganic fertilizers which most farmers cannot afford; so this necessitated into low cost, internally sourced, cheap and adoptable organic materials that can serve as fertilizer and it was also observed that cashew has not received much research attention in terms of fertilizer requirement in Nigeria but research so far indicated that it is needed for optimum cashew seeding growth (Ibiremo, 2008). Low establishment of cashew seedlings to be developed into full grown cashew plantation and un-rehabilitated moribund cashew plantation that has led to drastic reduction in production, hence, the urgent need to use soil amendment to assess their performance and at the same time making recommendation for the best fertilizer types that will have positive effect on cashew growth, compare to the control (with no fertilizer) (Hammed and Adeyemi, 2005).

The objectives of this study are:

1. Identify local and available sources of organic fertilizers that promote fruit crop growth;
2. Identify other fertilizer sources that could cushion the effect of high costing inorganic fertilizers.

MATERIALS AND METHODS

This research work was conducted January to April, 2012 and May to August, 2013 at the Screenhouse of Federal University of Technology, Akure, Ondo State, South western, Nigeria {54° 30^1 N and 70° 30^1 E}. Screenhouse was built with translucent plastic to allow penetration of daylight. The study area has an average temperature of 27°C at room temperature and total mean annual rainfall of 1600 mm.

Viable seeds of cashew with 8 to 9 g were selected for the study using Tetrazolium test (TZ) for seed viability and planted in 30 by 10 cm (length and width) nursery pot filled with non-disinfected, very fine dried loam soil. After two weeks of germination (a seed was considered germinated when the radical protrusion was approximately 2 mm), treatments were applied. Plastic bags (Pots) were placed on polythene of 0.5 mm thickness to cover the ground surface. Seeds were sown 3 cm depth in each pot. Weeds were controlled manually by hand pulling. Water was introduced through watering can to supplement rainfall and provide adequate moisture. Complete randomized design (CRD) was used for the experimental layout with each of the six treatments having three replicates. After two weeks of transplanting, treatments were applied in ring form at the following rates (Table 2):

1. N.P.K 15:15:15 (NPKF) = 100 g/stand
2. Sunshine organo-mineral (S.ORGM) = 300 g/stand
3. Composted cow dung (CDGF) = 300 g/stand
4. Composted pig dung (PDF) = 300 g/stand
5. Composted poultry droppings (PDG) = 300 g/stand
6. Control (No fertilizer) = 0 g/stand

Data collection

After two weeks of applying the treatments, data on growth parameters were collected on forth night bases (two weeks interval) which included plant height (PH), stem girth (SG), number of leaves (NL), leaf length (LL) and leaf width (LW) of the leaves. The seedlings height were measured from ground level in pot (soil base to the shoot tip) using meter rule (cm), girth of stem at the plant - soil base level using analogue veneer caliper (cm), number of leaves by visual count and leaf length and width using leaf area

Table 1. Soil analysis of pretreatment collected from the soil sample used.

Textural class	Percentage (%)
Sandy clay loam	67 sand, 12 silt, 21 clay
pH	5.4
Nutrient/organic composition	
Organic matter	1.25
Nitrogen	0.12
Available P	9.5 ppm
K	0.19 cmol/kg

meter; data were collected Four times.

Data analysis

Data collected for the experiment were averaged and analyzed. The data obtained were statistically analyzed with SPSS (version 15) through the analysis of variance (ANOVA) and significant mean differences were separated by Tukey at $p \leq 0.05$ level.

RESULTS AND DISCUSSION

Composted poultry droppings fertilizer (PDF) gave higher significant difference (0.76) compare with other organic fertilizer sources used in this experiment on stem girth of seedlings, this may be attributed to higher concentration of Nitrogen (N) in PDF than composted cowdung (CDGF) and pig dung (PDG), CDGF and PDG also gave higher significant values (0.75 and 0.73) respectively in comparism with sunshine organomineral, NPK and control. Composted poultry droppings also gave significant difference (16.44) on plant height of seedlings, this may be attributed to its high N and P concentration compared to cowdung and pig manure as stated in the treatment analysis above. Cow dung gave significant difference (7.41) on the number of leaves produced by seedlings at 2 to 8 weeks, this reiterates the fact that organic fertilizers steadily release available nutrients overtime and not like inorganic fertilizers that release nutrients within a short period to plant, then leaches away from the root zones (Carl and Roger, 2005). Sunshine organomineral (S. ORGM) and composted poultry droppings fertilizers (PDF) gave significant differences on leaf length and width (9.01 and 4.37) respectively, this also reiterates the fact that two separate mixture of fertilizers, based on the combination of Nitrogen (N), phosphorus (P) and potassium (K), manure and fertilizers promote growth of plants (Ojeniyi et al., 2007). These organic fertilizers have higher nutrient concentration compared with pig manure, cow dung and control, hence enhance more growth of seedlings. The positive growth response of the cashew seedlings to organic and inorganic soil amendments than control indicated that the soil collected for this research is inherently low in some essential nutrients (Table 1), hence the level of many essential nutrients in these soils is lower than critical value which was readily available and supplied from the organic and inorganic amendments (Tables 3 to 7). The cashew seedlings were more responsive to the animal sourced (organic manure) amendments compare to the inorganic fertilizer, thus indicating there were some important nutrients that were being supplied to the cashew seedlings by the organic manures which were not available in the inorganic NPK (15:15:15), thus, cashew seedlings were more responsive to organic amendments for stem girth (SG), plant height (PH) in pig dung and cow dung (Tables 3 to 7). Inorganic and organic sourced fertilizers were competitive in the growth pattern of cashew seedlings, and after four weeks of their application, they resulted to a general significantly higher plant height than control (Table 3). This trend was maintained throughout the observation period. Plant stem girth (SG) was generally higher for the fertilizer treatments compared to the control (Table 3).

Plant number of leaves, plant height and stem girth were significantly ($p \leq 0.05$) different for cashew seedlings treated with organic manures compared to the control from 2 to 8 weeks after its application (Tables 3 to 5). It was observed from this experiment that the amendments, especially the organic manures have further enhanced better growth performance of the seedlings in all the parameters measured compared to the inorganic (NPK) and organo-mineral nutrients source that is noted to be fast in nutrients release and prone to leaching, losses with the accompany environmental hazards (Giles, 2005). Better growth performance due to organic fertilizers than inorganic nutrient sources have been reported for *Amarantus cruentus* (Ipinmoroti et al., 2003), *Camellia sinensis* (Adeoye et al., 2007), coffee plants (Daniel and Obi, 2006), coffee seedlings (Ipinmoroti et al., 2006) and tomato (Adetunji et al., *2003*). The addition of organic matter content resulting from organic fertilizer application helps to improve nutrient availability to plants, especially in tropical soils that are generally low in soil organic matter and clay (Ogunwale et al., 2002).

Conclusion

It could be deduced from this study that application of nutrient supplements as soil amendments enhanced the growth performance of cashew seedlings resulting in rapid plant height, leaf production and increased plant stem girth that are inevitable for plant vigorous growth. Composted poultry droppings fertilizer (PDF) showed higher significant differences on stem girth, plant height and cow dung gave significant difference on number of leaves from 2 to 8 weeks of growth after treatments application. The use of organic fertilizers from animal source was significant in this experiment and hence, capable to cushion the hardship faced by farmer's on high costing and scarcity of inorganic fertilizers in Nigeria.

Table 2. Approximate major nutrient composition of organic and inorganic fertilizers used as treatments.

Organic	N (% dry weight basis)	P_2O_5	K_2O
Composted poultry droppings	3.5	5.2	2.3
Pig manure	2.9	2.3	1.5
Composted cow dung	1.4	2.2	2.4
Sunshine organomineral	4.5	2.0	2.2
Inorganic			
NPK	15	15	15
Control	0	0	0

Sunshine organomineral is a fortified organomineral fertilizer made up of plant and animal manure manufactured by Ondo State government, Nigeria.

Table 3. Effect of soil amendments on stem girth (cm).

Treatments	Weeks after application			
	2	4	6	8
S.ORGM	0.42^{b}	0.42^{b}	0.53d	0.73^{c}
NPKF	0.42^{b}	0.42^{b}	0.53d	0.73^{c}
PDG	0.43^{ab}	0.43^{b}	0.54^{c}	0.73^{bc}
PDF	0.44^{ab}	0.45^{a}	0.55^{b}	0.76^{a}
CDGF	0.45^{a}	0.46^{a}	0.56^{a}	0.75^{ab}
CONTROL	0.42^{b}	0.42^{b}	0.52^{e}	0.69^{d}

Table 4. Effect of soil amendments on plant height (cm).

Treatments	Weeks after application			
	2	4	6	8
S.ORGM	7.04^{d}	9.08^{d}	13.09^{d}	15.14^{d}
NPKF	6.82^{f}	8.84^{f}	12.88^{f}	15.03^{e}
PDG	7.32^{c}	9.45^{c}	13.79^{b}	15.82^{b}
PDF	7.53^{b}	9.55^{b}	14.39^{a}	16.44^{a}
CDGF	8.34^{a}	10.35^{a}	13.61^{c}	15.68^{c}
Control	6.94^{e}	8.95^{e}	12.98^{e}	14.99^{e}

Means on the same column with same prescript are not significantly different by Tukey at 0.05% probability level.

Table 5. Effect of soil amendments on number of leaves (visual counting).

Treatments	Weeks after application			
	2	4	6	8
S.ORGM	2.77^{c}	2.82^{c}	4.87^{c}	6.94^{c}
NPKF	2.69^{d}	2.72^{d}	4.75^{d}	6.77^{d}
PDG	3.03^{b}	3.04^{b}	5.07^{b}	7.09^{b}
PDF	3.04^{b}	3.05^{b}	5.10^{b}	7.11^{b}
CDGF	3.33^{a}	3.35^{a}	5.37^{a}	7.41^{a}
CONTROL	2.83^{c}	2.85^{c}	4.85^{c}	6.87^{c}

Means on the same column with same prescript are not significantly different by Tukey at 0.05% probability level.

Table 6. Effect of soil amendments on leaf length (cm).

Treatments	Weeks after application			
	2	4	6	8
S.ORGM	3.00[a]	4.01[a]	7.01[a]	9.01[a]
NPKF	2.96[a]	2.99[cd]	5.96[d]	5.97[b]
PDG	2.96[a]	3.03[bc]	6.84[b]	6.99[ab]
PDF	2.97[a]	2.98[d]	6.86[b]	7.03[ab]
CDGF	2.98[a]	3.00[c]	6.85[b]	7.02[ab]
CONTROL	2.98[a]	3.05[b]	6.06[c]	6.07[b]

Means on the same column with same prescript are not significantly different by Tukey at 0.05% probability level.

Table 7. Effect of soil amendments on leaf width (cm).

Treatments	Weeks after application			
	2	4	6	8
S.ORGM	1.17[c]	2.24[ab]	3.26[bc]	4.30[b]
NPKF	1.18[bc]	2.32[a]	3.34[a]	4.35[ab]
PDG	1.27[abc]	2.27[a]	3.32[ab]	4.34[ab]
PDF	1.29[ab]	2.32[a]	3.34[a]	4.37[a]
CDGF	1.30[a]	2.32[a]	3.32[ab]	4.34[ab]
CONTROL	1.20[abc]	2.24[ab]	3.25[bc]	4.27[b]

Means on the same column with same prescript are not significantly different by Tukey at 0.05% probability level.

Composted organic manure used in this experiment can be incorporated on large scale as against the filthy and bulky nature believed to be its limiting factor of use.

Conflict of Interest

The authors have not declared any conflict of interest.

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