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Influence of Compost Supplemented With Jatropha Cake on Growth, and Nutrient Uptake of Maize (*Zea mays L*)

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Abstract
The potentials of compost supplemented with jatropha cake as soil amendments were evaluated under screenhouse condition at Kwara State University, Nigeria. Maize (variety EVDT-W99 STR) was used as test crop. The experiment consisted of two consecutive trials in which residual effect was observed in the second trial. The experiment consisted of fourteen treatments; control (Zero addition), NPK 15 –15-15 at 60 kg N/ha, 30% Aleshinloye compost Grade B (un-amended compost) + 70% Jatropha cake at 1.5, 2.0 and 2.5 t /ha, 40% Grade B + 60% Jatropha cake at 1.5, 2.0 and 2.5 t /ha, 50% Grade B + 50% Jatropha cake at 1.5, 2.0 and 2.5 t /ha, 60% Grade B + 40% Jatropha cake at 1.5, 2.0 and 2.5 t /ha . The design was completely randomized design replicated three times. Results obtained showed that 50% Grade B + 50% Jatropha cake greatly influenced growth parameters of maize in both trials. The 50% Grade B + 50% Jatropha cake treatment recorded the highest Nitrogen, phosphorus and potassium uptake value; 13.28, 0.32and 14.60 mg/pot respectively during the second trial and were significantly ($p<0.05$) higher than all other treatments. The study showed that jatropha cake supplemented with compost at 2.5 t/ha resulted in higher growth parameters and nutrient uptake when compared with NPK in the second trial.

Keywords: Compost, dry matter yield, Jatropha cake, nutrient uptake.

Influence du Compost À Base du Gateau de Jaatropha Sur la Croissance Et la Production du Maïs (*zea Mays L*)

Résumé
Les potentialités du compost additionné de gâteau de jatropha lors de l'amendement des sols ont été évaluées dans des conditions de criblage à l'écran de dépistage à la Kwara State University, au Nigéria. Du maïs (variété EVDT-W99 STR) a été utilisé comme culture d'essai. L'expérience consistait en deux essais consécutifs dans lesquels un effet résiduel avait été observé dans le deuxième essai. L'expérience consistait en quatorze traitements; contrôle (addition nulle), NPK 15 –15-15 à 60 kg N / ha, 30% de compost Aleshinloye de grade B (compost non modifié) + 70% de tourteau de jatropha à 1,5, 2,0 et 2,5 t / ha, 40% de grade B + 60% de gâteaux de jatropha à 1,5, 2,0 et 2,5 t / ha, 50% de grade B + 50% de gâteaux de jatropha à 1,5, 2,0 et 2,5 t / ha, 60% de grade B + 40% de gâteaux de jatropha à 1,5, 2,0 et 2,5 t / ha. La conception a été complètement randomisée conception répliquée à trois reprises. Les résultats obtenus ont montré que les gâteaux à 50% de grade B + 50% de jatropha avaient une grande influence sur les paramètres de croissance du maïs dans les deux essais. Le traitement à base de gâteaux de jatropha à 50% de grade B et à 50% a enregistré les valeurs d'absorption d'azote, de phosphore et de potassium les plus élevées; 13,28, 0,32 et 14,60 mg / pot respectivement au cours du deuxième essai et étaient significativement plus élevés ($p <0,05$) que tous les autres traitements. L'étude a montré que le gâteau de jatropha additionné de compost à 2,5 t / ha entraînait des paramètres de croissance et une absorption de nutriments plus élevés par rapport au NPK dans le deuxième essai.

Mots-clés: Compost, rendement en matière sèche, tourteau de jatropha, absorption de nutriments.

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Introduction

Declining soil fertility is a serious limitation to crop production in Nigeria. The primary causes are loss of organic matter, acidity, low nutrient contents, nutrients imbalance and soil erosion (Ojo *et al*., 2014). The low nutrient status of most tropical soils necessitates the use of fertilizers (Ogundare *et al*., 2016). The majority of the small holder peasant farmers in Nigeria lack the financial resources to purchase sufficient fertilizers to replace soil nutrients exported with harvested crop products. As a result, soil fertility often decline and yields of staple food crops are typically low (Olowoake and Adeoye, 2013). One of the ways of increasing the soil nutrient status is by boosting the soil nutrient content either with the use of organic materials such as poultry manure, animal waste or compost (Dauda *et al*., 2005). Several sources of organic materials and residues abound in Nigeria which can be processed, packaged and made available as branded organic fertilizer at a cheap rate for home gardening, horticulture and farming as a whole (Olowoake *et al*., 2015).

Jatropha cake which is rich in nitrogen, phosphorous, and potassium can be used as organic fertilizer. The percentages of nitrogen (N), phosphorous (P), and potassium (K) in jatropha cake were 3.2–4.5, 1.4–2.1, and 1.2–1.7%, respectively, however, this content differs depending on the source (Kumar and Sharma, 2008). The occurrences of these elements (N, P K) in the cake were known as the organic nutrients sources that are even greater than that of chicken or cow farm yard manure (Olowoake *et al*., 2018). Organic fertilizers are considered to be more sustainable than the mineral fertilizers because intensive use of mineral fertilizers has been reported to be linked with reduced crop yield; due to soil acidification and nutrient imbalance (AyanfeOluwa *et al*., 2015). Application of poultry manure and farmyard manure was found to increase the availability in soil and subsequently, the nutrient uptake in maize (Hossain *et al*., 2013). However, there is paucity of information on the use of compost augmented with jatropha cake for the production of maize in Ilorin, Nigeria. Therefore, this study was carried out to evaluate the influence of compost supplemented with jatropha cake on growth, dry matter yield and nutrient uptake of maize.

Materials and Methods

Pot experiment was conducted in 2016 at Kwara State University Malete, Nigeria (Latitude 80 71'N and Longitude 40 44'E). The university lies in the southern guinea savanna belt of Nigeria. Forty two pots were each filled with 5.5 kg of soil. The treatments used were Control (No fertilizer), NPK 15–15-15 at 60 kg N/ha (1.1 g), 30% Grade B + 70% Jatropha cake at 1.5, 2.0 and 2.5 t /ha (4.1 g, 5.5 g and 6.9 g respectively), 40% Grade B + 60% Jatropha cake at 1.5, 2.0 and 2.5 t /ha (4.1 g, 5.5 g and 6.9 g respectively), 50% Grade B + 50% Jatropha cake at 1.5, 2.0 and 2.5t /ha (4.1 g, 5.5 g and 6.9 g respectively), 60% Grade B + 40% Jatropha cake at 1.5, 2.0 and 2.5 t /ha (4.1 g, 5.5 g and 6.9 g respectively). Grade B is a commercial fertiliser product of Aleshinloye Fertiliser Plant, Ibadan, Oyo State, Nigeria. The results of the laboratory analyses of Grade B fertilisers and jatropha cake are summarized in Table 1. The treatments were arranged in a completely randomized design (CRD) with three replicates. The soil and Aleshiloye Grade B compost (un-amended) supplemented with jatropha cake were left to mineralize for two weeks before sowing while the mineral fertiliser was applied two weeks after planting. Four maize seeds, yellow variety, streak resistance (EVDT-W99 STR) were sown in each pot, but later thinned to two after germination. Pre-cropping chemical analysis of the experimental soil used in the screen-house was carried out before the experiment and repeated at the first and second harvest to determine the nutrient status of the soil. Particle size distribution was determined by the hydrometer method (Bouyoucos, 1962) and the soil pH was determined in 0.01M $CaCl_2$. Soil organic carbon and the total N were evaluated by the Walkey and Black (1963) method and the micro-Kjeldahl digestion method (Bremmer and Mulvaney, 1982), respectively. Available P was extracted by the method of Bray and Kurtz (1945), while exchangeable bases (Ca, Mg, K and Na) contents were extracted with neutral 1M NH4OAc at a soil solution ratio of 1:10, and Na and K were measured by flame photometry. Calcium and Magnesium were determined with an atomic absorption spectrophotometer (AAS). Micronutrients were extracted with 0.1 EDTA and determined using atomic AAS. Plants were watered daily and weeding was also carried out as

Table 1: Chemical composition of Aleshinloye Grade B compost and jatropha cake

Nutrient element	N	P (g/kg)	K	Na	Cu	M n	Ca mg/kg	Mg	Fe	Z
Grade B	11.7	7.6	20.9	29.6	16.9	106.7	23.4	2.4	8195.4	19.9
Jatropha cake	34.1	0.7	2.2	0.08	0.02	0.01	0.3	8.39	2.1	0.08

required. The plants were observed for six weeks after which they were harvested and analysed for N, P and K contents based on the procedures described by Okalebo *et al*. (2002). The experiment was repeated without any fertiliser application at the second planting.

Plant height and number of leaves were recorded at an interval of two weeks. At six weeks after planting (6 WAP), maize shoots from ground level were harvested, oven dried at 70°C to a constant weight, and weights documented. The dried maize shoots were milled using Willey E. D. 5 milling equipment. Plant samples were analysed for N, P and K as described by Okalebo *et al*, (2002). The data collected were subjected to analysis of variance (ANOVA) and treatment means were separated by Duncan Multiple Range Test.

Results

The physico-chemical properties of soil used are presented in Table 2. The textural class of the soil was sandy loam and slightly acidic with pH of 5.7. The pH of most agricultural soils in the tropics has been reported to range from 5.0 to 6.8 (Udo and Ogunwale, 1977). Organic matter content was 6.84 g/kg compared with critical level for optimum crop production given as 30 g/kg (Agboola and Corey, 1972). 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 (Adeoye and Agboola, 1985). This shows that the soil needed amendment for crop optimum production.

Table 3 shows the effect of compost supplemented with Jatropha cake and NPK on growth parameters, dry matter yield and nutrient uptake of maize during the first planting in the screenhouse at 6 WAP. NPK at 60 kgN / ha and 50% Grade B + 50% JC at 2.5 t / ha were significantly ($p < 0.05$) higher than the control and other treatments. The highest plant height of 45.3 cm was recorded on plant fertilized with 50% Grade B + 50% JC at 2.5 t / ha. Maize number of leaves in 50% Grade B + 50% JC at 2 .5 t / ha was significantly ($p < 0.05$) higher than number of leaves from NPK and all other fertiliser treatments including control. The dry shoot weight in the compost supplemented with jatropha cake and NPK pots was larger than control by 39-80%. Dry shoot weight was significantly ($P < 0.05$) influenced by the fertiliser treatments in the first trial. Table 3 showed the mean N, P and K uptake of maize during the first planting in the screenhouse. For the N uptake, the highest value of 13.5 mg N / pot from NPK was significantly ($p < 0.05$) higher than that from all other fertiliser treatments. P uptake values showed that NPK had highest value (3.0 mg P / pot). K uptake had the values of 60.7 mg K / pot from the treatment NPK. Apart from control, 30% Grade B + 70% JC at 1.5 t /ha had the lowest value of 14.5 mg K / pot. The effect of 50% Grade B + 50% JC at 2.5 t/ha on shoot dry matter yield of maize was significantly ($p < 0.05$) different from all other fertiliser treatments including control.

Table 2: Physico-chemical properties of experimental soil

Parameters	**Soil test value**
pH(H_2O)	5.7
Org.C(gk/g)	6.8
Total N(g/kg)	3.1
P (mg/kg)	9
Exchangeable bases (cmol/kg)	
Mg	4.5
Ca	19.8
Na	0.7
K	1.5
Extractable micronutrients (cmol/kg)	
Cu	3.7
Fe	229.0
Mn	124.0
Zn	1.2
Sand (%)	75.8
Silt (%)	13.4
Clay (%)	10.8
Textural class	Sandy loam

Table 3: Effects of compost supplemented with jatropha cake and NPK on dry matter yield and nutrient uptake of maize during first cropping

Treatment	Rate (t/ha)	Plant height (cm)	Number of leaves	Dry matter yield (g)	N (mg / pot)	P	K
Control	0.0	33.8c	8.2d	3.5e	3.3d	0.8d	8.4d
30% Grade B + 70% JC	1.5	39.8b	9.8abc	5.7d	5.1c	1.2c	14.5c
30% Grade B + 70% JC	2.0	40.3b	9.3bcd	8.2c	8.5c	2.1b	37.1b
30% Grade B + 70% JC	2.5	37.7b	10.0ab	7.9c	8.7c	2.5b	40.2b
40% Grade B + 60% JC	1.5	39.0b	9.5bcd	7.4c	6.5c	1.2c	23.0c
40% Grade B + 60% JC	2.0	43.8b	9.5bcd	7.7c	7.2c	1.4b	27.8c
40% Grade B + 60% JC	2.5	42.4b	9.5bcd	7.4c	6.1c	1.5b	28.9 c
50% Grade B + 50% JC	1.5	37.6b	8.5d	7.7c	5.1c	1.5b	29.4c
50% Grade B + 50% JC	2.0	39.7b	8.5d	6.9c	4.9c	1.1c	30.9c
50% Grade B + 50% JC	2.5	45.3a	10.5a	10.3b	10.0b	2.9a	54.9b
60% Grade B + 40% JC	1.5	39.2b	9.1bcd	4.9d	6.4c	1.5b	17.8c
60% Grade B + 40% JC	2.0	38.8b	9.1bcd	4.7c	5.7c	1.1c	14.9c
60% Grade B + 40% JC	2.5	42.3b	9.2bcd	4.9c	6.2c	1.5b	16.0c
NPK	60 kg N/ha	45.0a	8.5cd	17.7a	13.5a	3.0a	60.7a

Means having the same letters along the columns indicate no significant difference using Duncan's Multiple Range Test at 5% probability level.

Legend: Grade B – Un-amended compost JC- Jatropha cake

Table 4: Effects of compost supplemented with jatropha cake and NPK on dry matter yield and nutrient uptake of maize during second cropping

Treatment	Rate (t/ha)	Plant height (cm)	Number of leaves	Dry matter yield (g)	N	P (mg / pot)	K
Control	0.0	16.8e	8.2c	2.5d	2.84f	0.03e	2.34e
30% Grade B + 70% JC	1.5	19.0cd	9.2b	2.9d	8.78c	0.04d	10.44b
30% Grade B + 70% JC	2.0	17.9d	9.3b	2.7d	7.33c	0.05d	7.25c
30% Grade B + 70% JC	2.5	18.8cd	8.8b	4.9c	6.56d	0.08d	7.19c
40% Grade B + 60% JC	1.5	20.9cd	8.8b	2.7d	6.32d	0.14c	5.80d
40% Grade B + 60% JC	2.0	20.7cd	9.2b	2.8d	6.34d	0.14c	7.11c
40% Grade B + 60% JC	2.5	20.8cd	8.7b	2.6d	6.69d	0.22b	5.95d
50% Grade B + 50% JC	1.5	28.6b	9.0b	8.9b	4.52e	0.09d	3.34d
50% Grade B + 50% JC	2.0	32.1b	9.2b	7.9b	4.27e	0.15c	3.48d
50% Grade B + 50% JC	2.5	39.3a	10.3a	11.1a	13.28a	0.32a	14.60a
60% Grade B + 40% JC	1.5	29.3b	9.0b	3.5cd	3.70 e	0.09d	3.46d
60% Grade B + 40% JC	2.0	25.9bc	8.8b	5.4c	3.81e	0.10	3.76d
60% Grade B + 40% JC	2.5	28.7b	9.0b	3.5cd	3.85e	0.09	3.35d
NPK	60 kgN/ha	27.3b	8.9b	8.6b	9.28b	0.15c	4.22

Means having the same letters along the columns indicate no significant difference using Duncan's Multiple Range Test at 5% probability level.

Legend: Grade B – Un-amended compost
JC- Jatropha cake

Table 4 shows the residual effects of different rates of fertiliser treatments on plant height, number of leaves, dry matter yield and nutrient uptake of maize during the second planting in the screenhouse. Height of maize plants treated with 50% Grade B + 50% JC at 2.5 t /ha on maize was significantly ($p<0.05$) different from all other fertiliser treatments including control. The highest height of 39.3 cm was observed under 50% Grade B + 50% JC at 2.5 t /ha. Control (no fertiliser)

produced plant that were shorter than 50% Grade B + 50% JC at 2.5 t /ha by 57 %. Effect of fertiliser treatment on maize number of leaves (Table 4) shows that 50% Grade B +50% JC at 2.5 t/ha was significantly ($p< 0.05$) higher than all fertiliser treatments. For Nitrogen uptake, 2.5 t/ha 50% Grade B + 50% JC had the highest (13.28 mg N / pot) which was significantly ($p< 0.05$) different from other treatments. 60% Grade B + 40% JC at 1.5, 2.0 and 2.5 t/ ha had the least N uptake of 3.70, 3.81 and 3.85mg N / pot respectively excluding the control. In P uptake, 2.5 t / ha 50% Grade B + 50% JC had the highest values (0.32 mg P / pot). Control had the least P uptake of 0.03 mg P / pot. For the K uptake 2.5 t/ ha 50% Grade B + 50% JC had the highest (14.60mg K/ pot) which is significantly ($p< 0.05$) different from other fertiliser treatments.

Discussion

Results of this study showed that applied fertilizer treatments resulted into significantly higher maize dry matter yield different from plant height and number of leaves. This might have been caused by the difference in the rates of the compost supplemented with Jatropha cake. Similar result was obtained from Olowoake *et al.,* (2018), in which application of 2.5 t / ha 50% Grade B + 50% JC increased the maize plant height and number of leaves. This could be as result of the stability of the compost with Jatropha cake when applied to soil. Application of 50% Grade B + 50% JC at 2.5 t/ha resulted in significantly ($P <0.05$) higher maize dry matter yield compared to NPK in the second planting of maize. The increase in maize dry matter yield observed could also be attributed to improvement in physical and chemical properties of the soil as reported by Udom et al. (2007) that, organic manures supply nutrients to plants, improve soil structure, aeration and encourages good root growth which may invariably had resulted in higher dry matter yield of the maize plant. The nutrient uptake of N, P and K by the maize plant was higher in 50% Grade B + 50% JC at 2.5 t/ha treated pots compared to other treatments. This could be attributed to the release of nutrients by the organic residues upon decomposition and their absorption by the maize plant. Waniyo *et al.* (2006) made similar observations on leaf nutrient (N, P and K) contents of maize in the experimental area. Observations on plant height and number of leaves in second planting showed that residual effects of maize were significantly different from other treatments. This may probably be due to favourable nutrient mineralization of this fertiliser as a result of the influence of the mineral component on the organic (Olowoake et al., 2015). The low dry matter yield produced by the NPK compared to 50% Grade B + 50% JC at 2.5 t/ha during the second planting of the maize under the screen house conditions establishes the findings of Ojeniyi et al. (2012) that the use of chemical fertilizers has not been able to sustain high productivity due to enhancement of soil acidity, leaching and degradation of soil organic matter and physical conditions. The result of residual nutrient uptake effects on maize as a result of applied treatment showed that maize plants grown in pots where 50% Grade B + 50% JC at 2.5 t/ha was applied, performed better than the maize plants that received NPK fertiliser.

Conclusion and Recommendation

It can be deduced that jatropha cake supplemented with compost at 2.5 t/ha can serve as an alternative to mineral fertiliser for maize in Kwara State, Nigeria.

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