Growth and yield of okra (*Abelmoschus esculentus* L.) as influenced by NPK, jatropha cake and organomineral fertiliser on an Alfisol in Ilorin, Southern Guinea Savanna of Nigeria

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Abstract

A field experiment was conducted at Kwara State University, Malete, Ilorin, Nigeria during 2013 growing seasons to study the growth and yield of okra (*Abelmoschus esculentus*) as influenced by NPK, jatropha cake and organomineral fertiliser on an Alfisol in Ilorin. The four treatments tested were; control, NPK, jatropha cake and organomineral fertiliser. The treatments were replicated three times in a randomised complete block design. Each treatment was applied at 100kg N/ha. The experiment lasted for over three month crop cycles. The parameters assessed were significantly influenced ($p<0.05$) by the applied fertilisers. Results of the experiment indicated that applications of organomineral Grade A fertiliser significantly ($p< 0.05$) increased plant height, stem girth, number of leaves, number of flower per plant, fruit weight and fruit yield as compared to NPK, jatropha cake and control. Okra fruit weight values obtained from organomineral Grade A, NPK and jatropha cake were 235.3, 207.7 and 157.7g respectively. Fruit yield values obtained from organomineral Grade A (6.53 t/ha) was also significantly ($p< 0.05$) higher than that of NPK values (5.75 t/ha). Although mineral fertiliser is cost effective, it is difficult to procure and cannot substantially redress the physical fragility of the soil. However, organomineral Grade A and jatropha cake are cheap, readily available and environmentally friendly as fertilizers. In conclusion, this study showed that organomineral Grade A applied at 100 kg N/ha could be effectively used as alternative to mineral fertiliser in growing okra on an Alfisol of Ilorin, Nigeria.

Keywords: *Abelmoschus esculentus*, fertiliser, growth, jatropha, yield.

Introduction

Okra, *Abelmoschus esculentus* (L) (Moench), is a multipurpose-use crop of the family of Malvaceae. It is grown in all agro-ecological zones in Nigeria mainly for its immature fruits, which is eaten as a cooked vegetable or added to soups and stews as a thickener (Tindale, 1983, Akanbi, 2002). Leaves, buds and flowers are also edible. Dried seeds are nutritious foods, with up to 20% protein (Martin et al., 1981). Okra is often grown continuously on the same piece of land, especially near urban centres. This leads to loss of soil fertility, reduced nutrient uptake and drastic fall in yield.

Most farmers in the tropics have adopted the use of mineral fertilisers, but the intensive use of this over time could constitute a setback to soil fertility (Phicot, et al., 1981, Isherwood, 2000). Another major limitation to the usage of chemical fertilisers is due to the adverse effects they have on plant quality and disease susceptibility. A continual dependence on chemical fertilisers may be accompanied by a fall in organic matter content, increased soil acidity, degradation of soil physical properties and increased rate of erosion due to instability of soil aggregates (Olowoake & Ojo, 2014).

However, the supply of inorganic fertiliser is inadequate and the farmers lack sufficient money to procure the fertiliser and, when supplied, the supply is often late. Inorganic fertilizer costs and the other constraints deter farmers from using them in the recommended quantities and in balanced proportions (Babatola et al., 2002). Unlike inorganic fertiliser, some organic fertilisers are cheap, easy to come-by, generally safe to use, are not poisonous and may be environmentally friendly. However, they must be applied to the crop in large quantities because the nutrient concentration is very low compared with inorganic fertiliser which would definitely result to high transportation cost of manure materials.

The prospect of obtaining enough chemical fertiliser to meet the requirements of the increasing population in the tropics is remote (Law-Ogbomo 2013). The current price of fertiliser calls for its economic utilisation to meet specific requirements of crops. The current world-wide shortage of fertiliser and its anticipated adverse effect on food production has made many countries to explore the value of organic manure to reduce pressure on the demand for mineral fertiliser as complementary use.

Research studies have shown that the use of inorganic fertiliser in combination with organic materials is able to give the desired higher and sustainable crop yields than the sole use of inorganic fertiliser or animal manure. (Ogunlade et al., 2011).

Total reliance on inorganic fertiliser or organic materials alone as fertiliser may not be realistic, use of organic fertiliser should be employed so as to sustain soil fertility management strategy for okra production. Several sources of organic materials and residues abound in Nigeria which can be processed, packaged and made available as branded organic fertiliser at a cheap rate for home gardening, horticulture and farming as a whole (Olowoake & Adeoye, 2010). Hence, the prospect of jatropha cake and organomineral as organic fertilisers needs to be further evaluated in greater details. jatropha cake contained up to 58% of crude protein by weight (Achtena et al., 2008). 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. The presences of these elements were recognised as the organic nutrients sources that are even higher than that of chicken or cow manure (Srinophakun et al., 2012).

Some studies showed that organomineral fertiliser gave significant increases in yield of okra (Akanbi et al., 2004) and watermelon (Ojo et al., 2014). There is little or no information on the usage of jatropha cake and organomineral fertiliser for the production of okra in Ilorin, North-central Nigeria. The objective of this work is to investigate the growth and yield of okra as influenced by NPK, jatropha cake and a commercially available organomineral fertiliser on an Alfisol in Ilorin, Southern Guinea Savanna of Nigeria.

Materials and methods

The study was carried out at the Teaching and Research Farm of Kwara State University, Malete, Ilorin, Nigeria. The farm extends from latitude 8°71' N and longitude 4°44' E. The climate is characterised 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 (Olaniyan, 2003).

The treatments consisted of three fertiliser types; Grade A (compost amended with mineral fertiliser, Aleshinloye Fertilizer Company, Ibadan, Nigeria), jatropha cake, NPK 15-15-15 and control (no soil additive). The results of analyses of the Grade A fertiliser and jatropha cake are summarised in Table 1. Costs for the fertiliser products were: USD 11.9 for 50 kg Grade A; USD 10 for 50 kg Jatropha cake cost, 28.5 USD for 50 kg NPK 15-15-15 (USD 1 approximately NGN 210 as at April 2015).

Table 1. Chemical composition of Grade A organo-mineral fertiliser and jatropha cake used for cultivation of okra.

Nutrient element	Concentration Grade A fertiliser	 Jatropha cake
N (g kg^{-1})	50.9	34.1
P (g kg^{-1})	44.0	0.7
K (g kg^{-1})	10.8	2.2
C (g kg^{-1})	232.6	4.9
Mg (g kg^{-1})	1.9	8.39
Ca (g kg^{-1})	27.7	0.3
Na (g kg^{-1})	3.5	0.08
Fe (mg kg^{-1})	715.2	2.1
Zn (mg kg^{-1})	1.5	0.08
Mn (mg kg^{-1})	93.3	0.01
Cu (mg kg^{-1})	14.9	0.02

The fertilisers were applied at the rate of 100 kg N/ha (Oshunsaya, 2010). Grade A and jatropha cake were applied a week before planting while inorganic fertiliser was applied a day to planting. Three seeds of okra were planted and latter thinned to one plant per stand at two weeks after sowing, giving a spacing of 60 cm x 30 cm. The experiment was randomised complete block design with three replications. Each plot size was 2.7 m x 2.1 m (5.67 m^2) with 48 plants per plot. Weeding was carried out using a hoe and the plot was kept free of weeds throughout the experiment.

Six out of the competitive plants per plot were tagged for determination of growth parameters. Collection of data commenced from 8 weeks after planting and growth parameters collected include plant height, stem girth. Harvesting of pods commence at 8 weeks after planting, Young pods were harvested 4 days after flowering. The harvesting was carried out over a period of six weeks. Yield parameters taken were; number of flowers per plant, percentage fruit set, number of fruits per plant and mean fruit weight.

Prior to land preparation, soil samples from the top 0 -15 cm were collected from the experimental site for laboratory analysis. The samples were randomly collected to represent the experimental area. A small sub-sample was air dried ground and sieved to pass through a 2 mm sieve for physical and chemical characterisation of the soil. The soil sample was analyzed for soil texture, pH, organic carbon, total N, extractable P, exchangeable levels of Ca, Mg, Na and K, and cation exchange capacity. Soil texture was determined by the Bouyoucos hydrometer method (Juo, 1978). Soil pH was measured electrometrically in a 1:2.5 soil-water suspension (McLean, 1982). Organic carbon was determined by rapid dichromate oxidation method. Total nitrogen was determined by the Micro Kjeldahl method (Bremner & Mulvaney, 1982), whereas extractable P was determined by Bray 1 Method (Bray & Kurtz, 1945). Exchangeable levels of Ca, Mg, K and Na were determined by the atomic absorption spectrophotometer following the procedures outlined by Wilde et al. (1979). Cation exchange capacity was determined by the ammonium acetate saturation method (Thomas, 1982). The plant data collected were subjected to analysis of variance (ANOVA) and treatment means were separated by Duncan Multiple Range Test ($P<0.05$) using SAS Institute (2010).

Results and discussion

The results of the soil analysis are presented in Table 2. The soil was loamy sand and slightly acidic. The soils were low in organic carbon (OC), total N and Potassium. The concentrations of exchangeable bases were generally low. The concentrations of these nutrients are below the recommended critical values of the nutrients in the soil of Guinea Savanna (Aduloju, 2004; Aduayi et al., 2002). It could be inferred from these results that the soils are of low fertility levels, justifying the need for additional fertiliser input to boost the yield of okra.

Table 2. Physico-chemical properties of teaching and research farm.

Parameters	Soil test value
pH	6.5
Organic C (g kg^{-1})	1.5
Total N (g kg^{-1})	2.20
P Bray (mg kg^{-1})	11.3
Exchangeable bases (cmol kg^{-1})	
K	0.3
Mg	0.3
Na	0.7
Ca	1.1
Extractable micronutrients (cmol kg^{-1})	
Fe	51.7
Zn	2.2
Mn	69.5
Cu	0.7
Textural Class (cmol kg^{-1})	
Sand	844
Silt	94
Clay	62
Textural class	Loamy sand

Growth parameters as affected by organic amendments and NPK are shown on Table 3. The study showed that fertiliser types significantly affected the growth plant height, number of branches stem girth and number of leaves of okra plant. There were significant differences ($p<0.05$) in plant height values obtained from the treatment of Grade A, jatropha cake and NPK during the growing period (Table 3).

The plant amended with Grade A gave the highest plant height value of 44cm while jatropha cake gave the least value (34 cm) excluding the control. The highest plant height recorded from Grade A may probably due to favourable nutrient mineralisation of this fertiliser as a result of the influence of the mineral component on the organic (Adeoye et al., 2008; Makinde et al., 2010; Oke et al., 2012).

With respect to the number of leaves all the fertiliser treatments differed significantly ($p<0.05$) from control. Grade A significantly enhanced the production of leaves and number of leaves value ranged from 9.0 cm in Grade A to 4.3 cm in control. There were no significant differences ($P<0.05$) on number of leaves for plot treated with jatropha cake and NPK. The higher number of leaves produce from Grade A over the NPK throughout the growing period could be due to sustaining release of nutrients from the former over the latter (Ogunlade, et al., 2011, Ojo et al., 2014).

Application of Grade A, jatropha cake and NPK had significant effect on the stem girth of okra. The fertilisers treatments were significantly ($p<0.05$) higher than stem girth of control. However, Grade A produced the highest stem girth of 3.5 cm which was 34.3 % greater than the control. Organomineral grade A had significantly ($p<0.05$) highest number of branch compared with the other treatments throughout the growing period. NPK and jatropha came second and it was significantly better than control. The number of branch obtained from Grade A treatment may probably due to faster release of nutrient than those of other fertilisers. The result obtained in this study reconfirmed the work of Akanbi et al, (2004) who reported that application of organomineral fertiliser significantly increased the growth of okra.

Table 3. Effects of fertilisers on growth parameters of okra. Means with the same letter in the columns indicate no significant difference using Duncan's Multiple Range Test at 5% probability level.

Treatment	Height (cm)	Stem girth (cm)	Number of leaves	Number of branches
Control	31.0d	2.3c	4.3c	4.0c
Grade A	44.0a	3.5a	8.3b	9.0a
Jatropha cake	34.0c	2.5b	7.3b	7.3b
N P K	40.0b	2.7b	9.0a	8.0b

Table 4 shows the effects of different fertilisers on the component of yield of okra. All the treatments differed significantly ($p<0.05$) from the control. The number of flower per plant was significantly different among the fertiliser treated plants. The control plant gave significantly lower numbers of flower per plant. The percentage fruit set and fruit weight were all significantly affected by Grade A.

Okra fruit production was observed to be more favoured by the organomineral fertiliser than mineral fertiliser. This is in line with the similar to the works of Sridhar & Adeoye (2003), Akanni et al, (2011) and Olowoake & Ojo (2014) who reported that the combinations of organic and mineral fertiliser perform better on crop yield than when each of them is solely used. This indicated that the combined use of organic and inorganic nutrient management strategy is certainly good substitute for enhancing soil fertility and crop productivity (Oke et al., 2012). The reduction in the yield and some yield components from the plants that received NPK fertiliser as compared to plants under organomineral Grade A might be due to the leaching and runoff effect on the applied mineral fertiliser which makes N unavailable to plants especially during fruit production (Olowoake et al., 2013).

Table 4. Effects of fertiliser treatments on the components of yield of okra. Means with the same letter in the columns indicate no significant difference using Duncan's Multiple Range Test at 5% probability level.

Treatment	Flowers/plant	% fruit set	Fruit weight (g)	Fruit yield (t/ha)
Control	5.0c	67.9d	45.7d	1.26d
Grade A	9.4a	82.1a	235.3a	6.53a
Jatropha cake	6.0b	71.4c	157.7c	4.38c
NPK	8.0a	78.6b	207.7b	5.75b

Conclusions

Result of the present study indicated that the application of organomineral Grade A (combination of both organic and chemical fertiliser) gave the overall best performance of okra. Although, the result of the laboratory analysis of jatropha cake showed that it has high percentage of N. The low performance of the jatropha cake on the okra could be due to slow rate of decomposition of jatropha cake compared with NPK and organomineral fertiliser.

More so, the use of Grade A fertiliser could serve as an alternative to the use of mineral fertiliser. This is because for most of the growth and yield components, organomineral fertiliser gave the highest significant values when compared to mineral fertiliser in terms of cost and availability.

From the experiment carried out it is recommended that organomineral fertiliser Grade A at 100 kg N/ha should be used as a source of fertiliser for the production of okra in Alfisol of Ilorin, Nigeria.

In summary, it can be deduced that amended compost showed a promising potential for improving growth and yield performance of okra. Hence, Grade A should be promoted for sustainable okra production for poor resource farmers.

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