Nigerian Journal of Soil Science

journal homepage:www.soilsjournalnigeria.com

COMBINED AND SOLE APPLICATION OF COMPOST AND NPK EFFECT ON OKRA YIELD, SOIL AND NUTRIENT CONTENT

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ABSTRACT

An on-farm experiment was conducted at Uyinmwendin, Edo State, Nigeria in 2009 and 2010 to study immediate and residual effect of compost alone or combined with NPK fertilizer (NPK) on okra (*Abelmoschus esculentus*) and nutrient availability. Five treatments applied to okra on ultisol of Benin formation were a control, compost (CM) at 20 and 40 t ha^{-1}, NPK 200 kg ha^{-1}, 20 t ha^{-1} CM + NPK 100 kg ha^{-1} (CM + NPK). The test soil was slightly acidic, low in organic carbon, nitrogen and calcium. The CM, NPK and CM + NPK (at half rates) increased soil N, P, K, Ca and Mg on immediate and residual basis. The CM, NPK and CM + NPK also increased N, P and K uptake significantly. The control and NPK respectively had least values. Relative to control, 20 t ha^{-1} CM, 40 t ha^{-1} CM, NPK, 20 t ha^{-1}, CM + NPK 100 kg ha^{-1} increased pod count by 12, 41, 29 and 33 %. Yields given by 40 t ha^{-1}CM and CM + NPK were similar. The treatment (CM + NPK) is recommended.

INTRODUCTION

Okra is a major tropical vegetable grown for its fruits (pods) and leaves. It responds significantly to availability of soil nutrients and organic manure. However, due to the problems associated with the use of chemical fertilizers such as imbalance nutrition, soil acidity, scarcity and high cost, farmers rarely use inorganic fertilizers (Makinde *et al*., 2010; Adeniyan and Ojeniyi, 2003, 2005; Akanni *et al*., 2011). It is also believed that inorganic fertilizers adversely affect quantity and storability of okra pods.

Studies that have been conducted on response of okra to organic manures generally gave favourable results. In study of effect of twenty organic fertilizer treatments and NPK on okra, Moyin Jesu and Ojeniyi (2000), found out that plant residues at 6 t ha^{-1} increased leaf N, P, Ca and Mg contents, growth and pod count of okra. The amendment of the residues with animal manures improved their effectiveness. Relative to control, NPK, wood ash, ground cocoa husk, spent grain and sawdust increased pod count, by 79, 385, 168, 115, 230 and 150 %, respectively. The study by Adekunle (2008), found that poultry manure, cow dung and sawdust increased growth of okra and reduced population of nematodes. Field experiment conducted at Akure, Southwest

Nigeria showed that sawdust ash applied at 3 to 12 t ha^{-1} increased pod yield and leaf P, K, Ca and Mg (Owolabi *et al.*, 2003). A field study was conducted on an ultisol at Uyo, Southeast Nigeria to assess response of okra to organic and inorganic fertilizers. The NPK fertilizer enhanced growth and yield of okra. Complementary use of poultry manure and NPK fertilizer at reduced levels (50:50) resulted in 21 – 58 % increase in pod yield relative to sole use of either inorganic or organic fertilizer (Ndaeyo *et al*., 2005). Udoh *et al.* (2005), indicated that organic manures are best for okra, although the crop responds to NPK with high analysis of N.

Through composting kitchen wastes, plant and animal wastes can be harnessed to produce useful organic manures for enhancing crop production in highly weathered tropical soils. Obi *et al.* (2005), conducted field studies to ascertain agronomic potentials of kitchen waste compost on the yield of okra on ultisol of Southeast Nigeria. The amendment of 6 t ha^{-1} significantly increased number of fruits by 300 %, and the 20 t ha^{-1} compost represented the economic rate. Compost significantly increased soil organic C, P, Ca, Mg by 2 to 5 times, soil pH was also increased.

Research is rare on integrated use of compost and NPK fertilizer in okra cultivation. Whereas studies by Ndaeyo *et al.* (2005), and Ano and Asumuogha (cited by Ojeniyi *et al*., 2001) showed benefit of integrated plant nutrition over sole fertilizer use in okra production. Similar findings were made in respect to other crops such as amaranthus (Ojeniyi *et al*., 2009), tomato (Ayeni *et al*., 2010), maize (Ayeni *et al.*, 2010; Adeniyan and Ojeniyi, 2003, 2005). Problems associated with total dependence on either organic or inorganic fertilizers have been highlighted by researchers (Makinde *et al*., 2010; Adeniyan and Ojeniyi, 2003, 2005; Akanni *et al*., 2011).

The aim of this work carried out on ultisol of the Benin formation is to study the use of compost in okra production with respect to its combined use with NPK fertilizer and effect on soil and plant nutrients composition and yield of okra. It is expected that suitable combination of compost and NPK fertilizer will be developed.

MATERIALS AND METHODS

The study was conducted in the forest zone of Edo State, Central Southern Nigeria in 2009 and 2010. The soil is ultisol of Benin formation. The land was manually cleared and made into beds. Five treatments applied to okra were the control (no treatment), compost (CM) at 20 and 40 t ha^{-1}, NPK (20-10-10) at 200 kg ha^{-1} (NPK), and 20 t ha^{-1} compost + 100 kg ha^{-1} NPK fertilizer (CM + NPK). Treatments were replicated three times using a Randomized Complete Block Design. The compost was thoroughly mixed with soil and left for two weeks to allow for mineralization. Compost was made of decomposed plant residues and was obtained from Lake Projects Limited, Lagos, Nigeria. While okra variety "OCRA" was obtained from Premier Seed Limited, Benin City. NPK fertilizer was applied one week after transplanting. Each plot was 3 x 3.6 m and made into beds. Three okra seeds were sowed at 50 x 50 cm and later thinned to one seedling per stand. At harvest, the number of fruits was counted and fresh weight was obtained per hectare. The experiment was repeated in 2010 without NPK or compost manure.

Soil analysis

Soil samples collected from treatment plots after the first experiment were air dried, crushed and passed through 2 mm sieve for analysis (Mylavarapus and Kennelley, 2002). Soil samples were collected after harvest of second crop to study the residual effect of treatments.

Chemical analysis of fruits

At the harvest of the second crop, three fruits were randomly selected from each plots, air dried and oven dried for two days at 60 ^{0}C to constant weight. The fruits were ground for determination of N, P and K (Mylavarapus and

Kennelley, 2002). The nutrient uptakes were computed by multiplying fruit weight with nutrient concentration. Analysis of compost was done as for organic C, N, P, K, Ca and Mg (Mylavarapus and Kennelley, 2002).
Data on yield, nutrient concentration, uptake and soil chemical properties were subjected to analysis of variance, mean separation was done using LSD at P = 0.05.

RESULTS AND DISCUSSION

The chemical analysis of compost is given in Table 1. Values of nutrients reduced in the order organic C, N, Mg, P, K and Ca. The analysis of the untreated soil indicates that it is slightly acidic, low in organic C, N and exchangeable Ca (Table 2).

Table 1: Chemical properties of compost manure

Parameter	Value
pH (H_2O 1:1)	7.20
Organic carbon (%)	2.10
Total nitrogen (%)	1.50
Phosphorus (%)	0.92
Calcium (%)	2.1
Magnesium (%)	1.41
Potassium (%)	0.57

Table 2: Soil fertility status after treatment with fertilizer

	Treatments				
Property	**Control**	**20 t ha^{-1} CM**	**40 t ha^{-1} CM**	**NPK**	**CM + N**
pH (H_2O) 1:1	6.00	6.10	6.20	5.50	6.10
Organic carbon (%)	0.90	1.10	1.30	0.74	1.30
Total nitrogen (%)	0.12	0.63	0.98	1.05	0.78
Available phosphorus (mg kg^{-1})	9.56	16.13	30.45	96.53	116.72
Exchangeable cations (cmol kg^{-1})					
Calcium	1.02	5.15	6.00	9.18	16.10
Magnesium	0.53	1.10	5.50	8.35	16.51
Potassium	1.20	1.70	5,30	8.35	10.51

CM – Compost manure, CM + N – Compost manure + NPK Under the first crop, CM alone, NPK and CM + NPK increased soil N, P, K,

Ca and Mg in relative to control (Table 2). Generally, the nutrients increased in the order, 20 t ha^{-1} CM, 40 t ha^{-1} CM, NPK and CM + NPK. On residual basis, CM treatments, NPK and CM + NPK increased significantly soil N, available P, exchangeable Ca, Mg and K. The soil organic C, and pH were increased by 40 t ha^{-1} CM and CM + NPK ha^{-1}. Thus, aside from increasing organic C and nutrients, the CM had liming effect which is attributable to release of cations. On immediate and residual basis, CM + NPK has highest values of available P, exchangeable Mg, Ca and K. On residual basis, the treatments had also higher values of soil organic carbon and N (Table 3). It is ascertained that CM supplied to the soil organic carbon, N, P, K, Ca and Mg which is consistent with its chemical composition (Table 1). Compared with NPK, CM + NPK had more residual effect on increase in soil organic C, N, P, Ca and Mg (table 3)

Table 3: Residual effects of soil amendments on soil chemical properties

		Treatment					
Parameter	**Control**	**20 t ha^{-1} CM**	**40 t ha^{-1} CM**	**NPK**	**CM + N**	**Mean**	**LSD (0.05)**
pH (H_2O 1:1)	5.60	5.90	6.00	5.00	6.00	5.54	0.200
Organic C (%)	0.80	1.00	1.14	0.54	1.35	0.96	0.403
Total N (%)	0.03	0.76	0.99	0.95	1.01	0.71	0.320
Available P (mg kg^{-1})	6.73	18.56	46.17	22.54	101.19	45.19	28.765
Exchangeable cations (cmol kg^{-1})							
Calcium	0.52	5.96	7.40	6.90	13.35	6.63	3.633
Magnesium	0.35	0.95	4.35	6.10	16.00	4.34	3.683
Potassium	0.70	1.50	6.30	5.70	8.90	4.22	1.674

CM. - compost manure

CM + N - compost manure + NPK

Data on pod nutrient concentration (Table 4) and uptake (Table 5) indicate that CM treatments and CM + NPK significantly increased values for N, P and K. The control and NPK respectively had the least values. Thus, CM and NPK alone or combined at lower values also increased N, P and K uptake aside from increasing soil organic C, N, P, K, Ca and Mg. Nutrients release from CM is attributable to decomposition of organic matter and mineralization of organic nutrients. The increased Ca and Mg due to NPK might be due to enhanced decomposition and mineralization of organic matter due to increased microbial activity.

Table 4: Residual effects of soil amendments on nutrient concentration in okra

Treatment	**Nutrient concentration (%)**		
	N	**P**	**K**
Control	0.73	0.11	0.28
20 t ha^{-1} Compost	2.52	0.43	2.38
40 t ha^{-1} Compost	2.09	0.41	2.18
NPK at 200 kg ha^{-1}	1.22	0.13	0.62
Compost 20 t ha^{-1} + NPK 100 kg ha^{-1}	2.13	0.43	1.81
Mean	1.74	0.30	1.45
LSD (0.05)	0.581	0.258	0.546

Table 5: Residual effects of soil amendments on nutrient uptake of okra

	Nutrient uptake (g kg^{-1})		
Treatment	**N**	**P**	**K**
Control	18.10	0.28	0.69
20 t ha^{-1} Compost	73.58	1.26	69.50
40 t ha^{-1} Compost	70.64	1.39	73.68
NPK at 200 kg ha^{-1}	38.55	0.41	19.59
Compost 20 t ha^{-1} + NPK 100 kg ha^{-1}	64.11	1.29	54.48
Mean	53.00	0.93	43.59
LSD (0.05)	26.873	0.181	19.519

The yield data are shown in Table 6. Relative to control, the 20 t ha^{-1} CM, NPK and CM + NPK significantly increased number of okra fruits and fruit weight. The 40 t ha^{-1} CM and CM + NPK gave the similar and highest values of number of pods. Many workers have identified number of pods as an important component of okra pod yield (Ariyo, 1991). Relative to control, 20 t ha^{-1} CM, 40 t ha^{-1} CM, NPK and CM + NPK increased pod count by 12, 41, 29 and 33 %, respectively.

Table 6: Okra yields as influenced by compost and NPK fertilizer

Treatment	No. of fruits (plant^{-1})	Average fruit wt (g)	Average wt of fruit (g plant^{-1})	Fruit yield (t ha^{-1})
Control	8.33	15.25	126.67	7.92
20 t ha^{-1} Compost	10.33	13.57	139.67	8.73
40 t ha^{-1} Compost	11.67	12.56	146.00	9.13
NPK	10.67	13.30	141.33	8.84
20 t ha^{-1} CM +100 kg ha^{-1} NPK	11.00	12.73	140.00	8.75
Mean	10.40	13.48	138.73	8.64
LSD (0.05)	0.833	Ns	10.113	0.240

ns – Not significant at 5% level of probability

The increased yield of okra associated with application of CM and NPK is attributed to increased availability of N, P, K and other nutrients in soil and for crop uptake. A number of studies confirmed the positive response of okra yield to N, P and K fertilizers (Majanbu *et al*., 1985). Obi *et al.* (2005), also observed that significantly increased soil organic C. P, Ca, Mg by 2 to 5 times and at 6 t ha^{-1}, it increased number of fruits by 300 %. It also increased soil pH. The latter is important since okra performance is reduced by soil acidity (Aduayi, 1980).

CONCLUSION

The combination of reduced levels of compost and NPK maximized availability of nutrients in soil, and significantly increased N, P and K uptake and pod count of okra. Compared with NPK, the treatment had more residual effect on nutrient availability and uptake compared with NPK. CM + NPK gave similar pod yield as 40 t ha^{-1} CM. The combination is recommended.

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