Influence of Bioremedants on the Performance of Okra and Selected Properties of Soils of Ogoniland Southeastern Nigeria.

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Abstract
The influence of bioremedants on the growth and yield of okra and physicochemical properties of soils of Ogoniland, Nigeria was assessed at the School to Land Authority Farm, Kpaa, in Khana Southeastern Nigeria. The treatments used were: poultry manure PM cow dung CD Goat dung GD, Siam weed manure and NPK. This was arranged in a randomized complete block design(RCBD) with three replicates giving a total of eighteen (18) replicates using okra as a test crop. Soil samples were collected before and after the experiment and analyzed for soil physical and chemical properties. Data collected were statistically analyzed using analysis of variance and mean separated using DMRT. Plot treated with poultry manure recorded the highest value for plant height at 4, 6 and 8 WAP (7.60, 14.40 and 18.95cm) followed by Siam weed (7.59, 14.38 and 17.93cm), NPK (7.55, 14.50 and 16.98cm), and Goat dung (7.10, 13.21 and 16.96cm). The least plant height was observed in the control (6.59, 12.23 and 15.34 cm) at 4, 6 and 8 WAP. Poultry Manure (15.48, 28.15 and 30.92 cm) had the highest leave area value at 4, 6 and 8 WAP followed by Siam weed (15.12, 27.18 and 30.90cm), cow dung (14.82, 26.58 and 30.70cm), Goat dung (14.80, 26.59 and 30.71cm) and NPK (9.66, 16.30 and 22.58cm), respectively. The least leaf area was also observed in the control (8.52, 15.02 and 19.84cm) at 4, 6 and 8 WAP. Siam weed ($2.13^{t}/ha^{-}$) gave the highest fresh fruit yield. This was followed by Poultry Manure (($2.05^{t}/ha^{-1}$), cow dung ($1.89^{t}/ha^{-1}$), Goat dung ($1.69^{t}/ha^{-1}$) and NPK ($1.15^{t}/ha^{-1}$), respectively. There was significant difference between NPK ($1.15^{t}/ha^{-1}$), control ($0.94^{t}/ha^{-}$) and other treatments at $P<0.005$. The residual effect of bioremedants on physicochemical properties of soils revealed that soil physical properties (sand, silt and clay increased from 690, 80 and 60g/kg in control to 790, 150 and 70g/kg in poultry manure. The pH ($1:H_2O$) increased from 5.0 in control to 6.60 in poultry manure treated plot. There was also an increase in total N from 6 g/kg in control to 1.3 g/kg in cow dung. Organic carbon also increased from 0.6 g/kg in control to 14.6 g/kg in poultry manure treated plot. There was also a decrease in available P in goat dung treated plot from 81.08 Mg/Kg^{-1} to 62.00 Mg/Kg^{-1}. Exchangeable basis increased across treatments except Na (0.62 cmol/kg) in the control plot. The result showed that application of poultry manure as bioremedants at 5 $^{t}/ha^{-1}$ produced the best growth and yield parameters and improved physicochemical properties of soils followed by Siam weed. It therefore recommended that the used of poultry manure and Siam weed as a bioremedant in acid soil of OgoniLand, Southeastern Nigeria be adopted.

Keywords: Bioremedants, Kpaa, Land use, okra and ultisol

Introduction

Increase in the cost of chemical fertilizer and the associated adverse effects on the environment is of major concern to land users. Chemical fertilizers have negative effect on fruits and leafy vegetables such as okra, cucumber, tomato and pumpkin etc have renewed interest in the use of organic materials nutrient source for agricultural crop production. Continual usage of soils without improvement leads to the depletion of nutrients and their physical properties(Onweremadu *et al*.,2007a). However, land use is rarely permanent as the soil is abandoned for regeneration when yield declines markedly. But, in a situation where shifting cultivation is associated with shortened bush fallows(Onweremadu *et al*.,2007b), as it is observed in our environment to be, the use of bioremedants is very necessary to maintain sustained soil use which is a *sine qua non* to sustainable agriculture.

Bioremedants are soil nutrient supplements added to the soil to enhance its productive capacity. Bioremedants include organic materials (organic manure) that mainly comes from crop residue and certain animal by products like fecal materials, urine and animal beddings. Bioremedants enhance the level of both major plant nutrients such as NPK and micronutrients. They supply organic matter to the soil.

According to Peter and Ayolagha (2013), bioremedants are less expensive and easily affordable and they have been widely used as organic fertilizer to increase crop productivity thereby replacing the costly inorganic fertilizer.

Sanguinga *et al.* (2001) reported that the high cost of inorganic fertilizers and the inadequate distribution system as well as non availability of this fertilizer have often constituted major problem to their usage by local farmers who depend on them for their agricultural production.

Again, to increase soil productive capacity and crop yields, farmers now apply chemical fertilizer, but continuous usage of these mineral fertilizer has been found to decrease base saturation, increase acidification and degradation of soil physical properties (Isherwood 2008) as cited by Ovie *et al.(*2013).

According to Adenawola *et al*.(2005) and Olowekere *et al.* (2003), organic-based fertilizers (Bioremedants) increase crop yield as well as crop and soil quality. They observed that it is cheaper when compare with in organic fertilizers and it could be prepared easily by farmers using plants and animal residues.

Okra is a popular fruit vegetable crop grown in most parts of Nigeria especially in Ogoniland and command a high market value because it features daily in the diet of most Nigerians. But, its yield is limited by nutrient status in the soil. Okra has been found to respondent to application of organic fertilizers on wide range of soils.

Ogonisands are mostly sandy and acidic with low organic matter that make them unproductive; hence the need for the application of bioremedants or soil amendment materials to boost their productive capacity as well as improve soil properties.

Therefore, the main objective of this research was to assess the influence bioremedants on the growth and yield of okra as well as their effects on physicochemical properties of an ultisol of Ogoniland.

Materials and Methods

Study Area

This research was carried out at the School to Land Authority farm, in Kpaa, Nyokhana District of Khana Local Government Area of Rivers State (Latitude $4^{o}48^{1}$ 27.8^{11} N; Longitude $6^{o}59^{1}$ 16.3^{11} E). Soils of the study area are the well-drained and are derived from coastal plain sands marine and deltaic deposits commonly called Ogoni sands. The altitude is less than 20 meters above sea level.

The rainfall distribution of the study area ranges between 2000 – 3000mm/annum in a bimodal form with two peaks in June and September and a period of low precipitation popularly known as August Break (Oyegun and Olosunorisa, 2002). The area is characterized by two distinct seasons, namely wet and dry seasons, governed by the Tropical Maritime Air Mass and Tropical Continental Air Mass, respectively.

The monthly minimum and maximum temperatures vary between 28^{o}C and 33^{o}C depending on the season of the year, while the relative humidity also varies between 81 – 87% depend on the season of the year (Ayolagha and Peter, 2013). Soils of the area have suffered continued cultivation due to increasing population and urbanization leading varying degree of degradation(Onweremadu,2006).

The area is generally dominated by secondary forest and mangrove swamps. Giant grasses dominated towards soils proximal to water bodies. Generally, the vegetation is arranged in tiers with emergent tree species towering high above other plant species, followed by interlocking canopy of shorter trees and shrubs while the forest floor is dominated by herbaceous plants. Crop production and capture fishing are major socio-economic activities in the area. Nets are commonly used for fish capture in the natural water bodies. Conventional land clearing techniques involving slash-and-burn are still in use. Major crops grown are plantain (Musa spp), cassava (*Manihot esculenta*), yam (*Dioscorea* spp.), tomato (*Lycopersicon esculentum*), Pawpaw (*Carica papaya*), Okra (*Abelmoschus esculentum), etc.*

Experimental Site

The site of the experiment was at the Rivers State School-To- Land Authority Farm, Kpaa in Nyokhana District of Khana Local Government Area of Rivers State. The experimental site has been fallow for one year after some years of intensive cultivation of crop plants such as maize, okra, yam, cocoyam, cassava, pumpkin, pepper, garden egg and pineapple by School –To – Land Authority.

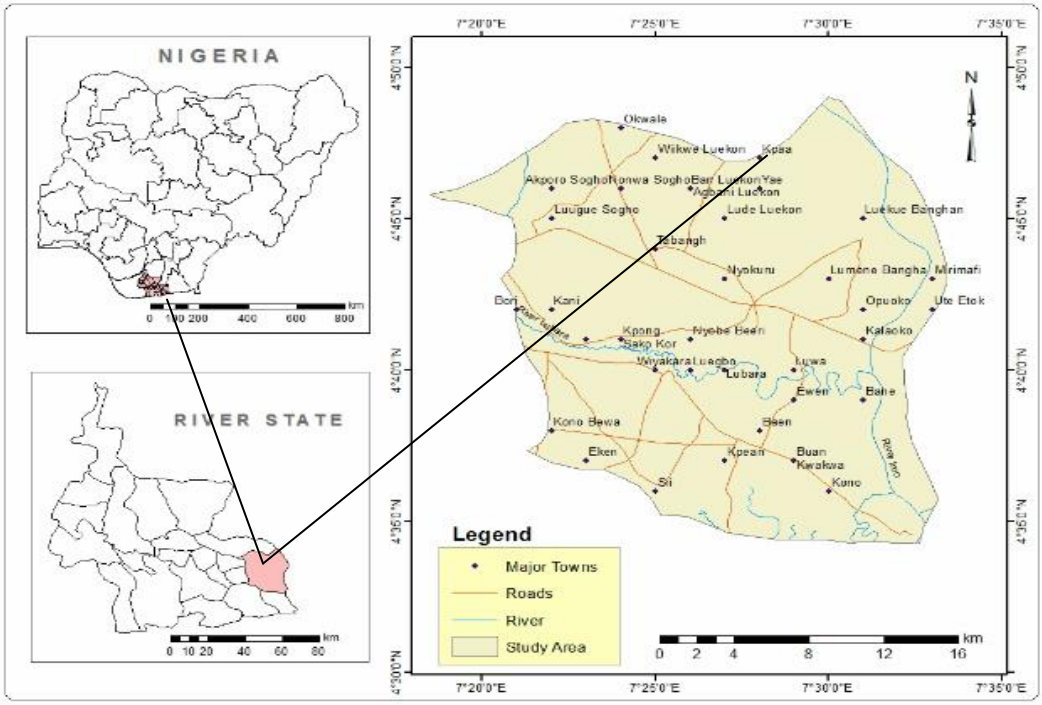

Fig. 1: Map of Khana Local Government Area

Preparation of the Siam weed Manure

Large quantity of fresh Siam weed was collected from the fallowed portion of the School To Land Authority Farm Land and was properly sorted to remove certain contaminants attached to it. The fresh leaves were chopped and pounded using locally made mortar and pestle. Quantity applied per plot was measured and mixed thoroughly in 500 cm^3 of water in a plastic bucket with cover and allowed to ferment to enhance the process of decomposition. This was later analyzed to ascertain it chemical composition before application.

Experimental Design and Treatments

The experiment involves six treatments with three (3) replicates. This gave a total of eighteen plots in a randomized complete block design. Each plot was 3m x 4m size and a pathway of 2m between plot and 1m spacing between each block. The manure used was sourced locally from the Bori slaughter house and poultry farm within the area. It was shaded, dried and pulverized and later analyzed for the major nutrient elements such as N, P and K and other secondary nutrient elements such as Ca and Mg using standard procedure of Juo (1981).

The different manures were measured as required (5 t/ha of cow dung, 5 t/ha of goat manure, 5 t/ha of poultry manure, 5 t/ha of Siam weed and 250 kg of NPK). These rates were later worked into the soil using hand trowel, and soils were moistened for 7 days to allow proper mineralization of the treatments for nutrient release into the soil (Sanni *et al*., 2013).

The okra seeds LD 88 variety was used as test crop for the experiment. It was obtained from the Rivers State School Authority Kpaa Farm in Khana Local Government Area of Rivers State, Nigeria.

The okra seeds were planted four seeds per hole at a spacing of 60 cm X 60 cm on 30th August, 2014. They were later thinned to two stands per hole two weeks after planting (WAP). Weeding of the plots was done three times: 3 WAP, 6 WAP and 10 WAP to reduce the incidence of weeds and pests.

The bioremedants were later applied 2 WAP and 6 WAP using the ring method of application by placing the bioremedants 6 cm away from the base of the plant. The vegetative part of the okra was sprayed with Neem extract 2 WAP and 6 WAP against leaf curl and Lady beetle (Podagilla Sp) that is predominant in the area. Composite soil sample was taken using soil auger for determination of soil physicochemical properties before planting and after harvest. The soil samples collected were air-dried, ground and sieved to pass through 2-mm sieve at the Soil Science Laboratory, Rivers State University of Science and Technology, Port Harcourt. The soils and bioremedants used for the experiment except NPK 15:15:15 were analyzed using standard laboratory procedures. Soil pH was assessed using soil: water ratio of 1:2.5(Thomas,1996), organic carbon by oxidation method of Nelson and Sommers (1982), total nitrogen by semi micro-Kjeldahl method(Bremner,1996), available P by Bray I method(Olsen and Sommers,1982), exchangeable basic cations, exchangeable acidity, effective cation exchange capacity(Rhoades,1982) were all determined; while the particle size analysis was measured using the Bouyoucos hydrometer method(Gee and Or,2002).

Table 1: Initial physicochemcial properties of the soil before the commencement of the experiment.

Properties	Values
Soil pH	5.20
Total N (g/kg)	0.6
Available P ($MgKg^{-1}$)	68.80
Ca ($Cmol\ Kg^{-1}$)	1.00
K ($Cmol\ Kg^{-1}$)	0.13
Mg ($Cmol\ Kg^{-1}$)	0.42
Na ($Cmol\ Kg^{-1}$)	0.03
Organic Carbon (g/kg)	5.6
Sand (g/kg)	806
Silt (g/kg)	90
Clay (g/kg)	107
Bulk density (g/cm^3)	1.58
Textural class	Loamy sand

Data collection and Analysis

Five 5 okra plants were randomly selected from each plot and the following data were collected: plant height, leaf area at 4,6 and 8 WAP. Number of fruits per plot and were analyzed statically and compared using the Least Significant Difference (LSD) test at 5% level.

Table 2: Chemical properties of bioremedants use for the experiment

Bioremedants	Mg	Ca	K	Na	P	N	O/c
			$CmdKg^{-1}$			g/kg	
Poultry manure	2.0	6.25	0.55	1.30	31.60	134	281.5
Cow dung	2.43	3.87	1.02	7.03	20.63	30.2	300.1
Goat dung	0.60	1.35	0.04	0.10	0.93	25	295
Siam weed	0.31	1.83	0.70	0.39	0.91	28	260

Results and Discussion

Effect of bioremedants on Okra Plant height 4, 6 and 8 weeks after Planting

The effect of bioremedants on okra plant height 4, 6 and 8 WAP from the studied are presented in Table 3. According to the results of effect bioremedants on okra plant height 4, 6 and 8 WAP, poultry manure has the highest plant height (7.60, 14.40, 18.95 cm), followed by Siam weed (7.59, 14.58, 17.93 cm), NPK (7.55, 14.50, 16.98cm) cow dung (7.21, 14.27 and 17.41cm) and goat dung (7.10. 13.21, 16.96 cm), respectively. The least plant high is observed in the control (6.59, 12.23, 15.34 cm). It is possible that the fermentation of poultry manure and Siam weed enhanced the process of decomposition and mineralization for easily release its nutrients leading to the increase in height observed in okra.

At 6 WAP Siam weed (14.58cm) was highest, followed by NPK (14.50CM) poultry manure (14.40cm) and cow dung (14.27cm). The control also recorded the lowest plant height at 6 WAP. Then at 8 WAP poultry manure treated plots had the highest. Plant height of 18.95 followed by Siam weed (17.93cm), cow dung (17.41) and NPK 16.98cm. The control plots also recorded the lowest okra plant height. The decrease in plant height in plot treated with NPK (16.98cm) was as result of leaching. But there was an increase in okra plant height in plot treated with cow dung (17.41) at 8 WAP. This was due to the fact that at 8 WAP the rate of decomposition and mineralization has increased over time. While the easy dissolvability and absorbability of poultry and NPK also help to enhanced increase in height of okra plant. This is in line with the report of Peter and Ayolagha (2013). However, result of plant height after various treatment were not significantly different from one another at $P < 0.05$.

Table 3: Effect of Bioremedants on Okra Plant Height (cm) 4, 6 and 8 WAP

Treatments	Weeks After Planting(WAP)		
	4	6	8
Poultry manure	7.60[a]	14.40[a]	18.95[a]
Cow dung	7.21[a]	14.27[a]	17.41[a]
Goat dung	7.10[a]	13.21[a]	16.96[a]
Siam weed	7.59[a]	14.58[a]	17.93[a]
NPK	7.55[a]	14.50[a]	16.98[a]
Control	6.59[a]	12.23[b]	15.34[b]

Value with the same superscripts in a column are not significantly difference (DMRT) at 5% level of probability

WAP = weeks after planting

Effect of bioremedants on okra plant leaf area 4, 6 and 8 WAP.

The results of the effect of bioremedants on okra plant as indicated by the leaf area are presented in Table 4. The result showed that leaf area as recorded for poultry manure, Cow dung, goat dung, Siam weed, NPK and control at 4, 6 and 8 WAP were (15.48, 28.15 and 30.92 cm), (11.48, 26.58 and 30.70 cm), (14.80, 26.56 and 30.71cm), (15.12, 27.18 and 30.90 cm), (9.66, 16.30 and 22.58 cm). The least leaf area was also observed in control plot (8.52, 15.02 and 19.84 cm) at 4, 6 and 8 WAP, respectively. Decreased leaf area observed in plot treated with NPK at 4,6 and 8 WAP could be due to leaching which easily removed nutrient from the reach of plant roots. This is also in line with the finding of Peter and Ayolagha (2013) that NPK is in form that is easily dissolved and absorbed by plant root and also easily leached down the watertable by rainwater infiltration.

Table 4: Effect of bioremedants on Leaf area of Okra Plant. (4, 6 and 8 WAP) in cm

Treatments	W A P		
	4	6	8

Poultry manure	15.48[a]	28.15[a]	30.92[a]
Cow dung	14.82[a]	26.58[a]	30.70[a]
Goat dung	14.80[a]	26.56[a]	30.71[a]
Siam weed	15.12[a]	27.18[a]	30.90[a]
NPK	9.66[a]	16.30[b]	22.58[b]
Control	8.52[a]	15.02[b]	19.84[b]

Effect of bioremedants on fresh fruits yield of okra plant

Result of bioremedants on fresh fruit is yield of okra plant are presented in Table 5. The results showed that fresh fruit yield of okra was markedly improved by application of Siam weed ($2.13\ ^{t}/ha^{-1}$). The result of the study also showed that poultry manure ($2.05\ ^{t}/ha^{-1}$) treated plots were superior to Cow dung ($1.89^{t}/ha^{-1}$) and NPK $1.15\ ^{t}/ha^{-1}$. The control gave the least fruit yield ($0.94\ ^{t}/ha^{-1}$). The results showed that the effectiveness of Siam weed and poultry manure on okra plant was remarkably improved through their solubilizing effect. Siam weed, poultry manure, cow dung and goat dung gave significantly higher yield than NPK and control treated plot at $P<0.005$ (Table 5).

Table 5: Effect of Bioremedants on fresh fruit field of okra plant

Treatments	SEM
Poultry manure	2.05[a]
Cow dung	1.89[a]
Goat dung	1.69[a]
Siam weed	2.13[a]
NPK	1.15[b]
Control	0.94[c]

Value with the same superscripts in a column are not significantly difference (DMIRT at 5%) level of probability.

Effect of bioremedants on physicochemical properties of soil

The physicochemical properties of the soil as affected by the application of bioremedants are shown in Table 6. The various soil properties varied greatly. The textural classes of soils were predominantly sandy loam from surface to sandy clay loam in the subsurface layers. Values of sand ranged from 690 g/kg in control to 800 g/kg in NPK treated plot. Silt increased from 60 g/kg in NPK treated plot to 150 g/kg in poultry manure treated plot; while clay increased from 50 g/kg in NPK treated plot to 73.8 g/kg in cow dung treated plot. However, soil texture is an inherent property of soils that rarely varies. The pH value was 5.0 in the control, 5.20 in NPK treated plot followed by goat dung (5.50), cow dung 5.8, 6.24 in Siam weed treated plot and 6.60 in poultry manure. Poultry was significantly higher (6.60) than in control and NPK treated plot. There was decrease in total N (0.06%) in control to (0.13%) in the cow dung treated plot. This could be due to crop uptake, crop removal and leaching.

The reduction in pH was highest in the control and NPK treated plots. This is in line with the finding of Ojeniyi (2000) that the use of inorganic fertilizer as soil amendment increased soil acidity by lowering the soil pH.

Available P decrease in control (62.00Mg/Kg^{-1}) and cow dung (64.85Mg/ Kg^{-1}) followed NPK by Siam weed (64.92Mg/Kg^{-1}), NPK (73.58Mg/ Kg^{-1}), poultry manure (76.39Mg/ Kg^{-1}) and goat dung (81.08Mg/ $Kg^{1)}$ in that order, respectively.

Exchangeable K increase in Siam weed (0.40-Cmol/ Kg^{-1}) and cow dung treated plot but decreased in NPK (0.09 Cmol/ Kg^{-1}) and goat dung (0.10 Cmol/ Kg^{-1}), respectively.

The same trend in exchangeable K was observed in exchangeable Ca. There was a decrease in NPK-treated plot (0.9 Cmol/ Kg^{-1}) to 2.0 Cmol/ Kg^{-1}) in cow dung-treated soils . There was an increase in exchangeable Mg in control (0.42 Cmol/ Kg^{-1}) to (0.65 Cmol/ Kg^{-1}) while exchangeable Na increased from 0.30 Cmol/ Kg^{-1}) in Siam weed treated plots to 2.02 Cmol/ Kg^{-1} in cow dung treated plots.

Table 6: Effect of Bioemedants on soils physical and chemical properties after the Experiment

Soil Properties	Bioremedants					
	PM	CD	GD	SW	NPK	C
Sand (g/kg)	790	780	780	780	800	690
Silt (g/kg)	150	140	140	130	60	80
Clay (g/kg)	70	73.8	70	55.8	50	60
pH	6.60	55.80	5.50	6.24	5.20	5.0
Total N (g/kg)	1.2	1.3	1.0	0.9	0.7	0.6
Organic Matter (g/kg)	14.6	10.3	9.4	10.6	6.2	0.6
Availability P (Mg/Kg^{-1})	76.39	64.85	81.08	64.92	73.58	62.00
K (CMol/ Kg^{-1})	0.12	0.32	0.10	0.40	0.09	0.13
Ca (Cmol/Kg^{-1})	1.30	2.0	1.40	1.90	0.9	1.00
Mg (Cmol/Kg^{-1})	0.52	0.49	0.48	0.65	0.45	0.42
Na (Cmol/Kg^{-1})	0.79	2.02	0.71	0.30	0.77	0.62
ECEC (Cmol/Kg^{-1})	2.73	6.81	2.69	6.02	2.21	2.17
Textural class	loamy sand					

PM = Poultry Manure, CD = Cow dung, G.D = Goat Dung
SW = Siam weeds, C = Control.

Conclusion

From the study, the effectiveness of bioremedants in improving okra plant growth and physicochemical properties of studied soils of Ogoniland has been demonstrated. Poultry manure, cow dung and Siam weed were more effective when compared to NPK. It is therefore imperative to recommend, bioremedants for optimal nutrient supply for okra production as well as increasing the soil quality for okra production in degraded and nutrient-depleted soils.

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