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EFFECTS OF DIFFERENT ORGANIC MANURES AND NPK FERTILIZER ON SOIL PROPERTIES

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ABSTRACT

A pot experiment was conducted to investigate the effects of different organic manures and NPK fertilizer on soil properties from Ibekwe Akpanya and Ekim town both in Mkpat Enin Local Government Area. The manures were incorporated into the soils two weeks before soil sampling while NPK fertilizer was applied at split doses before soil sampling. Some important parameters in the soil (before and after treatment) and manure (both organic and inorganic) were selected and analyzed using standard methods. Nitrogen (3.38%), phosphorus (0.98%), potassium (3.10 ppm) and magnesium (2.81 ppm) contents of the poultry manure were the highest when compared to other organic manures used for the experiment. NPK fertilizer had the highest Nitrogen (4.78%) and phosphorus (1.03%) content among all used for the experiment. The properties of the soil showed that the organic carbon, total nitrogen, phosphorus and calcium were of low nutrients. On application of the organic manures to both soils, there was an increase in the soil nutrient. The soil in which poultry dung was applied had a higher organic carbon content of 4.60% in Ibekwe Akpanya and 6.69% in Ekim town when compared to application of NPK fertilizer in Ibekwe Akpanya (3.45%) and Ekim town (5.66%). The applications of organic manures perform almost the same or better than NPK fertilizer and poultry dung seemed to be the best among the organic manures applied. Large quantity of manure will be required to improve poor soil properties, to achieve the best result.

Keywords: organic manure, NPK fertilizer, soil properties, application, nutrients

1.0 Introduction

Poultry and goat manure contain about thirteen (13) of the essential elements that are used by plants. These include nitrogen, phosphorus, potassium, calcium, magnesium, sodium etc. These elemental nutrients originate from the feed, supplements, medication and water consumed by the animals. The amount of elemental nutrients provided depends on the nutrient contents of the dung. The expansions in animal enterprises and cassava processing industries have led to the production of a large amount of wastes in urban and peri-urban areas, which becomes potential environmental hazard. The composition of elements in both poultry and goat dung contains organic and inorganic forms of elemental nutrients. These dungs serve as an organic fertilizer, which is a source of plant nutrients. Raston (2015) stated that poultry dung is used as organic fertilizer, especially for soil that is low in nitrogen. However, there is a renewed interest in proper and effective use of organic manures derivable from these wastes to get rid of such wastes and to improve agricultural soil fertility. These manures are known to decompose in soils to form humus and humid substances, which play a dominant role along with clay micelles in the complex soil reactions that, enhance the cation exchange capacity (CEC) of soils. According to Olatunji *et al.* (2006), the application of organic manure had been found to have higher comparative economic advantage over the use of inorganic fertilizer. A study conducted by Nwajiuba and Akinsanmi (2002) in Southeastern Nigeria, showed that returns per ha were higher in organic farms but outputs were slightly less in inorganic farms. Therefore, replenishment of nutrients and improvement in quality of nutrient depleted and acid soils could be achieved through the application of inorganic fertilizers, organic manures or a combination of both organic and inorganic fertilizers (Adeniyan and Ojeniyi, 2005).

The major problem faced by plant is deficiency of elemental nutrient (either macro elemental nutrient or micro elemental nutrient), which leads to stunted growth, death of plant tissue or yellowing of leaves, reduction of chlorophyll, curling of leaf tips and reduction of plant fertility. The solution to the above-mentioned problems is the effective and appropriate application of poultry manure, goat manure or cassava peeling compost to supply the necessary elemental nutrient to the plant. As human population increases, the intensity of anthropogenic threat exerted on the environment increases as a result of industrialization and agricultural activities (Ubong *et al.*, 2020). Also, there should be a reduction in the application of inorganic fertilizers in order to minimize their harmful effects on plant, soil and human being. Hence, the aim of this work was to investigate the effects of different organic manures and NPK 15-15-15 fertilizer on soil properties.

2.0 Materials and methods

2.1 Study area

The soils used for the pot experiment were collected from Ibekwe Akpanya (SIA)and Ekim town (SET) both in Mkpat Enin Local Government Area of Akwa Ibom State. Mkpat Enin soil is classified as nutrient depleted having been cropped for so many years and therefore is unable to support plant growth without heavy fertilization or a long-time

fallowing. Ibekwe Akpanya and Ekim town are small villages and the occupants are mostly farmers. Their main plants were vegetables such as fluted pumpkin, waterleaf, cucumber, melon and cassava. They were always in need of specific manure to improve the plants yield.

2.2 Treatment

Following the procedures used in Adeniyan *et al.,* (2011), three different organic manures; Poultry dung (PD), goat dung(GD) and cassava peelings compost(CPC) and NPK 15:15:15 inorganic fertilizer were applied to the potted soils at the rate equivalent to 5 kg of the organic manure and 3 g of NPK fertilizer for the pots to be planted with maize. The pots were arranged randomly with three replicates. The manures were incorporated into the soils two weeks before planting while the NPK fertilizer was applied at 2 split doses (the first at three weeks after planting and the second at maize tasseling). The control pots were planted without any application of treatment. Three seeds of maize were planted and watered daily appropriately and throughout the planting period (since it was dry season). The maize was properly nurtured in the pot until maturity (12 weeks after planting).

2.3 Preparation of Samples for Analysis

Initial (pre-planting) soil samples from the nutrient depleted soil were collected from ten points at the Ibekwe and Ekim town sites and then bulked separately. Post-planting soil samples were collected from the three replicates according to the treatments incorporated and bulked accordingly. The soil samples were air-dried and sieved with 2 mm sieve. Analyses of the soil samples (pre-planting and post-planting) were then carried out. Physicochemical parameters of goat dung, poultry dung, cassava peeling compost and NPK fertilizer used for the pot experiment were also prepared and analysed using appropriate standard methods.

2.4 Soil Samples Analyses

Each sample was prepared in a 1:2 ratio (soil : water ratio), stirred vigorously and allowed to settle. Temperature was determined using mercury in glass thermometer. pH and electrical conductivity readings were quickly determined using pH meter model 430 and DDS 307 conductivity meter respectively. All determinations were done in triplicates and the mean value recorded. Soil organic matter was determined using Walkey-Black dichromate method. Total Nitrogen was determined using micro Kjedahl method of analysis (Peters *et al.,* 2003). Soil available phosphorus was determined according to Koralage *et al.,* 2015. Organic manures were also analysed for total nitrogen and phosphorus.

2.5 Statistical Analysis

The mean values of the heavy metal contents in the different types of manure and NPK fertilizer were subjected to Analysis of Variance (ANOVA) to verify if there is a statistically significant difference in the mean.

3.0 Results and Discussion

Table 1 shows the Physicochemical parameters of Goat dung, Poultry dung, Cassava peeling compost and NPK fertilizer used for the pot experiment. Nitrogen, phosphorus, potassium and magnesium contents of the poultry manure were the highest compared to other organic manures used for the experiment. Table 2 shows the initial physicochemical parameters of soil at Ibekwe Akpanya (SIA) and soil at Ekim Town (SET) used for the pot experiment.

NPK fertilizer had the highest nitrogen and phosphorus content among all used for the experiment. The chemical properties of the soils showed that they were of low nutrients. This was indicated by having low concentration of organic carbon, total nitrogen, phosphorus and calcium. Nitrates in soil could be from fertilizers, agricultural run-off and gunpowder (Okori and Ekanem, 2022). The pH of the soil sample from Ekim town was approaching neutrality (6.89) while that at Ibekwe Akpanya was slightly alkaline (7.76).

Table 1: Physicochemical parameters of Goat dung, Poultry dung, Cassava peeling compost and NPK fertilizer used for the pot experiment.

PARAMETERS	Manure			NPK
	GD	PD	CPC	
pH	7.21	6.19	6.92	6.53
Electrical conductivity(S/m)	1536.00	1581.30	1314.27	1625.90
Temperature	28.07	28.20	31.10	28.45
Organic carbon (%)	14.2	16.8	13.5	10.3
Total nitrogen (%)	2.87	3.38	1.94	4.78
Phosphorus (%)	0.75	0.93	0.88	1.03
Potassium (ppm)	2.64	3.10	2.48	2.99
Calcium(ppm)	1.13	1.45	2.04	1.82
Magnesium (ppm)	2.27	2.81	1.05	2.06
Sodium (ppm)	1.39	1.41	1.95	1.77

Poultry dung (PD), goat dung (GD) and cassava peelings compost (CPC)

Table 2: Physicochemical parameters of soil used for the pot experiment

PARAMETERS	**Different Soil Sample/Location**	
	SIA	**SET**
pH	7.76	6.89
Electrical conductivity(S/m)	82.0	134.6
Temperature	28.4	28.8
Organic carbon (%)	0.96	2.00
Total nitrogen (%)	1.19	1.25
Phosphorus (%)	0.75	0.88
Potassium (ppm)	1.04	1.34
Calcium(ppm)	0.92	0.99
Magnesium (ppm)	1.05	1.84
Sodium (ppm)	1.14	2.11

SIA: soil sample (Ibekwe Akpanya), **SET:** soil sample (Ekim Town)

Also, the soil sample at SET had higher concentration among all the physicochemical parameters analysed when compared to that in Ibekwe Akpanya with recorded values of 134.6 S/M, 28.8 °C, 2.00%, 1.25%, 0.88%, 1.34 ppm, 0.99 ppm, 1.84 ppm and 2.11 ppm for electrical conductivity, temperature, organic carbon, total nitrogen, phosphorus, potassium, calcium, magnesium and sodium respectively.

Table 3: Effects of applied treatments on soil chemical properties

PARAMETERS	**TREATMENT**							
	Goat Dung		**Poultry Dung**		**Cassava peeling compost**		**NPK fertilizer**	
	SIA	SET	SIA	SET	SIA	SET	SIA	SET
pH	6.84	6.91	6.47	6.32	6.45	6.99	6.00	6.12
Electrical conductivity(S/m)	343.67	428.11	828.20	810.21	532.99	687.93	471.32	513.45
Temperature	28.4	28.5	28.0	27.9	29.3	28.7	28.1	28.2
Organic carbon (%)	3.99	6.12	4.60	6.69	3.67	5.72	3.45	5.66
Total nitrogen (%)	2.67	2.95	2.22	3.26	1.95	3.89	3.27	4.87
Phosphorus (%)	2.79	3.87	2.90	3.19	3.01	4.67	4.23	4.89
Potassium (ppm)	1.53	2.98	1.85	3.51	1.22	2.87	1.80	3.43
Calcium(ppm)	1.01	1.66	1.33	1.80	1.96	2.12	1.26	1.99
Magnesium (ppm)	2.22	2.44	2.17	3.22	1.30	2.03	2.34	2.21
Sodium (ppm)	1.63	2.32	2.00	3.15	2.18	3.11	2.42	3.23

SIA: soil sample (Ibekwe Akpanya), **SET:** soil sample (Ekim Town)

On application of the organic manures to both soils as observed in Table 3, there was an increase in the soil nutrient. On application of organic manure, the soil in which poultry dung was applied had a higher organic carbon content of 4.60% in Ibekwe Akpanya and 6.69% in Ekim town when compared to the application of NPK fertilizer in Ibekwe Akpanya (3.45%) and Ekim town (5.66%). Poultry dung is very concentrated in nitrogen and phosphate and is more effective to both plant and soil (Lustosa *et al.,* 2017). The increase in the soil organic carbon content was expected due to the fact that organic manures have the ability of increasing soil organic matter content (Ojeniyi, 2000). It was also reported by Adeniyan and Ojeniyi, 2005 that the contents of some major nutrients in the soil were slightly dependent on the level of organic matter. The nutrients in the NPK fertilizer (inorganic fertilizer) were already in the mineralized form and it provides a ready source of nutrients to the soils. That is to say that the nutrients released from NPK fertilizer were for a short period of time because leaching of nutrients may be higher in the soil treated with organic manures. Longer residual effect of organic manures have been reported by many researchers such as Adeniyan and Ojeniyi, 2003; Adetunji, 1997, Adeniyan *et al.*, 2011 etc.

When organic manures were applied in the soil, there was a significant pH values ranging from 6.32 to 6.99 compared to soil treated with NPK fertilizer with pH values ranging from 6.00 to 6.12. These results indicated that organic manures have greater potential of raising soil pH compared to NPK fertilizer. This shows that organic manures could serve as good amendment materials in enriching soils acidity. Organic fertilizer contains carbon as part of its chemical makeup and it is the carbon along with nitrogen, phosphorus and potassium that feeds microbes and enables them to make nutrients available for plants in a naturally occurring biological process (Kaitlyn, 2017). Busari *et al.*, 2005

reported that soil acidity is a major limitation to plant or crop growth in tropical region. Comparing the nutrients enhancement between soil sample from Ibekwe Akpanya and soil sample from Ekim town on treatment with both organic manure and NPK fertilizer, it was observed to be higher in Ekim town soil (table 3). Specifically, the increase in soil nutrients with the application of organic manures was more obvious with the application of poultry dung with respect to organic carbon, potassium, magnesium and sodium. This might be due to the high value of organic carbon, potassium and magnesium in the manure when compared with values in other organic manures. Kirhnamoothy (2018) commented that, the application of poultry dung as manure increase availability of nutrients in soil such as phosphorous, potassium, calcium and magnesium which aid plant development.

3.1 Analysis of Variance (ANOVA)

Analysis of Variance (ANOVA) which was obtained using Statistical Package for Social Science (SPSS) 20.0 is presented in Table 4. The significance of the difference between the different types of manure and NPK fertilizer was also depicted. The F_{cal} was greater than the F_{tab}, therefore, there is a significant difference in the concentration levels in the different types of manure and NPK fertilizer at 95% confidence interval. This implied that there was pronounced variation in concentration level of the monitored parameters in the different types of manure and NPK fertilizer used in the soil treatment.

Table 4: ANOVA of Physicochemical parameters of Goat dung, Poultry dung, Cassava peeling compost and NPK fertilizer used for the pot experiment

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	990320.9	9	110035.7	30.2391	9.88E-10	2.392814
Within Groups	72777.07	20	3638.854			
Total	1063098	29				

4.0 Conclusion

Application of different types of organic manures and NPK fertilizer enhanced availability of soil nutrients in the two soil samples (SET and SIA). The applications of organic manures performed almost the same or better than NPK fertilizer and poultry dung seemed to be the best among the organic manures applied. To gather greatest benefits, large quantity of organic manure will be required. The Cassava peeling compost and goat dung performed well like the poultry dung and NPK fertilizer when applied to the soil at the different locations. Therefore, the present study indicates that unproductive soils can be amended by the application of both organic manures and NPK fertilizer.

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