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Effect of Piggery and Poultry Dung on the Physico-chemical Properties of Humus Soils

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Abstract. In order to investigate the effect of Piggery and Poultry dung on the Physico-chemical properties of humus soils, an experiment was carried out in which humus soil was amended with Piggery and Poultry dung at 0, 40, 60, 80 and 100 g kg^{-1}. The soils treated were incubated in the dark at 25 °C for seven weeks at field capacity. Soil pH, OC, N, P, K, Ca, Mg, Na and CEC increased with rate of manure, while exchangeable acidity reduced irrespective of the concentration. The Poultry manure gave quick response and higher concentration of soil chemical properties especially in case of humus soil.

Keywords: Humus soil, amendment, dung, field capacity.

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1 Introduction

Soils are known to be low in organic matter and mark depletion in its nutrients within two years of cultivation. It functions as the principal source of nutrients; its decline

therefore affects not only crop yield but also physical and chemical properties of soil. Animal manure on the other hand is known to be effective in the maintenance of adequate supply of organic matter in soil, with attendant improvement in soil physical and chemical condition and enhanced crop performance [7, 14] its generation is also known to be substantial [12]. Poultry, cattle, goat, sheep and Pig manure has been found to improve soil fertility and crop yield [1, 13].

The concept of recycling waste nutrient and organic matter back to agricultural soils is feasible and desirable outlet and a potential cheap source of organic matter and fertilizer elements for farmers [8].

In addition to the potential beneficial component some waste materials may also contain non-essential elements, persistent organic compounds and micro-organisms that may be harmful to plants [9, 11]. The presence of heavy metals in natural manures raises serious concern about the adverse environmental impact as a result of excessive manure application to agricultural land.

High and excessive accumulation of heavy metals in soils may eventually contaminate both human and animal food chain [6]. Because of this, many countries in the world have established specific guidelines and standards for the application of manures in agricultural lands. However, these guidelines for natural manures obtained from wastes are lacking in most African Countries including Nigeria.

The aim of this study is to determine the concentration levels of heavy metals such as Cd, Ni, Zn, Fe, Pb and Mn in the soils of the study areas because of their potential for human exposure and increased health risk.

2 Materials and methods

The experiment was conducted on humus soil at Ambrose Alli University, Ekpoma. Fresh Poultry and Piggery dung were collected from farms in Ekpoma and around the University and were air-dried and allowed to mature. Two Sets of 4 kg soil were measured; the first set was amended with 0, 40, 60 and 100 g kg^{-1} of Piggery manure and the second set amended also with the same rate of Poultry manure. Amended soils were packed in labeled plastic pots, watered and covered to prevent soil from drying out. They were placed in the dark at about 25 °C to incubate for 7 weeks. Incubated soil samples were collected after seven weeks for chemical analysis.

Soil samples were air dried and passed through 2 mm–sieve. Total soil Nitrogen was determined by miro-kjeldahl method and organic matter by Walkley–Black wet oxidation method. Exchangeable K, Na, Ca and Mg were extracted with neutral 1 M ammonium acetate, K and Na were determined with flame photometer while Ca and Mg were determined by Atomic absorption spectrophotometer.

Available P was determined by colorimetry after Bray-1 extraction. The soil pH was measured by glass electrode in a 1:1 soil water suspension.

Cation exchange capacity (CEC) was determined by ammonium saturation method. Exchange acidity (EA) is determined by kcl extraction method.

Heary metals such as Cd, Ni, Pb, Fe, Zn and Mn were determined using Atomic Absorption Spectrophotometer.

Table 1: Effect of piggery dung on soil.

	Treatment level of (kg^{-1})									
Control	pH	Orgc. (%)	TN (%)	EA (Meg/100 g)	Na (Meg/100 g)	K (Mg/100)	Ca (Mg/100)	Mg (Mg/100)	CEC (Mg/100)	P (ppm)
0	5.30	1.85	0.14	0.40	0.48	0.18	2.40	0.72	4.18	1.05
40	7.20	2.59	0.19	0.30	0.52	0.40	2.89	1.46	5.57	2.93
60	7.10	2.83	0.20	0.40	0.56	0.41	2.93	1.64	5.94	4.40
80	6.80	4.10	0.30	0.20	0.59	0.52	3.09	1.75	6.15	4.73
100	6.20	4.08	0.30	0.20	0.67	0.68	3.25	1.76	6.56	7.43

Table 2: Effect of poultry dung on soil.

	Treatment level of (kg^{-1})									
Control	pH	Orgc. (%)	TN (%)	EA (Meg/100 g)	Na (Meg/100 g)	K (Mg/100)	Ca (Mg/100)	Mg (Mg/100)	CEC (Mg/100)	P (ppm)
0	5.70	1.85	0.13	0.40	0.43	0.9	2.42	0.83	4.27	1.44
40	6.70	1.90	0.14	0.30	0.51	0.23	5.17	1.12	7.33	1.45
60	7.10	2.11	0.16	0.30	0.54	0.41	7.23	1.38	8.48	1.82
80	7.40	2.38	0.18	0.10	0.56	0.50	7.59	1.42	10.20	5.17
100	7.40	2.75	0.20	0.10	0.68	0.71	8.28	1.42	11.20	5.86

Results

3 Discussion

Tables 1 and 2 show that incubation of soil with Piggery and Poultry manure for seven weeks lead to increases in soil pH, OC, N, P, K, Ca, mg, Na and CEC and decrease in EA. The level of the soil chemical properties increased with quantity of manure from 0 to 100 g kg^{-1} and EA decreased accordingly.

Table 3: Correlation Matrix of total heavy metals concentrations and soil chemical properties such as pH, organic carbon and cation exchange capacity.

	Cd	Ni	Pb	Fe	Za	Mn
pH	0.5645	−0.6369	0.5548	−0.3350	−0.2037	0.2346
Org. C	−0.1275	−0.0799	0.1528	−0.4489	0.3606	0.3239
CEC	−0.2667	−0.2787	−0.3946	0.4456	0.1989	0.5005
	Poultry dung (mg/kg)		Cow dung (mg/kg)		Control soil (mg/kg)	
Cd	$0.33-0.52$		$0.22-0.62$		$0.25-0.27$	
	0.42 ± 0.036		0.44 ± 0.197		0.26 ± 0.042	
Ni	$5.30-5.92$		$10.28-11.28$		$4.98-5.82$	
	5.77 ± 0.17		10.32 ± 0.398		5.18 ± 0.32	
Pb	$58.29-65.85$		$60.25-62.94$		$46.54-47.40$	
	62.46 ± 3.19		61.86 ± 1.06		46.64 ± 0.436	
Fe	$55.26-58.64$		$73.21-76.92$		$59.18-61.21$	
	56.95 ± 2.48		74.13 ± 2.79		60.02 ± 2.206	
Za	$57.33-60.15$		$45.22-47.39$		$32.61-34.19$	
	58.74 ± 14.59		46.63 ± 3.86		33.86 ± 1.11	
Ma	$18.24-23.36$		$18.19-20.29$		$11.96-13.04$	
	20.40 ± 1.87		19.41 ± 0.96		12.11 ± 2.149	

The changes in soil chemical properties given by 100 g kg^{-1} were significant ($P > 0.05$) for both poultry and piggery dung. Significant differences existed between control and 40 kg Piggery manure in pH, OC, N, P,K, CEC, Mg, EA except in Ca and Na. there were no significant difference between control and 40 g kg^{-1} for poultry manure except with respect to K. soil therefore responded faster to poultry manure

Table 4: Concentration of heavy metals in amended soils and the contro.

Linear regression analysis between pH and uptake of some heavy metals.					
pH	=	9.218	+	(−1.675) Cd	$(R^2 = 0.3187)$**
	=	7.322	+	(−0.0607) Ni	$(R^2 = 0.394)$**
	=	7.220	+	(−0.0029) Pb	$(R^2 = 0.3076)$**
	=	8.0967	+	(−0.0018) Fe	$(R^2 = 0.1123)$**
	=	7.2846	+	(−0010) Za	$(R^2 = 0.0414)$**
	=	6.2374	+	(0.02883) Mn	$(R^2 = 0.0551)$**
Linear regression analysis between organic carbon and heavy metal uptake.					
Org. Carbon	=	−0.2080	+	(0.2762) Cd	$(R^2 = 0.0590)$ ns
	=	3.971	+	(−0.0176) Ni	$(R^2 = 0.0064)$ ns
	=	4.090	+	(−0.0018)Pb	$(R^2 = 0.0234)$ ns
	=	7.6303	+	(−0.0056) Fe	$(R^2 = 0.02014)$ ns
	=	1.665	+	(0.0043)Za	$(R^2 = 0.1448)$ ns
	=	2.1080	+	(0.0889) Mn	$(R^2 = 0.1049)$ ns
Linear regression analysis between cation exchange capacity (CEC) and uptake of heavy metals.					
CEC	=	54.513	+	(−17.362) Cd	$(R^2 = 0.0659)$ ns
	=	34.7159	+	(−06142) Ni	$(R^2 = 0.0777)$ ns
	=	36.3762	+	(−0.0476) Pb	$(R^2 = 0.1558)$ ns
	=	69.1595	+	(−0.0552) Fe	$(R^2 = 0.1986)$ ns
	=	17.9901	+	(0.0221)Za	$(R^2 = 0.0396)$ ns
	=	2.8550	+	(1.3754) Mn	$(R^2 = 0.02505)$**

amendment compared with that of Piggery manure.

This can be related to higher value of P, Ca and Mg recorded for Poultry manure in literature. Significant difference ($P > 0.05$) occurred in EA between control and 40, 60, 80 and 100 kg^{-1} poultry manure but it was 80 g kg^{-1} Piggery manure that reduce EA significantly in soil.

Manure generally is known to have positive influence on soil type. Correlation results shown in Table 3 of total heavy metal concentrations and soil chemical properties show that the uptake of Ni is pH dependent as the correlation between Ni and pH is negative (-0.6269) which means that uptake increases as the pH of the soil decreases; that of Ni and cation exchange capacity, organic carbon are 0.3946 and -0.0799 respectively. This means that uptake of Ni depends on other soil conditions especially the manures applied to the soil.

In order to provide more information on the effect of some of the soil factors on the uptake of heavy metals, correlation analyses of the heavy metals concentrations and soil properties such as pH, Cation exchanges capacity (CEC) and organic matter were carried out and the result presented in Table 3. The results of the analysis show that Cd, Ni, Pb and Fe are negatively correlated with cation exchange capacity (CEC), while there was positive correlation

between pH, Ca and Mn. There was also positive correlation between organic carbon with Zn and Mn.

The linear regression relation shows that uptake of Ni is dependent on pH ($R^2 = 0.394$) but not significantly dependent on cation exchange capacity and organic cabon Cd is naturally present in the soil at concentrations of slightly more than 1 mg/kg [3] it is not only non-essential for life, but highly toxic to most organisms, having a toxicity of between 2 to 20 times higher than many other heavy metals [15], it is therefore considered a very serious pollutant. The negative correlation of (0.565) between pH

and Cd uptake indicates that as the pH increases, the uptake decreases. The linear regression between pH and Cd is significant with R square of (0.3187). It is however not significant for the cation exchange capacity and organic carbon.

The correlation studies show that Zn is positively correlated to organic carbon and cation exchange capacity but negatively correlated to pH.

The correlation matrices in Table 3 do not show any significant correlation between Fe, Cation exchange capacity and organic carbon but positive correlation exists with other metals such as Cd, Ni, Pb and Mn. The correlation of Fe with Zn is negative.

The correlation between Pb and soil properties such as pH, organic carbon and cation exchange capacity is not significant at the 5% level.

The correlation of total metal concentration in the soil and the soil properties show that Mn is positively correlated to pH, (0.235), organic carbon (0.324) and cation exchange capacity (0.501).

4 Conclusion

It is concluded that poultry and piggery manure improved soil chemical properties but poultry manure improved soil chemical properties more than Piggery manure especially as regards to the organic carbon and Nitrogen status.

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