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Effects of Poultry Manure and NPK Fertilizer on Organic Matter and Nutrients Concentration in the Soil of Makurdi, Nigeria

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Abstract

A field experiment was conducted at University Commercial Crop Farm, Federal University of Agriculture Makurdi, to evaluate the effects of poultry manure and NPK fertilizer on organic matter and nutrients concentration in the soil using sorghum as test crop. The study conducted in 2016 and 2017 cropping season under rain-fed condition. The experiment consisted of four (4) levels of poultry manure (0, 2.0, 3.5, and 5.0) t/ha and four (4) levels of NPK (0, 30, 60 and 90) KgN/ha. The experiment was laid out in 4 ×4 factorial in Randomised Complete Block Design and replicated three (3) times. Application of poultry manure as sole nutrient source raised soil pH, concentrations of OM, N, P and exchangeable cations in the soil. The soil pH, concentrations of OM, N, P and exchangeable cations in the soil was marginally increased by application of poultry manure plus NPK fertilizer. Application of NPK fertilizer as soul nutrient source decreased soil pH. Similarly, the soil pH was lowered in control treatments. Application of poultry manure with or without NPK fertilizer could be adopted for sustainable cultivation of sorghum in Makurdi.

1. Introduction

The practice of applying poultry manure to supplement NPK fertilizer as a strategy to overcome intrinsic challenges associated with sole application of NPK fertilizer has gained prominence in modern farm practice among low-income earners in the Sub-Saharan Africa; this could be adduced to the ability of poultry manure to improve the physical structure of the soil as recorded by several Authors (Adediran et al., [1]; Adeikiya and Agbede, [2]; Agber and Ali, [3]). There are several benefits associated with the use of poultry manure as nutrient source in agriculture; the crop on the field will benefit from the nutrients release from the manure while the low-income farmer who cannot readily afford fertilizer is able to supplement the quantity of the required inorganic fertilizer with poultry manure which is available at little or no cost. Adeikiya et al. [2] evaluated the effects

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of poultry manure on soil properties, leaf nutrients status, growth and yield of cocoyam in tropical Alfisol in South West Nigeria and found that manure increased yield of cocoyam, leaf nutrient status and also, improved nutrient concentration of the soil. Consequently, they recommended application of poultry manure for sustainable production of cocoyam. The efficacy of combined application of poultry manure and NPK fertilizer for sustainable crop production exist in many agro-ecological zones; Agber et al [3] evaluated the effects of fertilizer models on pearl millet performance in Makurdi and found that combined application of varying levels of poultry manure and NPK fertilizer increase yield of pearl millet and improved soil nutrients concentration. Thus, they recommended combined application of poultry manure and NPK fertilizer for optimum and sustainable production of pearl millet in Makurdi. This experiment was design to assess the effects of manure plus NPK fertilizer on soil organic matter and concentration of plant nutrient elements in the soil under rain-fed condition in Makurdi, Nigeria.

2. Materials and Methods

A field experiment was conducted at University Commercial Crop Farm, Federal University of Agriculture Makurdi, to evaluate the effects of poultry manure and NPK fertilizer on organic matter and nutrients concentration in the soil using sorghum as test crop. The study conducted in 2016 and 2017 cropping season under rain-fed condition. The experiment consisted of four (4) levels of poultry manure (0, 2.0, 3.5, and 5.0) t/ha and four (4) levels of NPK (0, 30, 60 and 90) KgN/ha. The experiment was laid out in 4 × 4 factorial in Randomised Complete Block Design and replicated three (3) times. The plant spacing adopted was 60 cm × 25 cm. Fertilizer was applied at sowing according to the treatments. Manure weeding was adopted for weed control and was done as at when due. Soil data collected included; soil Ph, organic matter, Nitrogen, Phosphorus and exchangeable cations. The soil data was analysed using standard procedure before and after harvesting of the test crop.

3. Result and Discussion

TABLE 1 below shows soil data at the experimental site before land preparation. The result indicates that the soil acidity was moderate and within optimum range required for sorghum production [4]. The soil organic matter (SOM), N,P and exchangeable cations were considerably low base on soil fertility rating of Food and Agricultural Organization (FAO,2004) [5].

TABLE 1. **Soil Properties of the Experimental Site.**

Soil parameters 0-15 cm	**2016**	**2017**
Sand (%)	76.64	78.36
Silt (%)	14.36	10.04
Clay (%)	9.0	11.60
Textural class	Sandy loam	Sandy loam
$pH_{(H2O)}$	6.64	6.66
pH(KCl)	5.88	5.67
Organic matter (%)	1.18	1.80
Total nitrogen (%)	0.21	0.23
Phosphorus (mg/kg)	1.20	1.64
K (cmol kg^{-1})	0.20	0.23

Ca (cmol/kg^{-1})	3.40	4.76
Mg (cmol kg^{-1})	2.18	2.51
Na (cmol kg^{-1})	0.15	0.18
CEC (cmol kg^{-1})	5.83	7.68

TABLE 2 shows data on soil properties after harvest. The result indicates that both manure and NPK fertilizer application ensured nutrients supply in the soil. The soil pH decreased with NPK fertilizer applied as sole nutrient source at all levels. This could be attributed to acid - yielding properties associated with nitrogen fertilizers as reported several Authors (Adepetu et al., [6]). The change in soil pH was marginal in manure plus NPK fertilizer treatments as can be deduced from TABLE 2. The slight increase in soil pH can be attributed to the poultry manure in the mixture which has the ability to resist change in soil pH as a result of it high buffering capacity. This has been reported by several researchers (Boateng et al., [7]). Poultry manure application as nutrient source proportionately increase soil pH. Several Authors (Brady and Weil, [8]; Adepetu et al., [6]) have demonstrated that manure contains high exchangeable cations (Ca, Mg, Na and K) which often lowers soil acidity . The high composition of exchangeable cations in poultry manure and subsequent release in the soil could be attributed to the increase in soil pH observed in all manure treatments. This similar trend was reported by Ayoola and Adeniyan [9] in South Western Nigeria. The lowest soil pH was obtained in control treatments (zero manure and NPK application) as can be observed in TABLE 2, this could be attributed to removal of organic matter prompting leaching of base forming cations and hence increase soil acidity. The concentration of soil organic matter followed a similar trend to soil pH, SOM increase proportionately to levels of poultry manure. Similarly, manure application either as sole nutrients source or when combined with NPK fertilizer at all levels (TABLE 2 and TABLE 3) increased total N, available P, and exchangeable cations concentration in the soil. Although, the much nutrient concentrations were observed in sole manure treatment compared to combined poultry manure plus NPK fertilizer (TABLE 4 & 5).

TABLE 2. **Effect of NPK Fertilizer and Poultry Manure on Soil Chemical Properties in Makurdi, 2016.**

Treatment	**pH**	**OM (%)**	**N (%)**	**P (mg/kg)**	**K** →	**Ca**	**Mg (cmol/kg)**	**Na**	**EA** ←	**ECEC**
Control	6.25	1.08	0.16	0.81	0.20	2.50	2.38	0.11	1.10	6.29
30 kg N/ha	6.50	1.16	0.16	1.10	0.23	2.53	2.44	0.11	1.12	6.43
60 kg N/ha	6.52	1.16	0.24	1.42	0.23	2.53	2.44	0.12	1.20	6.52
90 kg N/ha	6.43	1.05	0.28	2.08	0.26	2.55	2.48	0.12	1.22	6.72
2.0 t/ha PM	6.64	2.90	0.28	3.22	0.24	2.71	2.48	0.18	0.89	6.50
2.0 t/ha PM + 30 kg N/ha	6.64	2.76	0.30	3.10	0.26	2.74	2.60	0.18	0.89	6.67
2.0 t/ha PM + 60 kg N/ha	6.64	2.66	0.30	3.19	0.28	2.74	2.80	0.20	1.00	7.02

2.0 t/ha PM + 90 kg N/ha	6.64	2.62	0.34	3.28	0.31	2.78	2.86	0.21	1.00	7.16
3.5 t/ha PM	6.65	3.14	0.31	3.06	0.30	2.75	2.85	0.24	0.86	7.00
3.5 t/ha PM + 30 kg N/ha	6.65	3.14	0.34	3.30	0.32	3.15	2.88	0.23	1.01	7.59
3.5 t/ha PM + 60 kg N/ha	6.65	3.12	0.34	3.30	0.38	3.28	3.00	0.23	0.99	7.88
3.5 t/ha PM + 90 kg N/ha	6.64	3.12	0.36	3.47	0.40	3.83	3.01	0.24	1.09	8.57
5.0 t/ha PM	6.68	3.30	0.36	3.32	0.38	4.13	3.00	0.26	0.86	8.63
5.0 t/ha PM + 30 kg N/ha	6.66	3.19	0.38	3.60	0.41	4.13	3.03	0.26	1.00	8.83
5.0 t/ha PM + 60 kg N/ha	6.66	3.20	0.38	3.60	0.45	4.10	3.08	0.25	1.02	8.90
5.0 t/ha PM + 90 kg N/ha	6.65	3.19	0.39	3.64	0.45	4.10	3.14	0.25	1.02	8.95

TABLE 3. **Effect of NPK Fertilizer and Poultry Manure on Soil Chemical Properties in Makurdi, 2017.**

Treatment	**pH**	**OM (%)**	**N (%)**	**P (mg/kg)**	**K**	**Ca**	**Mg**	**Na**	**EA**	**ECEC**
					cmol/kg					
Control	6.58	1.65	0.20	0.86	0.20	2.03	0.50	0.14	1.02	3.89
30 kg N/ha	6.58	1.66	0.23	0.86	0.22	2.01	0.50	0.14	1.02	3.89
60 kg N/ha	6.64	1.66	0.23	1.55	0.22	2.04	0.82	0.16	1.05	4.29
90 kg N/ha	6.61	1.68	0.25	2.04	0.23	2.08	0.83	0.19	1.05	4.38
2.0 t/ha PM	6.68	1.99	0.28	2.16	0.24	2.52	1.25	0.20	1.00	5.21
2.0 t/ha PM + 30 kg N/ha	6.66	1.86	0.28	2.30	0.24	2.55	1.68	0.23	1.00	5.70
2.0 t/ha PM + 60 kg N/ha	6.66	1.83	0.30	2.74	0.26	2.55	1.68	0.23	1.02	5.74
2.0 t/ha PM + 90 kg N/ha	6.65	1.83	0.31	2.81	0.26	2.58	2.47	0.24	1.03	6.58
3.5 t/ha PM	6.71	2.51	0.33	3.08	0.28	2.90	2.73	0.25	1.00	7.06
3.5 t/ha PM + 30 kg N/ha	6.70	2.25	0.33	3.08	0.28	2.90	2.75	0.25	1.00	7.18
3.5 t/ha PM + 60 kg N/ha	6.68	2.11	0.34	3.31	0.30	2.96	2.75	0.28	1.02	7.29
3.5 t/ha PM + 90 kg N/ha	6.65	2.08	0.35	3.36	0.30	3.01	2.78	0.26	1.00	7.35
5.0 t/ha PM	6.76	3.50	0.36	3.81	0.37	3.02	3.06	0.28	0.98	7.71
5.0 t/ha PM + 30 kg N/ha	6.70	3.47	0.36	3.82	0.39	3.20	3.10	0.28	0.99	7.96
5.0 t/ha PM + 60 kg N/ha	6.70	3.47	0.37	3.82	0.41	3.24	3.15	0.30	0.99	8.09
5.0 t/ha PM + 90 kg N/ha	6.66	3.44	0.38	3.89	0.42	3.24	3.15	0.30	1.09	8.21

TABLE 4. **Mean Effect of NPK Fertilizer and Poultry Manure on Length of Panicle and Yield of Sorghum.**

Treatment	Panicle length (cm)		Yield (kg/ha)	
	2016	2017	2016	2017
NPK (kg/ha)				
0	33.6	32.3	379.3	387.9
30	35.2	32.5	1057.2	1081.0
60	35.8	33.0	1137.4	1153.6
90	35.8	33.7	923.4	944.6
LSD (0.05)	NS	NS	10.44	25.95
Poultry manure (t/ha)				
0	34.4	30.2	890	905.4
2.0	34.5	30.2	895.8	906.3
3.5	34.5	30.5	904.3	910.0
5.0	34.8	30.8	906.9	924.1
LSD (0.05)	NS	NS	10.44	25.95

TABLE 5. **Interaction Effect of NPK Fertilizer and Poultry Manure on Panicle Length and Yield of Sorghum.**

Treatment		Panicle length (cm)		Yield (kg/ha)	
		2016	2017	2016	2017
NPK (kg/ha)	PM (t/ha)				
0	0	26.9	22.6	320.1	375.8
	2.0	27.0	22.8	332.6	378.2
	3.5	27.6	24.0	340.0	461.3
	5.0	28.0	24.4	348.6	985.2
30	0	27.2	24.7	557.1	1004.6
	2.0	27.8	24.7	965.9	1012.2
	3.5	27.8	25.0	1025.5	1126.1
	5.0	28.1	25.2	1032.2	1129.1
60	0	28.3	25.2	1046.9	1140.7
	2.0	28.6	25.5	1031.3	1130.3
	3.5	28.8	25.5	972.0	993.1
	5.0	28.8	26.0	946.4	952.1
90	0	30.0	26.0	946.1	949.0
	2.0	30.3	26.1	922.2	936.0
	3.5	30.3	26.7	910.9	928.0
	5.0	40.5	28.0	910.5	928.0
LSD	(0.05)	NS	NS	23.89	15.90

This may be due to rapid mineralization and subsequent removal from soil in plots here manure was applied plus NPK. This positive response of soil nutrients elements to addition of poultry manure attest to the fact that manure has direct impact on SOM which is the store house of plants nutrients elements. These findings agreed with previous studies which established that soil amendment using poultry manure increase SOM, N, P and exchangeable cations concentration in the soil [10]. Conversely, SOM, total N, available P and exchangeable cations concentration in the soil decreased in zero fertilizer treatments. The depletion in nutrients concentration in the soil noticed in non-manure treatments is an indication that fertilizer application is essential ingredient for sustainable soil and crop productivity [6].

4. Conclusion

The concentration of nutrients element in the soil was significantly reduced due to plant nutrient uptake. Also, soil acidity was lowered by zero manure and sole NPK fertilizer treatments. Poultry manure either as sole nutrients source or plus NPK fertilizer increases plants nutrient concentration in the soil. Higher nutrients build up in the soil was observed with sole manure application compared to manure plus NPK fertilizer application. This result indicates that the use of poultry manure as plants nutrients source either sole or plus NPK fertilizer can be adopted for sustainable crop and soil productivity.

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