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# Effects of Animal Manure on the Growth and Yield of Maize (*Zea mays l.*) Grown on Ultisols in Obio Akpa, Akwa Ibom State, Nigeria

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#### Abstract

An experiment was conducted at the screen house of the Department of Soil Science, Faculty of Agriculture, Akwa Ibom State University to evaluate the effect of animal manures on the growth and yield of maize (Zea mays L.) grown on coastal plain sand parent material. Soil samples were collected from 0-15cm depth, air dried, sieved to pass through 2mm mesh to determine the physiochemical properties. Ten (10kg) of soil were used for the pot experiment. Nutrient compositions of manure were also analysed. The experiments were laid out in a 3 x 4 split plot arrangement fitted into a randomized complete block design with three replicates. The main plots were animal manure (Goat, Pig and Poultry manure (M)) and sub-plots were four (4) rates of animal M (0, 1, 2, 3 t ha<sup>-1</sup>) applications. Data collected on growth parameters (plant height, stem diameter, number of leaves) and fresh weight and dry matter yield were evaluated. Results showed that the soil was low in nutrients and the animal manures contained high essential plant nutrients (N, P, K, and Ca). Results also showed that application of animal manures significantly (P < 0.05)increased plant height, number of leaves, stem diameter, fresh weight, and dry matter yield over the control. The yield increased with the increasing rates of application and the performance was not significantly different among the manure sources. The trend was: 5.56 t ha<sup>-1</sup> ( at poultry M rate of 3.0 t ha<sup>-1</sup>), 5.07 t ha<sup>-1</sup> (at Pig M rate of 3.0 t ha<sup>-1</sup>) and 3.97 t ha<sup>-1</sup> (at Goat M rate 3.0 t ha<sup>-1</sup>) <sup>1</sup>). Therefore, this rate is recommended for use on coastal plain sand soils to improve maize production.

Keywords: Animal Manure, Soil Properties, Growth, Yield and Maize Plant

#### 1.0 Introduction

Low soil fertility is one of the limiting factors in crop production in Nigeria especially Akwa Ibom State. According to F. O et al. (2018), Umoh et al. (2019) and Udom et al. (2019), soil nutrient depletion due to continuous cropping and high leaching of basic cations could result in low soil fertility, through reduction in soil organic matter content and increase in soil acidity, which may cause a decline in crop yield. Soil productivity maintenance is therefore important in achieving

and sustaining high yields of crops. The application of inorganic fertilizer to the soil boosts the performance of crops. However, its persistent use results in soil physical degradation, increased soil acidity, soil nutrient imbalance, reduction in activities of soil microorganism, fixation of potassium and phosphorous thereby making the essential plant nutrient unavailable to crops (Omisore et al., 2010; Umoh et al., 2017; Umoh et al., 2021). Most importantly, the chemical fertilizer is not affordable to local farmers and so the use of organic manure is a great advantage, since it contains the essential nutrients required by plants, for optimal performance. Beneficial effects of organic soil amendments have been reported to include decrease in soil bulk density, increase in water holding capacity, aggregate stability, saturated hydraulic conductivity, and easy nutrient release from soils (Udoh et al., 2021; Umoh et al., 2020). It has been reported by several researchers (Iren et al., 2016; Udoh et al., 2021; Udom et al., 2019) that animal manure such as poultry, pig and goat waste contain essential nutrient elements, which increased nutrient availability and adequately improved the yield of maize, cocoyam, Amaranthus and water leaf.

Maize (*Zea Mays* L.) belongs to the grass family of Gramineae, widely grown in the tropical regions of the world, considered as a high nutrient demanding crop and requiring 90 days to mature (Bangroo et al., 2012). As a staple food crop in Nigeria, it is highly demanded by flour mills, confectioneries, brewing and livestock industries. The crop therefore has a strong potential for providing food for the increasing populations as well as improving financial returns (Umoh et al., 2021). This study was carried out to determine the effects of different rates of the three manure sources (Pig, Poultry and Goat droppings) on the growth and yield of maize.

# 2.0 Materials and Methods

# 2.1 Site Description

The study was conducted at the Screen House, Department of Soil Science, Faculty of Agriculture, Akwa Ibom State University Obio Akpa Campus. The area lies between latitude 4.32°N and 5.33°N and longitude 7.25°E and 8.25°E. The soils are derived from highly weathered parent materials also dominated by low activity clays such as kaolinite and the amorphous oxide of Al and Fe (Umoh et al., 2019). Akwa Ibom State is within the humid rainforest zone of West Africa. It is characterized by two distinct seasons, the wet season, and the dry season. The wet season lasts from March to October and the dry season from November to March with annual rainfall range of 250- 300 mm, relative humidity of 75 - 95% mean maximum temperature of 30°C and mean minimum temperature 23°C (Uniuyo Agromet, 2020).

# 2.2 Field Sampling and Preparation

The composite soil samples were collected from coastal plain sand within Akwa Ibom State University Teaching and Research Farm Obio Akpa at a depth of 0-15cm using a soil auger. The soils were air dried, crushed and sieved through 2 mm mesh to determine the physical and chemical properties. Part of the soil sample was used for pot experiments. The different manures were cured under shade for four weeks, sieved and analysed for chemical composition.

# 2.3 Experimental Design

The experimental design was 3x4 split plot arrangement fitted into a randomized complete block design with three replications. The main plots were the three manure sources (Poultry, Pig and Goat manure) and the sub-plots were four rates of manure 0.00g, 0.05g, 0.10g, 0.15g equivalent

to 0, 1, 2, 3 t ha<sup>-1</sup>. The manures were applied two weeks before planting. A total of 36 pots were generated.

## 2.4 Pot Experiment

Ten kilograms of each of the soil samples were weighed into 12 litres plastic pots and moistened to field capacity. Three seeds of hybrid maize (Oba super2) were sown per pot and the seedlings were thinned down to one stand per pot, two weeks after planting. A basal rate of NPK 15:15:15 at 0.2g was applied two week after planting (Aduayi et al., 2002). The samples were irrigated at four days intervals until they were harvested at 45days. Plant heights were measured with a meter ruler from the base to the tip, the fully opened leaves per plant was assessed by counting, stem diameters were measured with vernier calipers. The fresh and dry yields were measured using electronic weighing balance. Dry matter percentage was also determined and the percentage yield obtained.

## 2.5 Laboratory Study

The following soil parameters were determined as described by Udo et al. (2009)). Particle size distribution was determined by the Bouyoucos hydrometer method using sodium hexametaphosphate as a dispersing agent. The soil pH was measured in soil to water ratio of 1:2.5 using a glass electrode pH meter. The electrical conductivity was measured in the extract from 1:2.5 soils: water suspension using a conductivity bridge. Soil organic carbon was determined by wet oxidation method and the value was multiplied with factors of 1.72 to obtain organic matter. The nitrogen in the soil was determined by the micro Kjeldahl method. Available phosphorus in the soil was determined by Murphy and Relay method after extraction by Bray p-1 extractant. The exchangeable cation in the soil was extracted using IN NH<sub>4</sub> OAC (pH 7.0) K and Na in the extracts was measured using flame photometry while Mg and Ca were determined by the summation of the exchangeable cation and exchangeable acidity. Saturation (%) was calculated as follows:

Saturation 
$$\% = \frac{\text{sum of exchange cation X 100}}{\text{ECEC}}$$

#### 2.6 Data Analysis

Analyses of data were done using GENSTAT (2007) version 8.0 statistical software. Significant differences among means were separated and compared using fisher's least significant difference (F.LSD) at 5% level of probability.

# **3.0 Results and Discussion**

# 3.1 The physical and chemical properties of the soil

Physicochemical properties of the soil are presented in (Table 3.1). The texture of the soil is sandy in nature, which can cause high loss of soluble nutrients through numerous macrospores (F. O et al., 2018). The soil pH is 4.4 which are strongly acidic. Soils become acidic through the leaching of nutrient elements by percolating water. The soils are non-saline with low electrical conductivity value (0.08 dsm<sup>-1</sup>). The organic matter is slightly lower than the critical level of 20 gkg<sup>-1</sup> (Aduayi

et al., 2002). Total Nitrogen was low, available P were moderate. The order of abundance of exchangeable bases was as follows: Ca > Mg > K > Na. The effective Cation Exchange Capacity (ECEC) and base saturation were moderate.

## **3.2** Chemical Properties of the Animal Manures

The chemical properties of animal manures are shown in Table 3.2. The pH of the manure types was neutral, the values ranged from 6.90 (goat) to 7.84 (poultry). Organic matter, total nitrogen, available P, calcium, potassium, and sodium (Table 3.2) increased in these trends; Pig manure > Poultry > Goat manure. The variation could be as a result of their feed intake. Similar findings were observed by Udom et al. (2007) that animal litter contains essential nutrients.

Parameters	Values	_
Sand (gkg <sup>-1</sup> )	872	
Silt (gkg <sup>-1</sup> )	38	
Clay (gkg <sup>-1</sup> )	90	
Texture	Sand	
pH	4.4	
Ec (dsm $-^1$ )	0.08	
$OM (gkg^{-1})$	3.76	
TN $(gkg^{-1})$	0.14	
AvP (mgkg <sup>-1)</sup>	13.7	
Ca (cmol lg <sup>-1</sup> )	8.8	
Mg (cmol lg <sup>-1</sup> )	2.6	
Na (cmol $\lg^{-1}$ )	0.08	
K (cmol lg <sup>-1</sup> )	0.2	
EA (cmol lg <sup>-1</sup> )	1.93	
ECEC (cmol lg <sup>-1</sup> )	13.61	
BS %	85.82	

**Table 3.1: Physicochemical Properties of Soils** 

EC = Electrical Conductivity, OM = Organic Matter, TN = Total Nitrogen, AVP = Available Phosphorus, EA = Exchange Acidity, BS = Base Saturation, ECEC = Exchangeable Cation Exchange Capacity

Properties	Goat	Pig	Poultry	
рН	6.90	7.62	7.84	
Organic Matter (gkg <sup>-1</sup> )	22.00	25.9	26.1	
Total Nitrogen (gkg <sup>-1</sup> )	0.73	1.88	1.56	
Available P (mgkg <sup>-1</sup> )	5.44	14.33	12.82	
Calcium (cmolkg-1)	3.30	4.31	4.00	
Potassium (cmolkg-1)	0.30	0.35	0.84	
Sodium (cmolkg-1)	0.04	0.22	0.06	

**Table 3.2: Chemical Properties of Animal Manures** 

### **3.3** Effects of treatment on maize growth parameters

Table 3.3 showed a significant effect on types of manure applied on plant height at 2, 4 and 6 weeks after germination (WAG). The result indicated that the maize growth increased with increasing days, after germination. The result also indicated that goat manure produced the tallest plant at 2, 4, 6, WAG. The result of animal manure rates on maize height differed significantly (P < 0.05) as shown in Table 3.3. The plant height increased with increasing rate of animal manure application. The application of 2 t ha<sup>-1</sup> of organic manure produced the tallest plant while 0 t ha<sup>-1</sup> (control) produced the shortest plant. The interaction between the manure type and rate was not significantly different (Table 3.3). The interactive effects of manure type and rates on maize plant height at 2, 4 and 6 WAG as shown in (Table 3.4) indicated that pig manure at rate 2 t ha<sup>-1</sup> produced 40.87cm height, goat manure at 3 t ha<sup>-1</sup> produced 41.38cm height. Poultry produced the tallest plant at a rate of 2 t ha<sup>-1</sup> while the 0 t ha<sup>-1</sup> produced the shortest plant. This is in line with the work reported by Udom et al. (2007) that soil incorporated with organic manure types at 0.05 or 5% probability level.

The results obtained in Table 3.5 showed no significant difference between the mean number of leaves of maize as affected by manure types rates at 2, 4 and 6 weeks after germination (WAG). In terms of rate applied, there was a significant difference among the rate of manure applied, 3 t/ha produced the highest number of leaves (14.5) while 0t ha<sup>-1</sup> produced the least (9.01). This is in line with the work reported by Iren et al. (2016). The interactive effects of manure type and rate on the number of leaves of maize at 2, 4 and 6 WAG show no significant difference (Table 3.6). The height and number of leaves were as follows: goat manure 2 t ha<sup>-1</sup> (14.34), pig manure 3 t ha<sup>-1</sup> (14.33) and poultry manure 3 t ha<sup>-1</sup> (15.00). The results obtained (Table 3.7) showed no significant effects on stem diameter as affected by manure types and rate at 2, 4 and 6 weeks after germination (WAG). This was the trend: poultry manure (5.63), Goat manure (6.04 cm) and pig manure (6.26 cm) in diameter. The result showed an increase in animal manure type with an increase in stem diameter. The interactive effects of manure types and rates on stem diameter of maize at 2, 4 and 6 WAG is shown in Table 3.8. There was no significant difference in terms of rate and days. The higher stem diameters were observed as follows: pig manure = 2 t ha<sup>-1</sup> (7.40) poultry manure = 3 t ha<sup>-1</sup> (6.85) while goat manure 3 t ha<sup>-1</sup> (7.56 cm) and were higher than the control. Udoh et al. (2021) showed that soils amended with animal manures as fertilizer, increase nutrient uptake and yield of maize.

#### 3.4 Effects of manure treatments on maize dry weight, fresh weight and yield

Results obtained (Table 3.9) showed significant effect on type of manure on the fresh weight, dry weight and dry matter yield of maize. The result indicated that pig manure produced the highest fresh weight-51.02 g, dry weight-10.79 g and dry matter yield of 20.48 g while goat manure produced the lowest dry matter yield of 16.05 g. Among the manure rates applied, 3 t ha<sup>-1</sup> produced the highest yield of 24.34 g while 0t ha<sup>-1</sup> (control) had the least value of 10.77 g. Interactive effect of manure type and rate on fresh weight, dry weight and dry matter yield of maize showed no significant difference at 5% probability levels. The result indicated that yield increased with increasing rate of application while the control produced the lowest yield as shown in (Table 3.10). The increased yield in the treated plot could be as a result of animal manure applications which added nutrients, (Table 3.2) to soil and also eased the release of nutrients for uptake by maize

plants. Iyoyo et al. (2010) and Iren et al. (2016) have reported positive impacts of animal manures on the root growth and yield of maize.

Manure Type	2 WAG	4 WAG	6 WAG
Pig M	12.19	19.85	35.31
Goat M	11.98	20.07	38.06
Poultry M	11.10	17.82	31.73
LSD (0.05)	Ns	1.72	3.46
Manure Rate (t ha <sup>-1</sup> )			
0	9.36	16.01	28.02
1	12.35	20.95	35.09
2	12.23	20.27	39.02
3	13.08	19.76	37.99
LSD (0.05)	1.45	1.99	3.99
Manure Type x Rate Interaction			
LSD (0.05)	Ns	Ns	Ns

Table 3.3: Mean plant height of maize as affected by manure type and rate at 2, 4 and 6 weeks after germination (WAG)

LSD – least significant difference, Ns – not significant, Pig M – pig manure, Goat M – goat manure, Poultry M – poultry manure

Table 3.4: Inter	ractive Effects	of manure type	e and rate or	1 maize plant	height at 2, 4	and 6
WAG						
	1					

<b>Treatment</b> (t ha <sup>-1</sup> )	Plant Height (cm)		
	2 WAG	4 WAG	6 WAG
PigM=0	10.22	18.05	27.67
PigM=1	13.15	20.70	35.27
PigM=2	12.38	21.24	40.87
PigM=3	13.01	19.42	37.44
GoatM=0	8.67	15.65	31.45
GoatM=1	12.98	23.29	38.54
GoatM=2	12.85	20.86	40.87
GoatM=3	13.42	20.45	41.38
PoultryM=0	9.21	14.32	24.94
PoultryM=1	10.91	18.85	31.47
PoultryM=2	11.46	18.71	35.34
PoultryM=3	12.80	19.41	35.17
LSD (0.05)	Ns	Ns	Ns

Manure Type	2 WAG	4 WAG	6 WAG
PigM	5.68	8.30	11.76
GoatM	5.65	8.85	12.76
PoultryM	5.51	8.74	12.38
LSD (0.05)	Ns	Ns	Ns
Manure Rate (t ha <sup>-1</sup> )			
0	4.02	6.29	9.01
1	5.40	8.06	11.68
2	6.34	9.38	14.02
3	6.67	10.78	14.49
LSD (0.05)	0.56	0.80	1.66
Manure Type x Rate In	teraction		
LSD	Ns	Ns	Ns

Table 3.5: Mean number of leaves of maize as affected by manure type and rates at 2, 4 and 6 weeks after germination (WAG)

LSD - least significant difference, Ns - not significant, Pig M - Pig manure, Goat M - goat manure, PoultryM - poultry manure

Table 3.6: Interactive effects of manure type and rate on number of leaves of manure type and rate on number of leaves of manure type and rate on number of leaves of manure type and rate on number of leaves of manure type and rate on number of leaves of manure type and rate on number of leaves of manure type and rate on number of leaves of manure type and rate on number of leaves of manure type and rate on number of leaves of manure type and rate on number of leaves of manure type and rate on number of leaves of manure type and rate on number of leaves of manure type and rate on number of leaves of manure type and rate on number of leaves of manue type and rate on number of leaves of manure type and rate on number of leaves of manure type and rate on number of leaves of manure type and rate on number of leaves of manure type and rate on number of leaves of manue type and rate on numer on number of leaves of manue type and rate on numb	aize at 2, 4
and 6 WAG	

<b>Treatment</b> (t ha <sup>-1</sup> )	Number of Leaves			
	2 WAG	4 WAG	6 WAG	
PigM=0	4.37	6.33	8.67	
PigM=1	5.33	7.71	10.33	
PigM=2	6.67	8.82	13.71	
PigM=3	6.33	10.33	14.33	
GoatM=0	3.71	6.07	9.49	
GoatM=1	5.53	8.34	13.06	
GoatM=2	6.35	10.00	14.34	
GoatM=3	7.00	11.00	14.15	
PoultryM=0	4.00	6.48	8.89	
PoultryM=1	5.35	8.13	11.65	
PoultryM=2	6.00	9.33	14.00	
PoultryM=3	6.67	11.00	15.00	
LSD (0.05)	Ns	Ns	Ns	

Manure Type	2 WAG	4 WAG	6 WAG
PigM	2.51	4.42	6.26
GoatM	2.40	4.41	6.04
PoultryM	2.58	4.26	5.62
LSD (0.05)	Ns	Ns	0.34
Manure Rate (t ha <sup>-1</sup> )			
0	2.24	3.21	4.24
1	2.63	4.36	5.61
2	2.47	4.78	6.90
3	2.64	5.12	7.14
LSD (0.05)	0.39	0.48	0.51
Manure Type x Rate Inter	action		
LSD	Ns	Ns	Ns

Table 3.7: Mean stem diameter of maize as affected by manure type and rate at 2, 4 and 6 weeks after germination (WAG)

LSD - least significant difference, Ns - not significant, PigM - pig manure, GoatM - goat manure, PoultryM - poultry manure

Table 3.8: Interactive effects of manure type and rate on stem diameter of maize at 2, 4 and6 WAG

<b>Treatment</b> (t ha <sup>-1</sup> )	Stem Diameter (cm)		
	2 WAG	4 WAG	6 WAG
PigM=0	2.26	3.17	4.43
PigM=1	2.98	4.39	6.20
PigM=2	2.30	5.03	7.40
PigM=3	2.48	5.10	7.00
GoatM=0	2.23	3.38	4.33
GoatM=1	2.28	4.58	5.23
GoatM=2	2.44	4.49	7.02
GoatM=3	2.63	5.18	7.56
PoultryM=0	2.21	3.07	3.97
PoultryM=1	2.63	4.11	5.41
PoultryM=2	2.66	4.82	6.27
PoultryM=3	2.82	5.07	6.85
LSD (0.05)	Ns	Ns	Ns

Manure	Fresh Weight	Dry Weight	Dry Matter yield
Туре	<b>(g)</b>	<b>(g)</b>	(t ha <sup>-1</sup> )
PigM	51.02	10.79	4.10
GoatM	39.22	6.23	3.21
PoultryM	33.62	5.11	3.322
LSD(0.05)	12.05	0.98	Ns
Manure Rate (t ha <sup>-1</sup> )			
0	29.59	5.16	2.15
10	34.08	7.14	3.54
20	43.61	7.86	3.60
30	57.87	9.34	4.87
LSD(0.05)	13.92	1.13	1.88
Manure Type x Rate In	iteraction		
LSD	Ns	1.96	Ns

Table 3.9: Mean fresh weight, dry weight and dry matter yield as affected by manure type and rate

Table 3.10: Interactive effects	of manure type and rate o	n fresh weight, dry	weight and dry

## matter yield of maize

	Fresh Weight	Dry Weight	Dry Matter yield
<b>Treatment</b> (t ha <sup>-1</sup> )	(g)	(g)	$(t ha^{-1})$
PigM=0	37.56	6.28	2.26
PigM=1	41.03	11.36	4.27
PigM=2	51.55	12.10	4.774
PigM=3	73.92	13.43	5.07
GoatM=0	29.73	5.25	2.60
GoatM=1	31.87	5.63	3.23
GoatM=2	46.25	6.63	3.04
GoatM=3	49.04	7.40	3.97
PoultryM=0	21.47	3.97	1.60
PoultryM=1	29.34	4.43	3.13
PoultryM=2	33.03	4.83	3.00
PoultryM=3	50.63	7.20	5.56
LSD (0.05)	Ns	1.95*	Ns

#### 4.0 Conclusion and Recommendations

The results indicated that animal manure contain essential plant nutrient elements of Calcium (Ca), Potassium (K), Nitrogen (N), Phosphorous (P) and contain high organic carbon. The results also indicated that the application of animal manure improve the yield of maize. Pig manure produced the highest yield while Goat manure produced the lowest. The trends were: pig (4.10 t ha<sup>-1</sup> at 3 t ha<sup>-1</sup>) > poultry manure (3.21 t ha<sup>-1</sup> at 3.0 t ha<sup>-1</sup>) > goat manure ( 3.21 t ha<sup>-1</sup> at 3 t ha<sup>-1</sup>), and yield increased with increasing rates of applications. Therefore, these rates are recommended to be used on coastal plain soils.

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