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Soil Fertility Maintenance in Late Season Plaintain Production Using Poultry Manure and Time of Planting in Owerri, Southeastern Nigeria

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Abstract

Soil fertility management on small-scale farms in the tropics is of major concern given the spate of continued land degradation in the area. This experiment was carried out at the Federal University of Technology, Owerri, Teaching and Research Farm, in 2012 late season planting and continued until 2015 to determine the optimum manure rate that will increase soil fertility as well as enhance late season plantain cultivation in Owerri area of Southeastern Nigeria. The experiment was a 3x4 factorial fitted into a randomized complete block design replicated three times. The treatments were three late season months (September, October and November) and four poultry manure rates (0, 4, 8 and 12 t ha^{-1}). The pre and post planting soil fertility characteristics and yield data were collected and statistically analyzed. The post planting soil chemical analysis showed an increase in soil pH from5.30 to 6.07, 5.59 to 5.67 and 5.73 to 5.72 for September, October and November respectively. Increase were recorded in organic matter (2.098 - 2.098, 2.476 - 2.373 and 2.240 - 2.201 %), calcium (7.03 - 10.20, 3.60 - 6.40 and 5.40 - 5.70 l/kg), phosphorous (21.39 - 20.86, 20.20 - 18.80 and 14.60 - 13.90 ppm) and magnesium (0.67 - 2.00, 0.83 - 1.17 and 0.83 - 1.00 Cmol) in the treatment that received 8 and12 t ha^{-1} poultry manure in September, October and November planting respectively. The residual effect of poultry manure resulted in increased yield (8.6, 7.2 and 7.0 kg) of the first ratoon crop in September, October, and November planting that received 12 t ha^{-1} poultry manure, respectively. Plantain manured with 12 t ha-^{1} poultry manure in September production significantly (p = 0.05) improved the soil and enhanced plantain yield (9.2 kg in plant crop, 8.6 first ratoon) in Owerri area of Southeastern Nigeria.

Keywords: *Late season plantain, organic manure production, soil fertility regeneration, tropics*

1.0 Introduction

Plantain (Musa AAB group), a giant ratooning perennial plant of genus Musa and of family Musaceae is an important food crop in the humid tropics of sub-Sahara Africa including South Eastern Nigeria. Plantain provides more than 25 % of the carbohydrate and 10 % of calorie intake of approximately 70 million people thus making the crop one of the most important sources of calories in the region. (Nweke, 1996; Vuysleke, 2001.) Plantain requires large amount of nutrient element to maintain high yields, however soil fertility management on small scale farms in the tropics has become a major issue as a result of intensive cropping. The decline of plantain crop yield under continuous cultivation despite the use of inorganic fertilizer has

been attributed to such factors as acidification, soil compaction and loss of soil organic matter (Juo et al., 1995). In addition inorganic fertilizers are either expensive or scarce. In contrast, organic fertilizer are not only affordable, they can readily be sourced. They provide growth regulatory substances and improve the physical, chemical and microbial properties of soils (Belay et al., 2001) Cooke,(2002) reported that when organic manure is applied in sufficient quantity to the soil it would supply all the necessary primary and secondary nutrients required for crop growth. Dekissa *et al*., (2008) stated that poultry manure add organic matter to the soil which improves structure, nutrient retention, aeration, soil moisture holding capacity and water infiltration. Ayeni, (2011) also reported that Poultry manure is an important source of plant nutrient and in addition to releasing nutrients is very rich in organic matter which improves the physical properties of soil. Ibeawuchi *et al*., (2006) reported that poultry manure increased residual soil N, K, Ca, Mg and organic matter on a degraded soil.

Addition of organic amendments such as poultry manure to the soil is not only economical but a management necessity needed to reverse the current ugly trend of soil physical, chemical and biological degradation (Obi & Ebo 1995).

1.1 Objective of the Study

The objective of this research was to determine the optimum manure rate required to increase soil fertility and enhance the yield of late season plantain in Owerri area of Southeastern Nigeria.

2.0 Materials and Methods

2.1 Study Area

The field experiment was conducted between September 2012 and July 2015 at the Teaching and Research farm, Federal University of Technology Owerri, Nigeria. Latitude 5^0 30' N, Longitude 7^o 10' E and altitude 55.7 m above sea level. The climate of the area is characterized by wet and dry seasons which are influenced by the effect of the humid maritime air mass. The mean annual rainfall is about 2,500 mm and is bimodal with peaks in July and September. It has a temperature range of 20 to 32 ^{0}C. Soils are mainly dominated by ultisols characterized by deep porous red soils derived from sandy deposits in the coastal plain which are highly weathered, coarse textured, low in mineral reserve and natural fertility (Onweremadu *et al*., 2007).

2.2 Land Preparation

The field with an area of 0.12 ha was manually cleared stumped and its trash was packed. Experimental plots of 6 m x 4 m with 0.5 m inter plot and 1m inter block alleys were marked out with tapes, pegs and rope. Planting holes measuring 60.0 x 60.0 x 60.0 cm were carefully dug out separating top soil from sub soil. Each plot contained 9 plantain stands spaced at 3.0 x 2.0 m. The middle plants from each plot were sampled for data collection.

2.3 Experimental Design

The experiment was a 3 x 4 factorial in randomized complete block Design and replicated three times. The factors were time of planting at three levels namely: September, October and November and Poultry manure applied at four rates namely: 0, 4, 8, and 12 t ha^{-1}. These gave 12 treatment combination which were randomly allocated within each block

2.4 Cultural Operation

Cured poultry manure rates for each treatment was divided into two equal parts. The first dose was applied in appropriate planting hole one week before planting. The second dose of the manure was placed around each plant at 8 months after planting (MAP). The plantain planting materials were late sword suckers obtained from FUTO Genetic resource unit. Planting was carried out in September, October and November. Weeding was done manually by slashing the alleys while clean ring weeding was adopted within 50 cm diameter of each plantain stand at six weekly intervals. Insects like termites, beetle and grasshoppers were identified but with minimal damage.

Harvesting of matured plantain was done from December 2013 to July 2015. This was done manually using matchet to cut the pseudo stem about 2/3, allowing the bunch to drop under its own weight. The rachis was held with the left hand and the bunch cut off from the stalk.

2.5 Data Collection

Data on soil nutrient content, flowering and fresh bunch weight (kg) were collected at different stages of the plantain growth. Soil samples were randomly collected from the experimental site using soil auger from a depth of 0-30 cm, bulked, air dried and analysed for soil nutrient content at the beginning of the experiment. After crop harvest, soil samples were collected for chemical analysis to evaluate the current and residual effect of poultry manure on the soil. The soil analysis were conducted using procedures as outlined in IITA (1992). Days to 50 % flowering was taken by counting the number of days within which 50 % of the plantain in each treatment flowered. It was recorded at anthesis for each plant and 1st ratoon crop. The bunch weight (kg) for both plant and first ratoon crop was taken at harvest. The peduncle was cut off from the stalk and the fresh plantain bunch weighed using a 50 kg salter weighing balance and recorded per plant according to treatments.

2.6 Statistical Analysis

All data were subjected to analysis of variance and means separated with LSD at 5 % level probability using Genstat 2005 version.

3.0 Results

3.1 Soil Nutrient Status

The soil nutrient status under the various treatments (Table 1) showed marked variation after the experiment when compared with the initial value. There was a general increase in soil pH values in all the treatments in September, October and November. The September plot treated with 12 t ha^{-1}poultry manure had the highest pH value of 6.07. The result also showed an increase in organic matter content in all the treatment when compared with the initial value before the experiment. However, the September plantain treated with 8 t ha^{-1} poultry manure recorded the highest soil organic matter value of 2.923 % while the least value1.464 % was recorded by November plantain that received zero poultry manure. There was also general increase in the available phosphorus, calcium and magnesium in the treatments that received poultry manure. Less value were obtained where poultry manure was not applied. However there was reduction in soil nitrogen in all the treatments when compared with the initial value.

Table 1 Soil Chemical Properties at the Beginning and End of the Experiments

	%O.M	%N	Pmg/kg	K cmol/kg	Ca cmol/kg	Mg cmol/kg	Na cmol/Kg	TEA Cmol/kg	AL Cmol/kg	PH(water)
Pre planting Soil Property After Corp Harvest Treatments Manure t ha -1	1.376	0.039	4.90	0.006	0.32	0.10	0.004	0.180	0.12	4.50
Sept. 0.0	1.468	0.018	8.25	0.0032	0.60	0.4	0.006	0.31	0.27	4.80
4.0	2.545	0.031	19.70	0.0046	3.00	0.87	0.007	0.3	0.08	5.88
8.0	2.098	0.04	21.39	0.0051	7.03	0.67	0.0074	0.52	0.41	5.60
12.0	2.098	0.021	20.86	0.0064	10.20	2.00	0.0074	0.52	0.41	6.07
Oct. 0.0	1.464	0.019	8.20	0.0031	0.59	0.25	0.0061	0.30	0.25	4.90
4.0	2.855	0.035	18.22	0.0044	2.40	0.50	0.0068	0.56	0.40	5.28
8.0	2.476	0.030	20.20	0.0082	3.60	0.83	0.0068	0.56	0.40	5.59
12.0	2.373	0.027	18.80	0.010	6.40	1.17	0.0069	0.367	0.12	5.67
Nov. 0.0	1.465	0.017	8.24	0.0033	0.65	0.55	0.0061	0.158	0.28	4.70
4.0	2.236	0.024	17.60	0.004	4.5	0.85	0.007	0.283	0.08	5.78
8.0	2.240	0.025	18.60	0.0041	5.4	0.83	0.0074	0.27	0.07	5.73
12.0	2.201	0.023	17.90	0.0066	5.7	1.00	0.0074	0.6	0.08	5.72
$LSD_{0.005}$ Poultrymanure	0.0127	0.0016	0.1372	0.0064	0.169	0.1022	0.0010	0.0687	0.0851	.0934
$LSD_{0.005}$ Planting time	0.0110	0.014	0.1188	0.0056	0.1465	0.0885	0.0009	0.0595	0.0737	0.0809
$LSD_{0.005}$ PM x Planting	0.022	0.0028	0.2377	0.0011	0.2931	0.1769	0.0018	0.119	0.1474	0.1618

3.2 Days to Flowering and Fresh Bunch Weight Plants

Time of planting and manure rates significantly influenced the number of days to 50 % flowering in plantain. Planting plantain without manure prolonged the number of days to 50 % flowering. The plantain planted in September with 12 t ha-1 took significantly lesser days (313) to attain 50 % flowering than those

planted in November with 12 t ha^{-1} poultry manure (329). There was significant increase in yield of plantain bunch with time of planting and increased manure rate. The plantain planted in September had heavier bunch weight (yield) (0.8, 4.7. 8.6 and 9.2 kg/ha) than all others planted in October and November. The yield of plantain increased as manure rate increase but reduced significantly in plantain without manure application.

Table 2: Days to 50% Flowering and Fresh Bunch Weight (kg) in Crop Plant and First Ratoon Plantain as affected by Planting Time and Poultry Manure Rates

Time of planting	Poultry Manure Rate 0	4	8	12	Mean
			50% Flowering Crop Plant		
September	493	399.7	343.3	313.3	387.33
October	459	390	335.3	327	377.81
November	438.3	398.3	338.0	329	375.9
Mean	463.4	396	338.9	323.1	
			Ratoon Crop		
September	522.7	402.3	351.0	307.7	395.9
October	526	397.3	339	329.7	398.5
November	516.7	402.7	345.3	317.8	395.42
Mean	521.8	400.7	345.1	318.4	
			Bunch Weight Crop Plant		
September	0.8	4.7	8.6	9.2	5.8
October	0.4	4.3	5.7	6.0	4.1
November	0.2	3.0	4.9	5.8	3.46
Mean	0.47	4.0	6.4	7.0	
			Ratoon Crop		
September	0.6	3.5	8.0	8.6	5.12
October	0.3	3.4	6.0	7.2	4.23
November	0.2	3.0	5.8	7.0	4.0
Mean	0.37	3.3	6.6	7.6	

		50 % Flowering		Bunch Weight	
		Crop plant	1st Ratoon	crop plant	1st Ratoon
$LSD_{(0.05)}$ for planting times	=	6.55	3.3	0.59	0.22
$LSD_{(0.05)}$ for poultry manure rate	=	7.56	3.8	0.68	0.25
$LSD_{(0.05)}$ for planting x P. manure rate		13.10	6.6	1.07	0.44

4.0 Discussion

Fertility indices showed that the soil was acidic and low in fertility. This confirms earlier work which reported that soils in Rivers, Abia, Akwa Ibom and Imo states are in group H, characterized by low pH, low organic carbon and low exchangeable cations and bases. This acidic nature of soil is a critical factor (Onweremadu *et al*., 2007.) militating against increased crop productivity especially plantain. The general increase in soil pH and exchangeable cations obtained from post-harvest analysis is attributed to poultry

manure application. Hsich and Hsu (1993), Jinadasa *et al*., (1997) and Pitram and Singh (1993) similarly reported that poultry manure increased pH of the soil and thus neutralized the soil acidity. Bessho and Bell (1992) have also noted that the ability of organic manure to increase soil pH was due to the presence of basic cations contained in the organic manure. The observed increase in organic carbon, organic matter and exchangeable cations are indicative of a high residual effect that can sustain a second ratoon crop of plantain. Hisch and Hsu (1993) and Jinadasa *et al*., (1997) have equally reported that the residual effect of poultry manure could last into the third and fourth year of cropping.

Leaf area and leaf area index for all the manured treatments appeared higher in the man5ured treatments than the zero manure treatments at 8MAP and harvest. This vigorous leaf growth and expansion in the manured treatments resulted in high leaf area which confirmed that poultry manure is richly endowed with nitrogen needed for leaf expansion which helped in attracting more light energy needed for photosynthesis. This is in line with work done by Ewulo, (2005) who reported that poultry manure contains high percentage of nitrogen and phosphorous for the healthy growth of plants.

Days to 50 % flowering in treatments that received no poultry manure were significantly prolonged. This is attributed to nutrient stress which also caused poor floral initiation. Plants in plots that received 12 t ha^{-1} of poultry manure flowered early allowing more time to fill up the bunch and consequently gave very high fresh bunch yield of plantain (9.2, 6.0 and 5.8 kg) in the various months of late season planting (September, October and November) respectively. The absence of poultry manure impacted negatively on plantain fresh bunch yield in the treatment that received zero poultry manure. This suggested that poultry manure supplied the basic nutrient needed for growth and yield of the plantain. This is in line with Adejoro (1999) and Gupta *et al.*, (1997) who reported that poultry manure is very rich in nutrients that will boost crop growth and yield. Earlier work by Smith *et al.*, 2001 who reported that use of poultry manure as a means of boosting soil fertility is economically justified.

5.0 Conclusion

The post- harvest soil analysis revealed that poultry manure increased soil pH of soil samples from plots that received poultry manure. Thus the addition of poultry manure served as soil amendment and nutrient source which enhanced the growth and yield of late season plantain. The application of 8-12 t ha^{-1}poultry manure accelerated plantain maturity irrespective of the time of panting. Plantain planted in September, October and November, that received 12 t ha^{-1} poultry manure produced significantly ($p = 0.05$) high yield. However, application of 12 t ha^{-1} poultry manure in September produced significantly ($p = 0.05$) higher yield and improved soil pH and fertility in the humid tropics of Southeastern Nigeria.

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