Original Research Article

INFLUENCE OF POULTRY DROPPINGS ONSOIL CHEMICAL PROPERTIES AND PERFORMANCE OF RICE (*Oriza Sativa* L.) IN SOKOTO,SUDAN SAVANNA ZONE OF NIGERIA.

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Abstract

Proper management of poultry manure could serve as a sustainable source of fertilizer for increased rice production inSokotoState of Nigeria. As a result,anexperiment was conducted in ascreen house at the Botanical Garden, Biological Science Department of the Sokoto State Polytechnic,to determine the influence of poultry dropping on some chemical properties of soil and performance of rice(*OrizaSativa* L.). The treatments consisted of three levels of poultry dropping: 2, 5 and 10tha^{-1} and a control (without fertilizer). The experiment was laid in a completely randomized design (CRD) replicated three times. Plant parameters like plant height, number of tillers and number of leaves were taken fortnightly until harvest at 16th week after planting (WAP). Grain and stalk yield were taken at harvest. The nutrient composition of the soil samples and poultry droppings used was determined using standard laboratory procedures. The resultrevealed that application of poultry manure had significant (P>0.05) effect on soil organic carbon, available phosphorus, exchangeable bases(Ca, Mg, K, Na), CEC andrice performance in which application of 10 tha^{-1}recorded the highest rice stalk and grain yield.This research therefore, concluded that application of poultry dropping is an important means of improving soil fertility and that, application of 10tha^{-1} can bring about high growth performance and yield of rice in the study area.

Key words: Poultry Droppings, Levels, Soil, Rice and Sudan savanna

INTRODUCTION

Farming is the main occupation of people of Sokoto State of Nigeria and mostly, they grow cereal and vegetable crops. One of the major cereal crops grown in this area is rice. Rice belongs to the grass family poaceae from the genus Oryza of which two species (*Oryza sativa* and *Oryzaglaberima)* are cultivated. It is normally grown as annual plant in the tropical areas; it can survive as a perennial crop (IRRI, 2008). Rice is the staple food of over half of the world population and provides 20% of the world dietary energy supply, compare to wheat 19 and maize 5% (FAO, 2004). In Nigeria, rice is a major cereal crop consumed by over 120 million population of the country (EIARD, 2013), placing a high demand for this crop. However, production of rice requires fertile soil that are rich in nutrients, and soils of the Sudan savanna are constrained by erosion, degradation of physical condition, deterioration of nutrient status and changes in the composition and number of soil organisms (Ogunwole*et al.*, 2005; Adeniyan, 2008) which limit their productivity. Usman*et al.* (2007) stated that soils of the savanna region of Nigeria are relatively low in nutrients and organic matter content. Thus, application of fertilizers either in organic or inorganic form could be a sure way of meeting nutrient requirements for high productivity of rice in Sokoto state of Nigeria. However, short supply and high cost of fertilizers during the growing season are the major limitations to small holder farmers in this region (Sobulo and Osiname, 1985, Maobe*et al*., 2000). Therefore, the need to explore alternative sources of nutrient supply remains imperative.

It has been established that organic manure can serve as alternative practice to mineral fertilizers (Naeem*et al.*, 2006) for improving soil structure (Dauda*et al.*, 2008) and microbial biomass (Suresh *et al.*, 2004). Organic manure application on the farm has yielded good response of crops and residual effect on soils. Agboola and Obatolu (1989), Lombin*et al.* (1991), Ojeniyi and Adeniyan (1999), and Kwari (2003) have all demonstrated the use of organic manure as a sound strategy for maintaining soil fertility and crop productivity. Akanni (2005) mentioned that manure application improved organic matter (OM), N, P and exchangeable cation concentration of soil that could benefit growing crops. Poultry manure had been reported to improve growth and yield of maize (Ezeibekwe*et al*., 2009). It also improves the chemical and biological qualities of the soil which increases crop productivity than chemical fertilizers (Obi and Ebo,1995). In a similar way, Agbede*et al.* (2008) reported that application of poultry manure (7.5t/ha)increased growth parameter (plant height, stem girth, leaf area) of sorghum in south-west Nigeria. Further, Boateng*et al.* (2006) also reported increased in maize plant height due to organic fertilizer (poultry manure) in Ghana.

Livestock production is one of the major occupation of the people of Sokoto State of Nigeria and therefore relative availability of animal and poultry wastes in the area (Okafor, 1999), but are poorly managed for effective utilization due to lack of scientific basis for advising farmers on aspects such as appropriate application rates, storage techniques and application methods (Maerere, 2001). Adeboye*et al.* (2006) suggested that researches on soil fertility should be focused on locally available and affordable internally sourced materials to improve the production of cereals which are important in the diets of millions of people in the Nigeria.

In order to supply food for steadily increasing human population from fixed or limited land resources, improvement in existing management practices is essential through the use of locally available and affordable resources. This can be achieved through proper rate of nutrient selection which depends on the knowledge of nutrient supplying power of the soil and on which the crop is to be grown (Tisdale *et al*., 2003). This study was therefore conceived to determine the influence of poultry dropping on soil chemical properties and performance of rice in Sokoto, Sudan Savanna agro-ecological zone of Nigeria.

MATERIALS AND METHODS

Site Description

The experiment was conducted during the 2012/2013 dry season in a screen house at the Botanical Garden of the Biological Science Department, Sokoto State Polytechnic, Sokoto. Sokoto State is located between Latitudes 11^{o} 30^{1}N and 13^{o} 50^{1}N and Longitudes 4^{o} 0^{1}E and 6^{o} 0^{1}E, 315m above sea level. Sokoto falls in the Sudan savanna agro-ecological zone of Nigeria (Ojanuga, 2005) that is characterized by erratic and scanty rainfall that last for about four months (Mid June-September) and dry period (October- May). The annual rainfall of the area is highly variable over the years and averaged around 700mm (Singh, 1995) with minimum and maximum temperaturesof the year fluctuating between 15 and 40^{o}C, respectively (Arnborg,1988).

Screen House Procedure and Soil Analysis

The soil sample used for this experiment was collected from a fallow land within the Faculty of Agriculture Teaching and Research Lowland Farm, UsmanuDanfodiyo University, Sokoto, at 0-15cm depth. The soil was air dried, crushed and passed through a 2mm sieve. A sub-sample was analyzed for some physical and chemical properties using the methods described by IITA (1989). Particle size distribution was determined using the Buoyoucos hydrometer method. Soil pH was determined using glass electrode pH meter. Cation exchange capacity was determined by the neutral ammonium acetate saturation (NH_4OAC) method. Organic carbon was determined using Walkley and Black method. Exchangeable calcium and magnesium were determined using EDTA titration method, while exchangeable sodium and potassium was determined using flame photometer. Total N was determined using micro Kjeldahl digestion method, and available P was determined by Bray No.1 method.Seven and half (7.5 kg) kilograms each of the soil was placed in plastic container (10 L) according to the number of the treatments. Soil samples were also collected from each pot at harvest (16 WAP) and analyzed for pH, organic C, total nitrogen, available phosphorus, CEC and exchangeable bases contents. The poultry dropping used for the experiment was also analyzed for nitrogen, phosphorus and potassium contents.

Experimental Set-up, Data Collection and Analysis

Treatment consisted of three levels of poultry manure: 2, 5 and 10t ha^{-1} corresponding to 7.5g, 18.75g and 37.5 g in 7.5kg of soil per pot respectively and a control (without manure). An improved rice variety ($Faro_{44}$) was planted as a test crop. The experiment was laid in completely randomized design (CRD) replicated three times. The poultry dropping was mixed evenly with soil and watered to field capacity and allow for a period of one week before planting. Five seeds per pot were sown and latter thinned to three stands per pot at two weeks after planting. Weeds were controlled manually by hand picking and the plants were irrigated when necessary. Growth parameters, such as plant height, number of leaves and tillers per plant were recorded at 2 weeks interval. The crop was harvested 16 week after planting and some yield parameters were taken (stalk and grain yield). The data obtained were subjected to analysis of variance (ANOVA) using SAS (2003) procedure for CRD. Significant difference in the treatments means was further separated using least significant difference (LSD) (Gomez and Gomez, 1984).

RESULT AND DISCUSSION

Table 1: Initial Soil and Poultry Dropping Analysis

SoilParameters	Value
pH (H_2O) 1:1	7.01
Organic carbon (%)	2.87
Total nitrogen (%)	0.09
Available phosphorous ($mgkg^{-1}$)	0.99
Cation exchange capacity (CEC) ($Cmol\ kg^{-1}$)	9.42
Exchangeable bases ($Cmol\ kg^{-1}$)	
Calcium (Ca^{2+})	1.35
Magnesium (Mg^{2+})	0.55
Potassium (K^{+})	0.31
Sodium (Na^{+})	0.96
Sand (%) (9.0)	
Silt (%)	(5.0)
Clay (%)	(86.0)
Texture	Clay
Poultry Dropping	
Total nitrogen (%)	0.64
Available phosphorous ($mgkg^{-1}$)	1.68
Potassium ($Cmolkg^{-1}$)	0.54

Result of the initial physical and chemical propertiesof the soil is presented in Table 1. The result indicated that organic carbon content of the soil was high while, total nitrogen, and available phosphorus was very low (Table 1). Exchangeable potassium and sodium were high while magnesium was moderate. Cation exchange capacity was moderate and exchangeable calcium was low based on the standard ratings of Esu (1991).

Table 2: Influence of Poultry Manure on Chemical Properties of Soil

 Exchangeable bases

Treatment	pH	OC	Total N	Avail. P	Ca	Mg	K	Na	CEC
		%		mg/kg	Cmol(+)kg^{-1}				
0	7.08	1.84c	0.08	0.41d	1.23c	0.56b	0.35b	0.55b	4.25b
2	7.15	2.49b	0.09	0.46c	1.44b	0.76a	0.56a	0.62b	4.70b
5	7.25	2.71ab	0.10	0.51b	1.65a	0.75a	0.55a	0.58b	5.45a
10	7.26	2.82a	0.12	0.57a	1.77a	0.84a	0.57a	0.75a	5.27a
SE	0.21	0.09	0.04	0.01	0.04	0.03	0.02	0.02	0.13
SIG.	NS	*	NS	*	*	*	*	*	*

Means followed by same letter (s)within the same raw are not significantly different at 5% level of probability.
NS=not significant.
*= significant at 5% level.

Influence of poultry dropping on chemical properties of soil is presented in Table 2. The result indicated that treatments had significant ($P<0.05$) effect on all the considered chemical parameters of the soil except pH and total nitrogen. However, increased in pH was recorded due to treatments application as compared to the initial values with the highest increase due to application of 10tha^{-1}, Application of 10tha^{-1}also gave the highest value of organic carbon, total N, available phosphorous, exchangeable bases and cation exchange capacity of the soil (2.82%, 0.12%, 0.57mg/kg, 1.77, 0.84, 0.57, 0.75 and 5.27cmol(+)kg^{-1}) respectively. This could be attributed to the influence of poultry dropping on soil fertility as it mineralized, resulting to an improvement in the soil condition and microbial activities. However, the least values were obtained in pots where no poultry dropping was applied(control). The result of this finding was similarly reported byBalasubramanian and Singh(1978) and Wild(1988) that, application of farm yard manure increased the availability of phosphorous in soil solution and reduced phosphorous adsorption in an experiment conducted on an Ultisol in Nigeria. Pierre and Morrean (1997) observed that the addition of farmyard manure combined with mulch had enhanced the physical properties of soil. The authors reported that moisture retention, water infiltration and cation exchange capacity in the soil improved following the application of organic matter (3 and 4 tons ha^{-1}) on a farmland. Poultry manure application is known to improve SOM, micro-nutrient status and micro-nutrient qualities of the soil (Maerere*et al.*,

2001;Adeniyan and Ojeniyi, 2003). Adesodun*et al.*(2005) found that application of poultry manure to soil increased soil organic matter, N and P contents and aggregate stability.

Table 3: Influence of Poultry Manure on Growth Performance and Yield of Rice at 16WAP

Treatment	Plant height (cm)	No. of leaves/plant	No. of tillers/plant	Stalk yield (g/pot)	Grainyield (g/pot)
0	35.94b	30.11c	8.50c	28.32b	3.20b
2	38.91ab	32.47bc	8.67c	32.55ab	4.35ab
5	46.99a	33.58b	10.17b	33.93ab	5.20ab
10	40.14ab	52.25a	15.59a	38.67a	6.32a
SE	1.58	1.88	0.63	1.10	0.30
SIG.	*	*	*	*	*

Means followed by same letter (s) are not significantly different at 5% level.
* significant at 5% level.

The effect of different levels of poultry droppingon growth and yield parameters of rice is presented in Table 3. The result shows that, levels of poultry dropping had significant effect ($p<0.05$) on plant height, number of leaves and number of tillers per plant.

Plant Height

Application of5tha^{-1}poultry dropping gave the highest (46.99cm) plantheight at 16WAP. However, this was statistically similar with application of 10 and 2tha^{-1}, while the lowest plant height (35.94cm) was recorded in pots without poultry dropping (control). This could be due to the availability of more nutrients by the plant throughout the growing period as stated by Farhad*et al*. (2009) that,increase in plant height with poultry manure application was mainly due tomore availability of nutrients by poultry manure throughout the growing season. These results are in accordance with the findings of Mitchell and Tu (2005) and Warren *et al*. (2006).

This result also corroborates with the report of Opara – Nadi*et al.*(2000) on increase in the height of maize treated with organic fertilizer. This indicates the significance of organic manure on this very

important growth parameter of plant. Furthermore, Awotundun*et al.*(2000) observed a similar increase in height of maize plant that had cow dung application. Kwari (2003) observed that the height of millet increased when 7.5 t ha^{-1} cattle manure was added to soil relative the control plots. The positive influence of organic manure on plant height is also consistent with the report of Arunah*et al*. (2007) who also observe that, the height of two sorghum varieties had significantly increased due to amendment of soil with quantities of organic materials that was applied at 2 – 4 t ha^{-1} in Zaria, Nigeria.

Number of Leaves and Tillers

Application of poultry dropping at 10tha^{-1} recorded the highest number of leaves and tillers per rice plant at 16WAP (52.25 and 15.59 respectively). While the lowest numbers of leaves (30.11) and tillers (8.50) were obtained from plants in the control pots. This could also be attributed to availability of the required plant nutrients in that treatment which helped in promoting the vegetative growth of the plants. This is in line with the findings of Akanni (2005) who reported that manure application improved organic matter, N, P and exchangeable cation concentration of soil that could benefit growing crops. In a similar way, Agbede*et al.* (2008) reported that application of 7.5tha^{-1} poultry manure increased growth parameters (plant height, stem girth, leaf area) of sorghum in south-west Nigeria.

Stalk and Grain Yield

Effect of levels of poultry dropping on stalk and grain yield of rice is presented in Table 3. The result indicated that, the treatments had significant effect ($p<0.05$) on stalk and grain yield.Application of 10tha^{-1} recorded the highest stalk and grain yield. This was similarly reported by Farhad*et al*. (2009) that, grain yield of spring maize was significantly affected by the application

of different levels of poultry manure. These results are in accordance with the findings of Boateng*et al*. (2006), Deksissa*et al*. (2008)and Ezeibekwe*et al.* (2009) that poultry manure significantly increased the grain yield of maize in Ghana.

Conclusion

This research revealed that application of different levels of poultry dropping on soils under rice production has significant effect on soil organic carbon,available phosphorus,exchangeable bases and CECstatus of the soil. In addition, application of $10tha^{-1}$of poultry dropping could give a high growth performance and yield of rice in the study area.

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