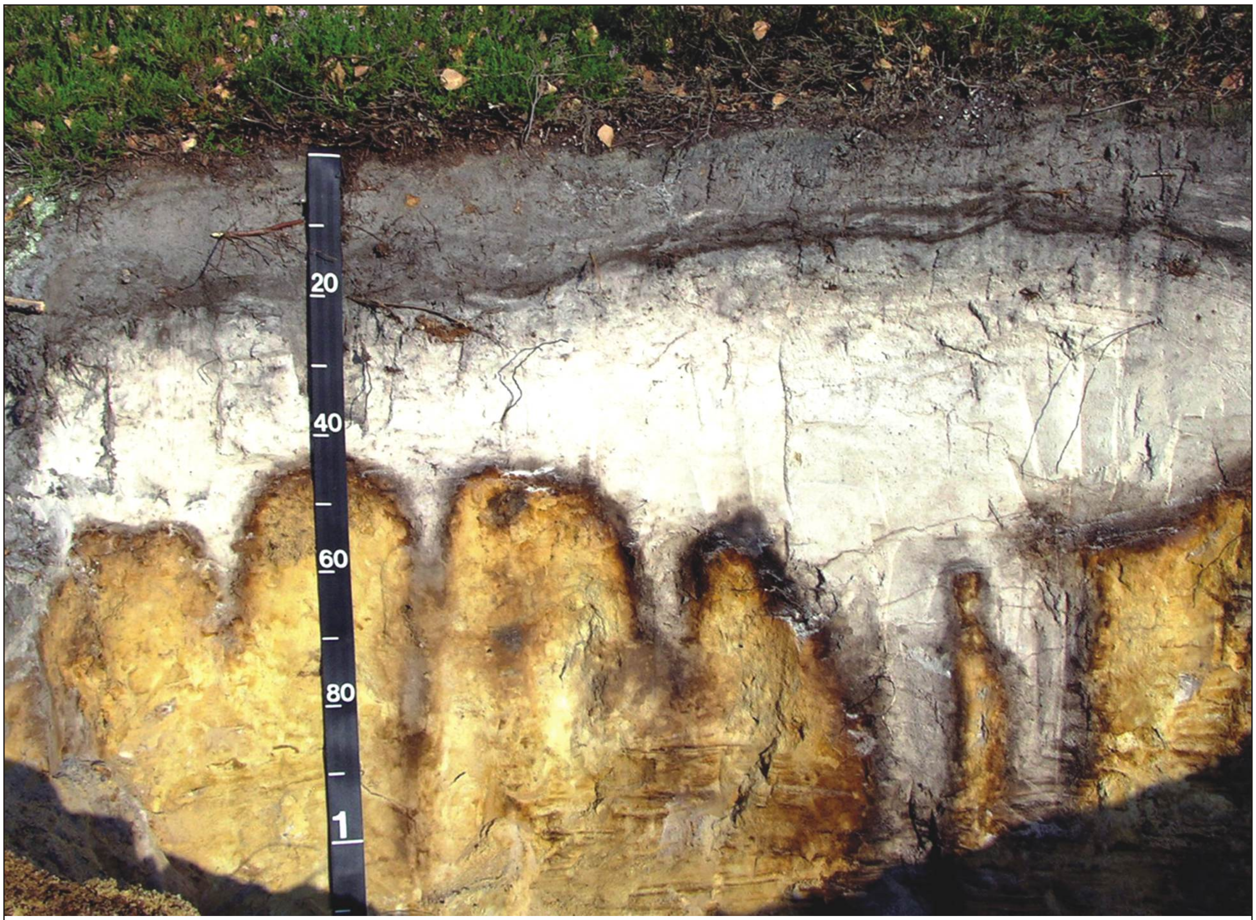

International Journal of

Soil Science

ISSN 1816-4978

Academic
Journals Inc.

www.academicjournals.com

International Journal of Soil Science 2 (2): 154-158, 2007
ISSN 1816-4978

Effect of Poultry Manure Rates on Soil Acidity in an Ultisol

[1]C.I. Duruigbo, [1]J.C. Obiefuna and [2]E.U. Onweremadu
[1]Department of Crop Science and Technology,
[2]Department of Soil Science and Technology,
Federal University of Technology, Owerri, Nigeria

Abstract: This study was conducted to determine the effect of poultry manure rates on soil acidity at the Federal University of Technology Research Farm Owerri. The experiment was laid out in randomized complete block design with three replications. Four poultry manure rates namely: 0, 5, 10 and 15 t ha^{-1} were used in the study. The soil physical and chemical status before and after application of poultry manure were analyzed. The chemical compositions of the poultry manure was analyzed. All data collected was subjected to analysis of variance according to the General linear model in statistical analysis software (SAS). Results indicated that application of poultry manure at the rate of 15 t ha^{-1} significantly increased soil pH from 4.14±0.9 (control) to 5.80±0.23 (pH in water) and from 3.62±0.13 to 5.78±0.18 (pH in KCl), respectively. Poultry manure rate of 5 t ha^{-1} did not significantly increase soil pH.

Key words: Poultry manure rates, soil acidity, ultisol

INTRODUCTION

Soil acidity is a major factor influencing the natural distribution of crops, macro and micro fauna and micro-flora. The adverse effects of soil acidity on plant nutrition and soil quality are usually the deficiency of essential plant nutrients such as calcium, magnesium and phosphorus as well as toxicity of micro-elements such as Al, Fe and Mn (Obi and Ekperigin, 2001). Two major types of acid soils limit food production in Nigeria - the leached acid soils (Ferrallitic soils with (pH 4.5) in high rainfall areas of the south and the drained acid sulphate soils (pH 3.5) of the Niger Delta areas.

In the humid forest zones, the major upland soils kaolinitic ultisols and oxisols are strongly weathered (Van Wambeke, 1991; Juo and Wilding, 1996). Both ultisols and oxisols are acidic and thus contain very low levels of mineral nutrients such as Ca, Mg, K and P.

The conventional liming materials such as calcium carbonate and calcium oxide are not only scarce and expensive but have been found to be environmentally unsafe for crop growth and yield (Ano and Agwu, 2004). There is need to focus research on development of locally adapted indigenous and sustainable way of managing soil acidity.

Agboola *et al*. (1975), reported that there is reduced acidification and increased contents of exchangeable cations when poultry manure is added to the soil, thus enhancing crop root growth and uptake of phosporus. The superiority of poultry manure over other organic manures has been confirmed by Follet *et al*. (1995), as well as Hsich and Hsu (1993).

Jinadasa *et al*. (1997), have reported that poultry manure applications increased soil pH, organic matter content, available phosphorus, exchangeable cations and micronutrients and decreased soil salinity and extractable iron. Pitram and Singh (1993) also reported that the application of agricultural waste (poultry manure) to an acid inceptisol increased the soil pH.

Corresponding Author: C.I. Duruigbo, Department of Crop Science and Technology,
Federal University of Technology, Owerri, Nigeria

The objective of this study is to evaluate the effect of four rates of poultry manure on soil acidity as well as to determine the chemical properties of the poultry manure that influence soil acidity. The study will also determine the optimum poultry manure rate that will neutralize soil acidity in an ultisol.

MATERIALS AND METHODS

Soil Analysis

The soil used in this study was an ultisol characterized by deep porous red soils derived from sandy deposits in the coastal plain, collected from the Federal University of Technology Teaching and Research Farm Owerri during the 2001 cropping season.

Before application of poultry manure, bulked soil samples were collected randomly from the experimental site using a soil auger, from a depth of 0-15 cm (top soil) and 15-30 cm (sub soil) for determination of soil physical and chemical properties, including the soil acidity status. The collected soil samples were air-dried in the laboratory, ground and sieved using a 2 mm mesh size sieve pan. The particle size fraction was determined by the hydrometer method of Bouyoucos (1951), using sodium hexa-metaphosphate as a dispersant

The soil pH was determined in distilled water and in KCI on a ratio of 1::2.5 soil/solution using the pH meter. The soil acidity status was also determined after application of poultry manure in 2001.

Organic carbon contents of the soil was ascertained using 2 g sample and by the dichromate wet oxidation method of Walkley and Black as outlined by Jackson (1969). The total nitrogen content of the soil was determined using the modified macro-Kjedahl method (Jackson, 1969) by crushing and sieving soil samples through a 0.5 mm mesh. The Bray-No. 2 method was used to extract available phosphorus while exchangeable cations were determined on extracts obtained after leaching samples with IN neutral ammonium acetate solution (Bray and Kurtz, 1945). Exchangeable potassium and sodium contents were estimated by the flame photometer while calcium and magnesium contents were determined by the versenate titration method. Effective cation exchange capacity was obtained by summation of exchangeable cations and acidity (IITA, 1979). The exchangeable acidity was determined by IN KCI extraction procedure as outlined by Mclean (1965). The percent base saturation was determined by expressing the sum of the exchangeable cations as a percentage of the ECEC values. The soil physical and chemical properties were also analysed after application of poultry manure using the methods outlined above after 21 days incubation period.

Analysis of the Poultry Manure

Samples of the cured poultry manure were collected randomly from the bulk, air-dried in the laboratory under room temperature for 3 days. The determination of the chemical nutrient contails was done as described above for the soil. Results are shown in Table 1. Analysis of variance was performed according to the General Linear Model procedure in Statistical Analysis System SAS (1998). Means were separated using the least significant differences at the 5% level of probability.

Table 1: Chemical properties of the poultry manure used in the experiment

Nutrient elements	Content (%)
Magnesium (Mg^{2+})	1.95
Calcium (Ca^{2+})	6.95
Potassium (K^{+})	0.52
Sodium (Na^{+})	0.20
Phosphorus (P)	1.30
Nitrogen (N)	1.37
Organic carbon (C)	21.15
Organic matter (OM)	50.53

Incorporation of the Poultry Manure

The four poultry manure rates namely 0, 8, 16 and 24 kg plot^{-1}, respectively were weighed out using a weighing balance and applied manually by broadcasting uniformly on experiential plots of 4×4 m and tilled into a depth of 0.30 cm using the garden fork. For control plots, no poultry manure was applied. The post-soil physical and chemical analysis was carried out after 21 days of applying poultry manure. The experimental design was the Randomized Complete Block Design with three replications.

RESULTS AND DISCUSSION

The soil physical and chemical properties before application of poultry manure are shown in Table 2. The soil pH in water was 4.7 (top soil) and 4.8 (subsoil) while the soil pH in KCI was 4.6 (top soil) and 4.5 (sub soil) which indicates high soil acidity. The low ECEC of less than 10 meq/100 g soil) and low base saturation suggest the dominance of 1:1 clays and high level of aluminium. Generally, the low soil organic carbon, total nitrogen and organic matter contents indicates poor soil fertility. The soil is of sandy loam textural class, thus confirming similar observations by Jungerius (1964), Ofomata (1975) and Ononiwu (1990). Table 3 shows the soil physical and chemical properties after poultry manure applications. Results indicated that there are significant differences ($p = 0.05$) in the soil pH among the various treatments and control.

Statistical analysis indicated that the soil pH in water and in KCl were significantly ($p = 0.0001$) affected by application of poultry manure.

The 15 t ha^{-1} poultry manure rate significantly ($p = 0.0001$) reduced soil pH from 4.14±0.09 (control) to 5.80±0.23 (pH in water) and from 3.62±0.13 to 5.73±0.18 (pH in KCl), respectively. The 5 t ha^{-1} did not significantly ($p = 0.0001$) reduce soil pH, however the 10 t ha^{-1} poultry manure significantly ($p = 0.0001$) reduced soil pH from 4.14±0.09 (control) to 5.20±0.19 (pH in KCl). This increase in soil pH with increased poultry manure rate of application as observed in this study agrees with Pitram and Singh (1993), who reported an increase in soil pH with the application of poultry manure. The mechanism responsible for this increase in soil pH was due to ion exchange reactions which occur when terminal OH^- of Al or Fe^{2+} hydroxyl oxides are replaced by organic anions which are decomposition products of the manure such as malate, citrate and tartrate (Besho and Bell, 1992;

Table 2: Soil physical and chemical properties before poultry manure application

Properties	Soil horizon: Top soil (0-15 CM)	Sub-soil (15-30 CM)
pH in Water (1:2.5 soil/water)	4.70	45.80
pH in KCl (1:2.5 soil/KCl)	4.60	4.50
Percent organic carbon	1.75	0.99
Total nitrogen (%)	0.08	0.06
Available phosphorus (PPM)	9.50	7.60
Total exchangeable base		
Calcium (meg/100 g soil)	1.55	0.70
Magnesium (meq/100 g soil)	1.54	0.85
Potassium (meq/100 g soil	0.04	0.03
Sodium (meg/100 g soil)	0.003	0.02
Total exchangeable acidity	2.00	1.62
E.C.E.C	3.14	2.40
Base saturation (%)	54.00	50.00
Percent silt (%)	3.00	5.00
Percent clay (%)	14.00	15.00
Percent sand (%)	83.00	80.00
Soil textural class		Loamy sand

Table 3: Physico-chemical properties of the soil after poultry manure application

Soil physical and chemical properties	Poultry manure levels (t ha^{-1}) 0	5	10	15	LSD (0.05)	Pr>F
pH in water (1:2.5 soil/water)	4.14±0.09	4.93±0.14	5.20+0.19	5.80±0.23	0.43	0.001
pH in HC (1:2.5soil/ACl)	3.62±0.13	4.61±0.11	5.30+0.14	5.73±0.18	0.33	0.001
Exch. H^+ (meq/100 g soil).	0.72±0.04	0.81+0.01	0.80+0.02	0.82±0.03	0.07	0.0001
Exch. Al^{3+} (meq/100 g soil)	2.91±0.10	3.10+0.06	3.26+0.13	3.50±0.16	0.23	0.0001
Exch. Acidity (meq/100 g soil)	3.78±0.09	3.89+0.16	3.60±0.13	3.78±0.08	0.29	ns
Exchangeable bases						
Exch. Ca^{2+} (meq/100 g soil).	0.37±0.02	0.42+0.02	0.40±0.02	0.41+0.02	0.05	ns
Exch. Ng^{2+} (meq/100 g soil)	0.63±0.03	0.94+0.06	1.25±0.13	1.19±0.11	0.21	0.0001
Exch. Na^+ (meq/100 g soil)	1.47±0.08	1.73+0.04	1.77±0.10	1.181±0.03	0.13	0.0001
Exch. K^+ (Meq/100 g soil)	0.17±0.08	0.33+0.11	0.54±0.10	0.62±0.09	0.21	0.0001
Total Exch. bases (Meq/100 g soil)	3.8±0.57	4.97+0.63	5.48±0.59	5.85±0.54	0.91	0.0001

Van *et al*., 1996; Pocknee and Summer, 1997; Hue and Amiens, 1989). The ability of organic manure to increase soil pH was due to the presence of basic cations contained in the poultry manure. Natsher and Schwetnmann (1991) reported that such basic cations are released upon microbial decarboxylyation. It may thus be recommended that use of 15 t ha^{-1} poultry manure will reduce soil acidity to near neutrality in an ultisol to enhance nutrient availability and uptake by crops.

REFERENCES

Agboola, A.A., G.O. Obigbesan and A.A. Fayemi, 1975. Interrelations between organic and mineral fertilizers in the tropical rainforest of Western Nigeria. FAO Soils Bull., 27: 337-365.

Ano, A.O. and J.A. Agwu, 2004. Effect of Application of Animal Manures on Soil pH. 2004 Ann. Rept of National Root Crops Res. Institute Umudike Nigeria, pp: 17.

Bessho, T. and L.C. Bell, 1992. Soil and Solution Phase Changes and Mung Bean Response During Amelioration of Aluminium Toxicity Organic Matter. Plant and Soil, pp: 140: 183-196.

Bouyoucos, G.H., 1951. A recalibration of the hydrometer for making mechanical analysis of soils. Agron. J., 43: 434-438.

Bray, R.H. and L.T. Kurtz, 1945. Determination of total organic and available forms of phosphorus. Soil Sci., 59: 39-45.

Follet, R.H., L.S. Murphy and R.L. Donahue, 1995. Fertilizers and Soil Amendments. Prentice Hill Inc. Englewood Cliffs, USA., pp: 250.

Hsich, C.F. and K.N. Hsu, 1993. An experiment on the organic farming of sweet corn and vegetable soya beans. Bull Taichung District Agric. Improvement State, 39: 29-39.

Hue, N.V. and I. Amiens, 1989. Aluminum detoxification with green manures Comm. Soil Sci. Plant Anal., 20: 1499-1511.

International Institute of Tropical Agriculture (IITA), 1979. Annual Report for 1978, IITA Ibadan, Nigeria.

Jackson, D.L., 1969. Effect of water, light and nutrition in flower bud initiation in apricots. Aust. J. Biol. Sci., 22: 69-75.

Jinadasa, K.B., P.N. Milham, C.A. Hawkins, P.S. Cornish, P.A. Williams, C.J. Kaldo and J.P. Conroy, 1997. Survey of cadmium levels in vegetables and soils of Greater Sydney. Aust. J. Environ. Qual., 26: 924-933.

Jungerius, P.O., 1964. The soils of Eastern Nigeria. Publicities van let Fysisch Geogra Fish laboratium van No. 4:1964, pp: 185-198.

Juo, A.S.R. and L.P. Wilding, 1996. Soils of the Lowland Forests of West and Central Africa. In: Essays on the Ecology of the Guinea-Congo Rain Forest. Proc. R. Soc. of Edingburgh. 104B. Edinburgh Scotland UK., pp: 15-26.

Mclean, E.O., 1965. Aluminum. In: Methods of Soil Analysis Agron Monograph. Black, C.A. (Ed.), No. 9: Part 2. American Society. Madison, Wisconsin, pp: 978-998.

Natsher and Schwetmann, 1991. Proton buffering in organic horizons of acid forest soils. Genderman, 48: 93-106.

Obi, O.A. and J. Ekperigin, 2001. Effect of wastes and soil pH on growth and yield of crops. African Soils, 32: 33-15.

Ofomata, G.E.K., 1975. Nigerian in Maps: Eastern. Ethiopie Publications House, Benin City Nigeria.

Ononiwu, N., 1990. The Physico-Chemical Properties of Soils and Associated Cropping/Land Use Systems in Ezi Obodo Village Owerri, Nigeria. Unpublished B. Agric. Tech. Project. School of Agric and Agric. Tech. Federal University of Technology Owerri (F.U.T.O).

Pocknee, S. and E. Summer, 1997. Cation and nitrogen contents of organic matter determines its liming potential. Soil Sci. Soc. Am. J., 61: 86-96.

Pitram, S. and K.A. Singh, 1993. Effect of continuous application of manure and nitrogenous fertilizer on some properties of acid Inceptisol. J. Indian Soc. Soil Sci., 41: 430-433.

Statistical Analysis System (SAS), 1998. SAS Users Guide Com. N.C. Statistical Analysis Institute, pp: 256.

Van, F., S. Schubert and K. Mengel, 1996. Soil pH increase due to biological decarboxylaton of organic anions. Soil Biol. Biochem., 28: 6,617-624.

Van Wambeke, A., 1991. Soils of the Tropics: Properties and Appraisal. McGraw Hill, New York USA.