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EFFECT OF COMBINED APPLICATION OF FORTIFIED POULTRY MANURE WITH ASH AND NPK FERTILIZER ON SOME SOIL PROPERTIES IN SOKOTO, NIGERIA

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ABSTRACT

A field trial was conducted to determine the effect of combined application of fortified poultry manure with ash and NPK fertilizer on some soil properties in Sokoto, during 2018/2019 dry season in Chimola (Gwadabawa LGA) and Wurno (Wurno LGA). The treatments consisted of three (3) levels of fortified poultry manure with ash (1:3 ratio) at 5, 10 and 15t ha^{-1}, and three (3) levels of NPK at 30, 45 and 60kg ha^{-1} which were combined and laid-out in a randomized complete block design (RCBD) replicated three (3) times. Sakanal onion variety was used as a test crop.Data on particle size, pH, organic carbon, total nitrogen, available phosphorus, CEC and exchangeable bases were collected on and after hrvest. The data generated were subjected to analysis of variance (ANOVA) procedure for RCBD using SPSS version 23.0. The results revealed that fortified poultry manure with ash and NPK fertilizer significantly ($P<0.05$) affected chemical properties of the soils such as organic carbon, organic matter, available phosphorus, exchangeable calcium, magnesium, electrical conductivity and cation exchange capacity in Chimola and Wurno, respectively. Exchangeable potassium was significantly ($P<0.05$) affected by the application of fortified poultry manure with ash and NPK fertilizer in Chimola location. The results of the study revealed that application of 15 tons fortified poultry manure with ash and 60 kg/ha NPK fertilizer significantly improved the physical and chemical properties of the soils in the study area.

Keywords: Fortified poultry manure; Ash; Fertilizers; Soil Properties

INTRODUCTION

Soils in tropical Africa are constrained by erosion, degradation of physical condition, deteriorating nutrient status and changes in the composition and number of soil organisms

(Adeniyan, 2008) which limit their productivity. Declining soil fertility, global short supply and high cost of fertilizer are also major limitations to small holder farmers in tropical region (Maobe *et al*., 2000). In this regard, soil fertility is a major overriding constraint that affects all aspect of crop husbandry (Mbah, 2006). Continuous cropping without adequate nutrient restoration practices may endanger the sustainability of agriculture (FAO, 2003). The selection of the proper rate of plant nutrient depends on the knowledge of nutrient supplying power of the soil on which the crop is to be grown, (Tisdale *et al*., 1985). Adesodun *et al.* (2005) found that application of poultry manure to soil increased soil organic matter, N and P and aggregate stability. The improvement in soil physical properties was attributable to mulching effect of organic matter and improved moisture retention as a result of improved soil structure and micro porosity (Adesodun *et al.*, 2005). 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 world. However, the use of manure by farmers is constrained by its inadequate supply which could be too little to meet the requirements of the farmer's crop land. The judicious use of farm yard manure along with mineral fertilizer could help in maintenance of soil fertility and enhance crop yield (Ojeniyi and Adeniyan, 1999).

The complementary application of organic fertilizer reduces the dependence of the farmer on inorganic fertilizer. It also reduces the exposure of the soil to the consequences of inorganic fertilizer application. However, Jeyathilake *et al.* (2006) have observed that the nutrient use efficiency of a crop is increased through a combined application of organic manure and mineral fertilizer.

The objective of this research was to investigate the effect of different rates of fortified poultry manure with ash and NPK fertilizer on the physical and chemical properties of the soil.

MATERIALS AND METHODS

Site Description

The experiment was conducted during 2018/2019 dry season in two (2) locations: Chimola (Gwadabawa LGA) located on the latitude 13^{o}18'693''N and longitude 5^{o}24'962''E and Wurno (Wurno LGA) located on the latitude 13^{o}30'489''N and longitude 5^{o}37'059''E, both of which are within Sudan Savannah agro-ecological zone of Nigeria. The climate prevailing in the location is characterized by long dry season extending from October to May, and a short but intense raining season from May/June to the end of September or early October (Ojanuga, 2006). The mean annual rainfall is about 704.2mm, with over 60% of the amount falling within July and August. In the dry season, maximum temperature reaches 25-35˚C during the day, but may fall below 15˚C at night. A harmattan wind blows from the North east, often with dust from the Sahara Desert. Relative humidity varies between a minimum of about 10% in February to a maximum of about 90% in August (NAERLS, 2014).

Treatments and Experimental Design

The treatments consisted of two (2) factors: (i) three (3) levels combination of fortified poultry manure with ash (1:3 ratio) at 5, 10 and 15t ha^{-1} (ii) three (3) levels of NPK fertilizer

at 30, 45 and 60kgha^{-1}. Sakanal onion variety was used as test crop which was sourced from Bejo Seed Company (Tays Food Limited). The treatments were as follows; 5t of fortified poultry manure with ash + 30kg of NPK (P5NPK1), 10t of fortified poultry manure with ash + 30kg of NPK (P10NPK1), 15t of fortified poultry manure with ash + 30kg of NPK (P15NPK1), 5t of fortified poultry manure with ash + 45kg of NPK (P5NPK2), 10t of fortified poultry manure with ash + 45kg of NPK (P10NPK2), 15t of poultry manure with ash + 45kg of NPK (P15NPK2), 5t of poultry manure and Ash + 60kg of NPK (P5NPK3), 10t of fortified poultry manure with ash + 60kg of NPK (P10NPK3), 15t of fortified poultry manure with ash + 60kg of NPK (P15NPK3) and a control. They were combined and laid in a randomized complete block design and replicated three (3) times making a total of 30 plots. The treatments were applied in the field according to their combinations.

Poultry Manure

Poultry manure used was sourced from Marina Farms, Nigeria Limited located along Bodinga Road, Sokoto state. The poultry manure collected was air dried, a sub-sample was collected and crushed using pestle and mortar for laboratory analysis.

Ash

Ash was sourced from local stove after completely burning wood fuel, sub-sample was collected and analysed in the laboratory.

Soil Sample Collection and Preparation

The soil samples were collected from the trial sites using auger at the depth of 0-15 cm. The composite sample obtained was air dried and sieved through 2mm sieve. A sub-sample was analysed for some physical and chemical properties. Soil samples were also collected from each plot at harvest and analysed for the physical and chemical properties of the soils.

Soil and Poultry Manure Analysis

Some of the physical and chemical properties of the soil that were analysed are particle size, pH, organic carbon, total nitrogen, available phosphorus, CEC and exchangeable bases. The poultry droppings and ash were analysed for total nitrogen, available phosphorus and exchangeable potassium. All analyses were done according to standard procedures in soil science.

Data Analysis

The data generated were subjected to analysis of variance (ANOVA) procedure for RCBD using SPSS version 23.0. All the output results expressed as mean ± standard deviation (SD). Where significant difference exists ($P<0.05$) Bonferroni post hoc test procedure was used to separate the means.

RESULTS AND DISCUSSION

Soil Characterization

The result in Table 1 shows the initial physical and chemical properties of soils collected from Wurno and Chimmola at 0 – 15cm depth. The result indicated that the soils were sandy loam and clay loam in texture respectively. The initial values of the soils show that pH was slightly acidic (6.4 and 6.5) in both locations. In Wurno, the organic carbon content, organic matter, total nitrogen and exchangeable magnesium were low. Exchangeable calcium was medium while exchangeable potassium, sodium and cation exchange capacity were high. In Chimmola, the organic carbon, exchangeable potassium and sodium were high, total nitrogen, available phosphorus, exchangeable calcium and magnesium were low while cation exchange capacity was high base on standard ratings of Esu (1991) and Chude *et al.* (2011).

Table 1: Nutrient composition of ash and poultry manure, and the physical and chemical properties of soils before the application of the treatments at Wurno and Chimola locations.

Chemical properties	Value	
	Wurno	Chimola
pH	6.4	6.5
Organic carbon (gkg^{-1})	10.0	10.2
Total nitrogen (gkg^{-1})	0.52	0.84
Available phosphorus ($mg\ kg^{-1}$)	0.77	0.79
Cation exchange capacity ($cmolkg^{-1}$)	10.0	11.6
Exchangeable bases ($cmol\ kg^{-1}$)		
Calcium (Ca^{2+})	1.50	0.5
Magnesium (Mg^{2+})	0.35	0.45
Potassium (K^{+})	0.90	0.87
Sand (gkg^{-1})	553.0	363.0
Silt (gkg^{-1})	294.0	210.0
Clay (gkg^{-1})	153.0	427.0
Textural class	Loam	Clay Loam
Chemical properties of poultry manure		
Total nitrogen (%)		1.83
Available phosphorus ($mgkg^{-1}$)		8.03
Potassium ($cmolkg^{-1}$)		2500
Chemical Properties of Ash		
Calcium ($mgkg^{-1}$)		4.15
Magnesium ($mgkg^{-1}$)		4.9
Potassium ($mgkg^{-1}$)		12600
Sodium ($mgkg^{-1}$)		1650
Phosphorus ($mgkg^{-1}$)		0.73

Effect of combined application of fortified poultry manure with ash and NPK fertilizer on the physical property of Soils at Wurno and Chimola Locations

The result of the effect of combined application of fortified poultry manure with ash and NPK fertilizer on the physical properties of soils in Wurno and Chimola is presented in Table 2. The result shows that application of poultry manure, ash and NPK fertilizer had no significant (P>0.05) effect on the soils physical properties in both locations. The field work lasted for 5 months which was not long enough to affect the texture of a soil. It has been established that the textural class of soils do not change within a short period of time. The result of this research is consistent with the findings of Manjunath (2006) who worked on the impact of farmers organic farming practices on soil properties in Northern Dry Zone of Karnataka revealed that, soil texture being an inherent property of soil was not affected by either conventional or organic farming practices.

Table 2: Effect of combined application of fortified poultry manure with ash and NPK fertilizer on the physical properties of Soils at Wurno and Chimola Locations

Treatment	Wurno				Chimola			
	Sand (g/kg)	Silt (g/kg)	Clay (g/kg)	Textural class	Sand (g/kg)	Silt (g/kg)	Clay (g/kg)	Textural class
P5NPK1	552.7	293.0	154.3	Loam	364.3	206.7	429.0	Clay loam
P5NPK2	546.7	286.3	167.0	Loam	356.7	210.0	433.3	Clay loam
P5NPK3	570.0	270.0	160.0	Loam	356.7	211.7	431.6	Clay loam
P10NPK1	538.3	283.3	178.4	Loam	361.7	213.3	425.0	Clay loam
P10NK2	547.7	292.3	160.0	Loam	358.3	220.0	421.7	Clay loam
P10NPK3	543.3	290.0	166.7	Loam	350.0	210.0	440.0	Clay loam
P15NPK1	543.3	286.7	170.0	Loam	360.0	203.3	436.7	Clay loam
P15NPK2	557.7	279.0	163.3	Loam	346.7	205.0	448.3	Clay loam
P15NPK3	540.0	286.7	173.3	Loam	353.3	220.0	426.7	Clay loam
CONTROL	556.7	290.0	153.3	Loam	360.0	208.3	431.7	Clay loam
Leve of Significance	NS	NS	NS	NS	NS	NS	NS	
SE	0.522	0.457	0.372		0.439	0.3530	0.270	

Means followed by the same letter(s) within the same column are statistically the same at 5% level of significance, SE: Standard Error, * = Significant at 5% level of probability, P5NPK1 (5t of poultry manure + Ash + 30kg NPK), P5NPK2 (5t of poultry manure + Ash + 45kg NPK), P5NPK3 (5t of poultry manure + Ash + 60kg NPK), P10NPK1 (10t of poultry manure + Ash + 30kg NPK), P10NPK2 (10t of poultry manure + Ash + 45kg NPK), P10NPK3 (10t of poultry manure + Ash + 60kg NPK), P15NPK1 (15t of poultry manure + Ash + 30kg NPK), P15NPK2 (15t of poultry manure + Ash + 45kg NPK), P15NPK3 (15t of poultry manure + Ash + 60kg NPK).

However, the values of the sand fraction ranged from 538.7 to 570.0g kg^{-1} at Wurno location and 346.7 to 364.3g kg^{-1} in Chimola location. The sand distribution varies between and within the treatment for each of the locations. Ojanuga (2006) stated that, flood plain soils of Nigeria are of the alluvial origin and differed widely in properties. It could therefore be explained that the dominance and variation of sand distribution at Wurno location among the treatments studied could be partly attributed to parent material rich in quartz minerals (Brady and Weil, 2008). Silt fraction of Wurno location ranged from 27.00 to 293.0g kg^{-1} while Chimola location silt fraction ranged from 203.3 to 220.0g kg^{-1}. The trend of silt distribution across and within the locations were irregular even though some treatments had similar values (P10NPK3, Control; P10NPK2 and P15NPK3) in Wurno and Chimola respectively. The variation in silt content of the soils may be the same as sand. Clay content

of Wurno area was low when compared with sand and silt fraction where Chimola location had higher values of clay fraction.

Effect of Combined Application of Fortified Poultry Manure with ash and NPK Fertilizer on the Chemical Properties of Soils at Wurno and Chimola Locations

Soil pH

The data in Table 3 and 4 showed the effect of combined application of fortified poultry manure with ash and NPK fertilizer on soil pH at Wurno and Chimola locations respectively. The results show that the combined application of fortified poultry manure with ash and NPK fertilizer did not significantly ($P>0.05$) affected soil pH in both Wurno and Chimola. Application of P15NPK3 recorded the highest value of 6.6 against other treatments. Similar result was reported by Quanash (2010) who worked on effect of organic, inorganic fertilizers and their combination on the growth and yield of maize in the semi-deciduous forest of Ghana.

Organic carbon

The data on the combined application of fortified poultry manure with ash and NPK fertilizer on organic carbon at Wurno and Chimola are presented in Table 3 and 4. The result shows that the combined application of fortified poultry manure with ash and NPK fertilizer significantly ($P<0.05$) affected soil organic carbon at both Wurno and Chimola location. It was observed that the treatment combination P15NPK3 fertilizer significantly ($P<0.05$) gave higher value of organic carbon than the other treatment combinations at Wurno, while at Chimola the combine application of P5NPK1 fertilizer significantly gave higher level of organic carbon than the other treatment combinations.

This was obvious since the carbonaceous material applied contributed to soil organic carbon after decomposition. This observation is in agreement with the work of Guttani *et al*. (1997) who studied the effect of continuous use of chemical fertilizers and manure on soil properties for five years and reported that, the organic carbon of the soil increased to 0.24 from 0.19 percent by manure application.

Table 3: Effect of combined application of fortified poultry manure with ash and NPK fertilizer on some chemical properties of soil in Wurno

Treatment	pH	OC(g/kg)	OM(g/kg)	Total N (g/kg)	Avail. P (mg/kg)	Exchangeable Bases				CEC (cmol/kg)	EC(dS/m)
						Ca(cmol/kg)	Mg(cmol/kg)	K(cmol/kg)	Na(cmol/kg)		
Control	6.20±0.20	1.0±0.03^{e}	1.723±0.01^{e}	1.5±0.24	1.56±0.02^{c}	1.10±0.10	0.47±0.07^{f}	0.35±0.02	0.22±0.02	6.20±0.20^{d}	453.33±2.52^{a}
P5NPK1	6.50±0.10	4.6±0.02^{bc}	7.926±0.01^{c}	2.2±0.00	1.68±0.03^{ab}	2.65±0.47^{a}	1.04±0.01^{e}	0.82±6.74	1.47±0.05	6.33±2.04^{cd}	1555.33±3.06^{ab}
P5NPK2	6.37±0.12	5.8±0.01^{b}	9.993±0.02^{ab}	2.1±0.00	1.65±0.03	2..07±0.02^{d}	0.96±0.02^{e}	0.83±0.01	1.53±0.01	8.37±0.15^{b}	1033.67±3.21^{d}
P5NPK3	6.30±0.00	5.7±0.09^{b}	9.821±0.02^{b}	2.1±0.00	1.67±0.01^{ab}	2.06±0.02^{d}	1.87±0.06^{a}	1.49±0.05	1.53±0.01	7.67±0.61^{c}	1226.00±21.66^{b}
P10NPK1	6.37±0.15	3.5±0.03^{cd}	6.031±0.02^{d}	2.2±0.00	1.66±0.02^{b}	2.28±0.03^{a}	1.74±0.01^{b}	1.14±0.01	1.61±0.01	8.20±0.53^{b}	1224.33±2.52^{b}
P10NPK2	6.40±0.20	3.6±0.02^{cd}	6.201±0.02^{d}	2.3±0.00	1.63±0.02^{d}	2.33±0.15^{c}	1.74±0.05^{b}	1.42±0.23	1.61±0.01	7.33±0.15^{a}	1226.67±1.53^{b}
P10NPK3	6.27±0.12	4.5±0.01^{bc}	7.754±0.04^{c}	2.3±0.00	1.63±0.02^{d}	2.41±0.12^{b}	1.77±0.02^{ab}	0.95±0.03	1.61±0.01	7.63±0.21^{c}	1255.33±3.06^{b}
P15NPK1	6.30±0.17	5.8±0.03^{b}	9.993±0.02^{ab}	2.4±0.01	1.62±0.02^{e}	2.63±0.25^{ab}	1.54±0.03^{c}	1.62±0.04	0.94±0.01	7.50±0.10^{c}	1156.00±3.00^{c}
P15NPK2	6.30±0.10	3.0±0.02^{d}	5.169±0.03^{a}	2.4±0.00	1.61±0.01^{e}	2.60±0.10^{b}	1.47±0.02^{d}	1.62±0.94	0.62±0.02	8.63±0.15^{ab}	1865.33±15.89^{a}
P15NPK3	6.60±0.20	6.2±0.05^{a}	10.683±0.02^{a}	2.5±0.00	1.73±0.07^{a}	2.66±0.02^{a}	1.87±0.02^{a}	1.78±0.12	1.29±6.34	10.47±0.31^{a}	652.00±1.00^{e}
Level of	NS	*	*	NS	*	*	*	NS	NS	*	*
Significant											
SE	0.086	0.022	0.012	0.045	0.017	0.108	0.021	1.244	1.158	0.412	5.084

Means followed by the same letter(s) within the same column are statistically the same at 5% level of significance, SE: Standard Error, * = Significant at 5% level of probability NS =Not significant, P5NPK1 (5t of poultry manure + Ash + 30kg NPK), P5NPK2 (5t of poultry manure + Ash + 45kg NPK), P5NPK3 (5t of poultry manure + Ash + 60kg NPK), P10NPK1 (10t of poultry manure + Ash + 30kg NPK), P10NPK2 (10t of poultry manure + Ash + 45kg NPK), P10NPK3 (10t of poultry manure + Ash + 60kg NPK), P15NPK1 (15t of poultry manure + Ash + 30kg NPK), P15NPK2 (15t of poultry manure + Ash + 45kg NPK), P15NPK3 (15t of poultry manure + Ash + 60kg NPK)

Table 4: Effect of Combined application of fortified poultry manure with ash and NPK fertilizer on some chemical properties of soils in Chimmola

Treatment	pH	OC (g/kg)	OM(g/kg)	Total N(g/kg)	Avail. P(mg/kg)	Exchangeable Bases					
						Ca(cmol/kg)	Mg(cmol/kg)	K(cmol/kg)	Na(cmol/kg)	CEC(cmol/kg)	EC(dS/m)
Control	5.80± 0.10	2.7 ±0.044^{e}	4.652 ± 0.02^{e}	1.12 ± 0.00	0.89 ± 0.03^{e}	1.46 ± 0.09^{e}	1.45 ± 0.03^{d}	1.18 ± 0.21^{e}	1.13 ± 0.03	8.63 ± 0.15	1363.00±2.65^{a}
P5NPK1	6.07 ±0.46	9.6 ±0.21^{a}	16.541 ± 0.03^{a}	2.11 ± 0.00	1.68 ± 0.02^{b}	2.97 ± 0.06^{c}	1.67 ± 0.06^{c}	1.59 ± 0.02^{c}	1.09 ± 0.04	9.60 ± 0.20^{c}	879.33 ±5.03^{ab}
P5NPK2	6.00 ±0.20	4.2 ±0.23^{cd}	7.237± 0.02^{cd}	2.12 ± 0.01	1.63 ± 0.02^{d}	2.00 ± 0.00^{d}	1.72 ± 0.03^{ab}	1.57 ± 0.03^{cd}	1.33 ± 5.69	10.00 ± 0.40^{ab}	298.67 ±54.88^{d}
P5NPK3	5.90 ±0.28	3.8 ±0.21^{d}	6.547± 0.16^{d}	2.12 ± 0.00	1.66 ± 0.01^{b}	3.13 ± 0.06^{ab}	1.73 ± 0.03^{b}	1.69 ± 0.02^{ab}	1.17 ± 0.01	10.13 ± 0.12^{ab}	776.00 ±3.00^{b}
P10NPK1	6.07 ± 0.25	4.1 ±0.18^{cd}	7.064± 0.02^{cd}	2.12 ± 0.00	1.67 ± 0.02^{b}	3.00 ± 0.00^{ab}	1.75 ± 0.01^{b}	1.43 ± 0.02^{d}	1.24 ± 0.02	9.20 ± 0.20^{d}	394.00 ±1.73^{c}
P10NPK2	6.13 ± 0.25	5.2 ±0.13^{c}	8.960± 0.01^{c}	2.13 ± 0.00	1.64 ± 0.02^{c}	3.03 ± 0.06^{ab}	1.84 ± 0.01^{a}	1.63 ± 0.03^{b}	1.08 ± 0.02	9.93 ± 0.31^{b}	396.00 ±1.00^{c}
P10NPK3	6.13 ±0.21	5.3 ±0.16^{c}	9.132± 0.04^{b}	2.12 ± 0.00	1.64 ± 0.03^{c}	3.00 ± 0.00^{ab}	1.80 ± 0.02^{ab}	1.99 ± 0.11^{a}	1.18 ± 0.02	10.33 ± 0.12^{a}	141.93 ±12.14
P15NPK1	5.93 ±0.25	6.1 ±0.19^{b}	10.510± 0.05^{ab}	2.11 ± 0.00	1.65 ± 0.02^{b}	2.90 ± 0.10^{b}	1.62 ± 0.03^{c}	1.36 ± 0.02^{e}	1.09 ± 0.01	10.00 ± 0.20^{ab}	363.67 ±0.58^{c}
P15NPK2	5.90 ± 0.26	6.2 ±0.23^{ab}	10.683± 0.02^{ab}	2.12 ± 0.00	1.61 ± 0.01^{d}	3.00 ± 0.00^{ab}	1.72 ± 0.03^{ab}	1.67 ± 0.02^{ab}	1.09 ± 0.00	10.20 ± 0.20^{a}	269.00 ±14.11^{d}
P15NPK3	6.13 ± 0.15	6.3 ±0.15^{ab}	16.51 ± 0.27^{a}	2.17 ± 0.08	1.70± 0.02^{a}	3.77 ± 0.15^{a}	1.82 ± 0.02^{a}	1.99 ± 0.02^{a}	1.23 ± 0.01	10.40 ± 0.20^{a}	138.67 ±15.53^{e}
Level of Significant	NS	*	*	NS	*	*	*	*	NS	*	*
SE	0.143	0.105	0.059	0.014	0.011	0.041	0.016	0.044	1.039	0.130	11.034

Means followed by the same letter(s) within the same column are statistically the same at 5% level of significance, SE: Standard Error, * = Significant at 5% level of probability NS =Not significant, P5NPK1 (5t of poultry manure + Ash + 30kg NPK), P5NPK2 (5t of poultry manure + Ash + 45kg NPK), P5NPK3 (5t of poultry manure + Ash + 60kg NPK), P10NPK1 (10t of poultry manure + Ash + 30kg NPK), P10NPK2 (10t of poultry manure + Ash + 45kg NPK), P10NPK3 (10t of poultry manure + Ash + 60kg NPK), P15NPK1 (15t of poultry manure + Ash + 30kg NPK), P15NPK2 (15t of poultry manure + Ash + 45kg NPK), P15NPK3 (15t of poultry manure + Ash + 60kg NPK)

Organic matter

The data on the effect of combined application of fortified poultry manure with ash and NPK fertilizer on organic matter at Wurno and Chimola are presented in Table 3 and 4. The result shows that the combined application of fortified poultry manure with ash and NPK fertilizer significantly ($P<0.05$) affected soil organic matter at both Wurno and Chimola location. It was observed that the treatment combination P15NPK3 fertilizer significantly ($P<0.05$) gave higher value of organic matter than the other treatment combinations at Wurno, while at Chimola the combine application of P5NPK1 fertilizer significantly gave higher level of organic matter than the other treatment combinations. This is because the more the organic matter, the higher the organic carbon in the soil and or direct addition of organic materials as treatment.

Total nitrogen

The data in Tables 3 and 4 showed the effect of combined application of fortified poultry manure with ash and NPK fertilizer on soil total nitrogen at Wurno and Chimola Locations respectively. The results show that the combined application of fortified poultry manure with ash and NPK fertilizer did not significantly ($P>0.05$) affected soil total nitrogen in both Wurno and Chimola. Application of P15NPK3 recorded the highest value of 2.17 to 2.50g kg^{-1} than any other treatments in Chimola and Wurno respectively. The high values of N recorded were due to the combined application of fortified poultry manure with ash which was reported to have easily fermentable N and also direct application of NPK. There was an increase in total nitrogen in all the treatments as compared to initial value at both locations, which could be attributed to application of the treatments. Anderson and Peterson (1973) reported that, continuous addition of manure for 20 years increased the total and available nitrogen significantly.

Available phosphorus

The data on the effect of combined application of fortified poultry manure with ash and NPK fertilizer on soil available phosphorus at Wurno and Chimola are presented in Tables 4 and 5. The result shows that the combined application of fortified poultry manure with ash and NPK fertilizr significantly ($P<0.05$) affected the available phosphorus in soils at both Wurno and Chimola location. It was observed that the treatment combination P15NPK3 fertilizer significantly ($P<0.05$) gave higher value (1.73mg kg^{-1} and 1.73mg kg^{-1}) of available phosphorus than the other treatment combinations at Wurno and Chimola. The reason could be due to difference in the concentration of P in the treatments, some treatments had higher levels of soil amendment and therefore more nutrients are expected. Somani and Saxena (1975) reported that, an increase in phosphorus with incorporation of wheat residue and farmyard manures was observed while inorganic fertilizer alone decreased available phosphorus when compared with initial status.

Exchangeable bases

The data on the effect of combined application of fortified poultry manure with ash and NPK fertilizer on exchangeable bases at Wurno and Chimola are presented in Tables 4

and 5. The result shows that the combined application of fortified poultry manure with ash and NPK fertilizer significantly ($P<0.05$) affected exchangeable calcium and magnesium in soils at both Wurno and Chimola location, it was observed that the combined application of fortified poultry manure with ash and NPK fertilizer did not significantly ($P>0.05$) affected soil exchangeable potassium and sodium in Wurno. While exchangeable potassium was significantly ($P<0.05$) affected by the combined application of fortified poultry manure with ash and NPK fertilizer in Chimola. The treatment combination P15NPK3 fertilizer significantly ($P<0.05$) gave higher value of exchangeable bases than the other treatment combinations at Wurno and Chimola. This could be due to the application of organic material which decomposed to release this nutrient into the soil. This result is in agreement with the findings of Yusuf *et al*. (2007), who reported that application of both organic and inorganic fertilizer increased soil exchangeable calcium, Similarly, Gana (2009) reported that plots with 60 and 120kg N/ha for sugarcane production increased exchangeable K in soils in Niger state while sodium (Na) was not significantly affected by the treatments at the location. Again, the findings of Mohammed (2012) who reported that values of exchangeable bases obtained was as a result of continuous irrigation of the soil with irrigation water that might have relatively higher value of Na, which may precipitate both Ca and Mg in the exchange sites over time.

Cation exchange capacity (CEC)

The data on the effect of combined application of fortified poultry manure with ash and NPK fertilizer on cation exchange capacity at Wurno and Chimola are presented in Tables 4 and 5. The result shows that the combined application of fortified poultry manure with ash and NPK fertilizer significantly ($P<0.05$) affected cation exchange capacity at both Wurno and Chimola location. The treatment combination P15NPK3 fertilizer significantly ($P<0.05$) gave higher value (10.47 and 10.40 cmol/kg) of cation exchange capacity than the other treatment combinations at Wurno and Chimola. The reason may be related to the amount of clay fraction and applied fortified manure with ash in Chimola. The higher the clay and organic material the more negative charges of the soil. This result is similar with the findings of Singh and Dahiya (1980) who reported that application of farmyard manure resulted in increase in cation exchange capacity, the increase in CEC was associated with rise in organic matter content.

Electrical conductivity (EC)

The data on the effect of combined application of fortified poultry manure with ash and NPK fertilizer on electrical conductivity at Wurno and Chimola are presented in Tables 4 and 5. The result shows that the combined application of fortified poultry manure with ash and NPK fertilizer significantly ($P<0.05$) affected electrical conductivity at both Wurno and Chimola locations. The treatment combination P15NPK2 fertilizer significantly ($P<0.05$) gave higher value of electrical conductivity at Wurno while control gave the highest value than the other treatment combinations at Chimola. Salinity problems may likely exist at both locations and the result shows the effect of combined application of fortified poultry manure with ash and NPK fertilizer in reducing or checking the potential salinity problem in the study locations.

CONCLUSION

Based on the findings of this study, the application of 15-tons poultry manure plus ash and 60 kg NPK fertilizer significantly ($P<0.05$) gave higher values of all the chemical properties considered in this research locations. However, electrical conductivity values were significantly ($P<0.05$) higher, which shows the potential danger of salinity in the study area.

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