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Maize Response to Organic and Inorganic (Poultry manure) and Inorganic Fertilizers (NPK 15-15-15) at Different Soil pH Levels

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ABSTRACT

A greenhouse experiment was carried out on an acid soil to investigate the effect of combination of organic (poultry manure) and inorganic fertilizer (NPK 15-15-15) on maize (M-S variety) performance at different soil pH levels. This was followed by a field trial to validate the findings from the greenhouse experiment. Four soil pH levels: pH 5.5, pH 6.0, pH 6.5 and pH 7.0 and six rates of treatment combination: T1 (200kg/ha NPK + 6t/ha PM); T2 (300kg/ha NPK + 4 t/ha PM), T3 (400kg t/ha NPK + 2t/ha PM); T4 (400 t/ha NPK only), T5 (8t/ha PM only); T6 (Control) and replicated three times were carried out in a 6x4factorial in Completely Randomized Design (CRD) and Randomized Complete Block Design (RBCD) respectively. The study results obtained showed that plant growth, dry matter and fruit yields of maize were significantly increased due to application varying combinations of organic (poultry manure) and inorganic fertilizer at different soil pH levels, when compared with the control. The performance was in the following other: T2 and T1 at soil pH 5.5 < T1 and T2 at soil pH 7.0. The results obtained in the field were similar to the trend observed in the pot study.

Thus, for better yield and productivity of maize crop, the use of T1 (200Kg/ha NPK + 6t/ha Poultry Manure) in a soil limed to pH 5.5 is recommended.

Key words: *Lime, maize performance, inorganic fertilizer, poultry manure, soil acidity*

INTRODUCTION

Maize (*Zea mays* L.) is the third most important cereal crop in the world after wheat and rice with respect to area of coverage and productivity. It is one of the most widely grown cereals in the world and has great significance as human food, animal feed and raw material for large number of industrial products. Maize has high production potential especially under irrigated condition when compared to any other cereal crop. The productivity of maize largely depends on its nutrient requirement and management particularly that of nitrogen, phosphorus and potassium(Arunkumar 2007)

Soil acidity is the most important cause of low yield for many crops (Hoekenga and Pineros 2004; Lucia et al, 2010). About 30% of the world's soils are acidic, and 60% of them are in tropical and subtropical areas associated with long periods of hot and moist weather (Hoekenga and Pineros, 2004). Soil acidification is an increasing problem in the world because of acid rain, removal of natural plant coverage from large production areas and the use of ammonium-based fertilizers (Johnson et.al, 1997).

One of the major problems associated with soil acidification is aluminum (Al) phytotoxicity. Aluminum is the principal component of mineral soils and is present in a wide range of primary and secondary minerals (Sommers and Lindsa, 1979). Soil acidity is a threat to crop production. It is common in all regions where precipitation is high enough to leach appreciable amounts of exchangeable bases from the soil surface.

Liming is an ancient rehabilitating agricultural material for soil acidity. The overall effects of lime on soils include among others, increase in soil pH, Ca and Mg saturation, neutralization of toxic concentrations of aluminum, increase in pH dependent CEC resulting in increase in P availability and improved nutrient uptake by plants (Oguntoyinbo, 1996). Kamprath and Foy (1971) reported that liming effect on P- availability of highly weathered soils varied from favourable to detrimental. Liming to pH 7 however, drastically reduced P uptake from acid, aluminous Latosols. According to Konsler1 and Shelton (1990), Dolomitic limestone contributed Ca and Mg directly to the soil. Although response to lime is frequently subtle (in contrast to the quick green-up that nitrogen application gives to corn), ignoring its regular use limits crop yields. Proper use of lime, in combination with other sound agronomic and pest control practices, increased crop income in North Carolina (Crozier and Hardy, 2003).

Adequate nutrient supply is essential for optimum production of maize. Due to high cost and scarcity of mineral fertilizer, most farmers cannot afford the use of chemical fertilizer. This necessitates research on organic wastes that are cheap, readily available and environmentally friendly which can be used as fertilizer. (Ayeni, 2011). Combination of organic and mineral fertilizer nutrient sources have been shown to result in synergistic effects and improved nutrient release and uptake by crop leading to higher yields. Leucaena biomass combined with mineral fertilizer gave higher crop yields as compared to sole use of mineral fertilizer or sole leucaena biomass (Mugendi *et al.*, 1999). Mbah and Onweremadu (2009) observed that organic and inorganic amendments improved the physicochemical properties of the studied soil.

Addition of organic matter (pressmud) improves soil nutrient availability and uptake by plants (Marschner, 1995). Soil pH is greatly influenced by addition of organic matter (OM) through different organic amendments and change in pH varies with the nature of OM (Walker *et al.*, 2004). Application of organic manures significantly increased levels of organic C and N and the formation of water-stable aggregates, as compared with application of chemical fertilizers (Adrien, 2006). Aziz *et al.*, (2010) suggested that integrated use of organic manure with chemical fertilizers would be a better and practical approach to sustain soil fertility and productivity. There have been many researches carried out on the combined effects of organic and inorganic fertilizers on growth and yield of maize (Mbah and Onweremadu, 2009). Katerji *et al.*, (1996), suggested that better utilisation of soil nutrients for high grain yield of maize is attained under the influence of certain physicochemical soil characteristics such as pH, electrical conductivity as well as $CaCO_3$ and organic matter content. However, there has not been adequate research on maize response to combined organic and inorganic fertilizers at different soil pH levels.

The benefits derivable from the use of organic materials have not been fully utilized in the humid tropics due to the huge quantities required to satisfy the nutritional needs of crops as well as transportation and handling costs which constitute major constraints. They are rarely available to the small-scale farmers in the required large quantities (Nyathi and Campbell, 1995). The objective of this research is to evaluate the effect of combination of organic and inorganic fertilizers on maize performance in soils of different pH levels.

MATERIALS AND METHODS

Location

The study was carried out on Soil Science Teaching and Research farm behind the metrological station, University of Nigeria, Nsukka. The site is located at latitude 06^o52^1N and longitude 07^o24^1E with an elevation of 447m above the sea level. Rainfall is bimodal; the rainy (April – October) and the dry seasons (November – March). There is usually a short break (August Break) in the month of August. The site has an average annual rainfall of about 1600mm with an average minimum and maximum temperature of about 22^oC and 30^oC respectively.

The relative humidty is rarely below 60% (Asadu *et. al*, 2002). The soils of the area have high percentage sand and granular structure at the top and the topsoil is characterised by rapid to very rapid permeability (Obi and Asiebgu, 1980). The soil is an Ultisol which belongs to Nkpologu series (Nwadialo, 1989). The soil is very deep, dark-reddish brown at the top layer and reddish in the subsoil. It is coarse to medium textured, granular in structure, acid in reaction and low in nutrient status. Its clay mineralogy is composed mainly of kaolinite and quartz (Akamigbo and Igwe, 1990).

Greenhouse trials

The greenhouse experiment was a 6 x 4 factorial with three replications laid out in Completely Randomized Design. The treatment combinations are shown in table 9. A 2kg sieved soil was weighed into 72 perforated pots. The soil samples were limed to different pH levels that is (pH 5.5 [original soil pH], 6.0, 6.5 and 7.0 respectively). After one month of lime application, the soils were also amended with poultry manure as shown in table 1. Thereafter, the maize grains (*Zea mays*, M-S yellow variety) were planted. NPK 15-15-15 fertilizer was applied two weeks after planting (WAP). The maize plants were harvested at 10 WAP and their dry matter taken.

Field trial

The field design was a 6 x 4 factorial in Randomized Complete Block Design (RCBD) with three replications. After land ploughing and harrowing, lime (CaO) was broadcast and mixed thoroughly into the soil using hoes. The land was left for one month to allow for proper integration of the lime with the soil so as to bring the soil to different pH levels (pH6, pH6.5 and pH 7.0). The lime requirement of the soil was determined following the procedure described by Shoemaker *et. al*, 1961). Thereafter, poultry manure was applied at different rates. The test crop was maize (Zeamays) M-S yellow variety. It was planted one month after lime and poultry manure application at the planting distance of 75cm x 25cm (53,333 plants/ha). A 400kg/ha NPK 15:15:15 was applied two weeks after planting at different rates as shown in table 1.

Table 1: Treatments combinations

Treatment combinations			
L1T1	L2T1	L3T1	L4T1
LIT2	L2T2	L3T2	L4T2
L1T3	L2T3	L3T3	L4T3
LIT4	L2T4	L3T4	L4T4
LIT5	L2T5	L3T5	L4T5
LIT6	L2T6	L3T6	L4T6

The treatments combinations were:
T1= 200kg/ha NPK + 6t/ha PM; T2 = 300kg/ha NPK + 4 t/ha PM
T3 = 400kg t/ha NPK + 2t t/ha PM; T4 = 400 t/ha NPK only
T5 = 8t/ha PM only; T6 = Control.
L1 = pH 5.5; L2 = pH 6.0; L3 = pH 6.5; L4 = pH 7.0

Soil Sampling and Analysis

Soil samples were collected from the top soil (0-15cm depth), air dried and sieved with a 2mm sieve. Organic carbon was determined by dichromate oxidation method of Walkley and Black (1934) and corrected to soil organic matter by multiplying with a correction factor of 1.724. Total nitrogen was determined using the Kjeldhal method as described by Bremner, (1996). Particle size analysis of the soil was determined using the Bouycous hydrometer method as described by Gee and Bauder (1986). Soil pH was determined potentionmetrically using pH meter in a soil solution ration of 1:2.5. Available phosphorus was determined using Bray II method as described by Bray and Kurtz (1945). Exchangeable calcium, magnesium, sodium and potassium were extracted with NH_4OAc. Calcium and magnesium was determined using Ethylenediamine tetra-acetic acid (EDTA) titration method while potassium and sodium was determined by flame photometer (Rhoades, 1982). Cation exchange capacity was determined titrimetrically using 0.01N NaOH. Exchangeable acidity was determined titrimetrically using 0.05N NaOH. Bulk density was determined by core method as described by Anderson and Ingram (1993)

Data analysis: The data collected were subjected to the analysis of variance (ANOVA) as outlined by Steel and Torrie (1980).

RESULTS AND DISCUSSION

Table 2 shows the initial characteristics of the soil used for the studies. The soil is sandy loam, strongly acid, low in organic matter, CEC, total nitrogen available phosphorus, and exchangeable cations.

Table 2: Soil Properties before planting.

Soil property	Nutrient Value
pH (H2O)	5.5
pH (KCl)	4.7
Available P (ppm)	14.34
Exch. H^+ ($Cmolkg^{-1}$)	1.20
Exch .EA ($Cmolkg^{-1}$)	0.8
Exch. Na^+ ($Cmolkg^{-1}$)	0.221
Exch. K^+ ($Cmolkg^{-1}$)	0.071
CEC ($Cmolkg^{-1}$)	6.2
Exch. Mg ($Cmolkg^{-1}$)	1.0
Exch .Ca ($Cmolkg^{-1}$)	1.60
Organic matter (%)	1.101
Total N(%)	0.05
Clay (%)	19.48
Silt (%)	7.56
Coarse sand (%)	43.70
Fine sand (%)	29.26
Textural class	Sandy loam

The low nutrient values in the soil could be attributed to high temperature, high rainfall and leaching loses which characterise tropical soils. (Parnes, 1990). According to Hoekenga and Pineros (2004) such acid soils are the most important causes of low yield in many tropical crops.

Table 3 shows the nutrient content of the poultry manure used for the study. The poultry manure is high in organic matter, exchangeable bases and pH which are strongly alkaline.

Table 3: Chemical Properties of the Poultry Manure Used for the Study.

Property	Quantity
pH	8.9
Organic matter	37.7
Total N (%)	3.1
Available P (%)	0.15
Exch. Na (%)	11.2
Exch. K (%)	9.0
Exch. Mg($Cmolkg^{-1}$)	3.4
Exch. Ca($Cmolkg^{-1}$)	15.8

Table 4 shows the chemical property of the soil one month after liming. Exchangeable acidity decreased as the pH of the soil increased, this shows that lime has potential effect in reducing the acidity of the soil.

Table: 4 Soil chemical properties one month after liming

Soil pH Level	Avail.P Ppm	pH H2O	pH KCl	H+	EA	Na	K	CEC	Mg	Ca	OM	Total N
				←		Cmol/Kg				→ %	%	
pH 6.0	13.99	5.7	4.9	1.7	0.5	0.172	0.078	8.6	0.4	3.2	1.568	0.09
pH 6.5	10.26	6.1	5.4	1.3	0.2	0.196	0.066	6.0	0.2	5.0	1.568	0.10
pH 7.0	15.86	7.3	6.8	0.5	trace	0.147	0.076	4.4	0.2	5.8	1.135	0.12

The CEC of soil decreased as the soil pH increased. Similarly, available P decrease as the soil pH increased, except in soil of pH 7.0. The exchangeable calcium increased as the soil pH increased, unlike the exchangeable magnesium which decreased as the soil pH increased. This is attributed to the type of lime (CaO) applied.

Plant Height

The result of analysis on the fertilizer combination application showed no significant ($p > 0.05$) effect on the plant height except at 6th and 8th week of planting as shown in table 5.

Table 5: Main Effect of Fertilizer and pH levels on Plant height in Greenhouse Trial

Treatment	2 wks	3 wks	4 wks	5 wks	6 wks	8 wks
Fertilizer						
T1	9.47	13.31	17.22	23.06	28.44	71.4
T2	8.67	12.43	18.16	22.17	30.37	61.4
T3	9.62	13.19	17.35	24.82	30.82	65.4
T4	9.73	12.15	17.16	22.37	30.47	64.8
T5	10.56	14.09	17.22	22.47	29.97	66.0
T6	9.66	12.48	15.32	19.73	26.70	51.3
F-LSD (0.05)	NS	NS	NS	NS	2.839	10.91
pH(Lime)						
B1	10.02	14.61	18.28	24.04	31.69	62.6
B2	8.40	11.32	15.64	19.66	24.88	56.4

B3	9.84	12.43	16.51	21.57	27.57	61.5
B4	10.21	13.40	17.86	24.49	33.69	73.1
F-LSD (0.05)	1.461	1.789	1.750	2.812	2.318	8.91

T1:200Kg/ha NPK + 6t/ha Poultry Manure; T2: 300Kg/ha NPK + 4t/ha PM;
T3 400Kg/ha NPK + 2t/ha PM; T4: 400Kg/ha NPK only. T5: 8t/ha PM only; T6: control. B1: pH 5.5; B2: pH 6.0; B3: pH 6.5; B4 pH 7.0

Although T1 (200Kg/ha NPK + 6t/ha Poultry Manure) to T5 (8t/ha PM only) were statistically the same, they were significant higher than T6 (control) except T1 in the order: T3 (400Kg/ha NPK + 2t/ha PM) > T4 (400Kg/ha NPK only) > T2 (300Kg/ha NPK + 4t/ha PM) > T5 (8t/ha PM only) > T1 (200Kg/ha NPK + 6t/ha PM) > T6 (control) by 15.43%, 14.12%, 13.75%, 12.25%, 6.52% respectively as shown in table 2. Similar trends were obtained at 8th week, except that T1 had the highest value. This shows that fertilizer combination gives better performance than sole application of inorganic fertilizer (NPK) or poultry manure. This is in line with findings of Ayoola and Makinde (2007). They observed that the highest values of 7.20 and 7.90 t ha^{-1} were obtained from plots treated with complementary inorganic and organic fertilizers.

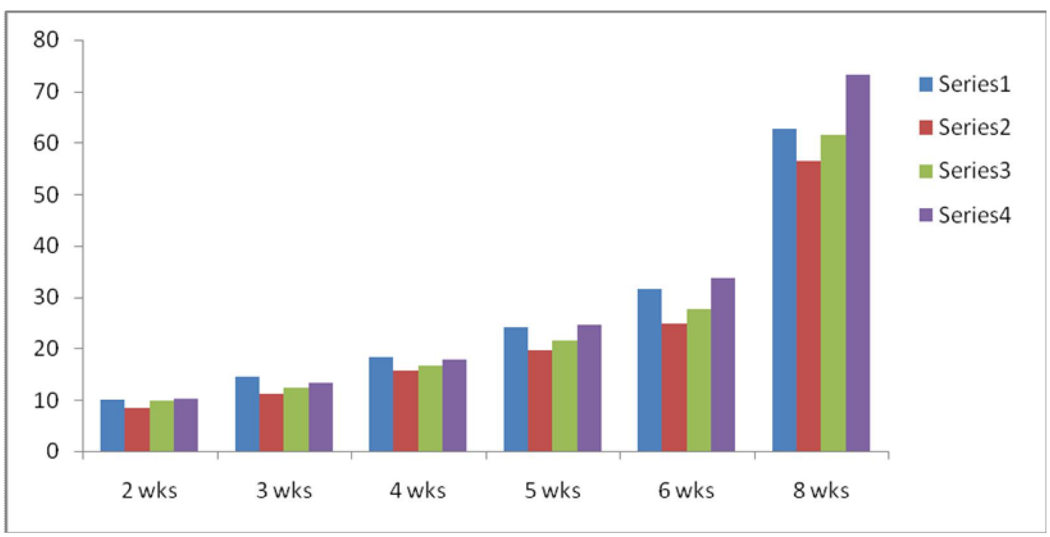
Throughout the growth stage, unlike fertilizer combination application, lime application at different soil pH levels had significant ($p > 0.05$) effect on the plant height. This is shown in figure 1. Plant height in soils with pH 6.0 and 6.5 were the same except at 6th week where plant height in pH 6.5 soil was 10.8% over that in pH 6.0 soil. Plant heights in soil of pH5.5 were significantly higher than soils of pH 6.0 by 19.3%, 29.1%, 16.88%, 22.2% and 27.4% at respective weeks except at 8th week.

Although soil of pH 7.0 gave higher value than soil of pH5.5, they were statistically the same except at tasselling stage while the plant height in the soil of pH 7.0 was significantly different from soil of pH5.5 by 16.8%. Soil of pH 7.0 was significantly different from soil of pH6.0 throughout the growth period and that of pH6.5 from the 5th week of growth.

This result is in line with the findings of Oluwatoyinbo *et.al*, (2005) that Plant height was significantly ($p = 0.05$) increased by the application of all rates of lime and P applied either singly or in combination both in the greenhouse and field studies. The results obtained in the field at 4th and 8th week of growth corroborated with the greenhouse trial as shown in table 4. At 4th and 8th week, T6 (control) had the lowest plant height value while T5 (8t/ha PM) and T1 (200Kg/ha NPK + 6t/ha PM) gave the highest value respectively.

Soil at different pH levels had significant effect on the plant height. Though soils of pH 5.5, pH6.0 and pH 6.5 were not significant at 4th and 8th week, soil of pH 6.0 gave the least value. Soils of pH 7.0 were significant over pH 5.5, pH 6.0 and pH6.5 by 18%, 22.5%, and 21% respectively at 4th week and by 22.5%, 30%, and 23.5% respectively at 8th week. This is clearly shown in figure 1.

Figure: 1. Main Effect of pH Levels on Plant Height in Greenhouse Trial



Series1 = pH5.5, Series2 = pH6, Series3 = pH6.5, Series 4 = pH7.0, Wks = weeks

Leaf Area Index (LAI)

Fertilizer application had no significant effect on the LAI except at tasselling stage (8th week), where T6 (control) was significantly lower than all other treatment application in the order: T2 > T1 > T4 >T5 > T3 by 51.8%, 49.5%, 46.1%, 40.8% and 37.4% respectively as shown in table 6. Treatment (T6) gave the least LAI value throughout greenhouse trial. Soil at different pH levels was significant only at 4th and 8th week.

Table:6 Main Effects of Treatment Combinations on Leaf Area Index from Greenhouse Trial

Treatment combination	2 wks	3 wks	4 wks	5 wks	6 wks	8wks
Fertilizer						
T1	0.1522	0.284	0.495	0.660	0.656	1.066
T2	0.1312	0.261	0.492	0.560	0.594	1.082
T3	0.1365	0.300	0.519	0.607	0.627	0.980
T4	0.1700	0.270	0.418	0.555	0.585	1.042
T5	0.1658	0.342	0.450	0.647	0.667	1.004
T6	0.1221	0.205	0.367	0.466	0.466	0.713
F-LSD (0.05)	NS	NS	NS	NS	NS	0.1833*
pH(Lime)						
B1	0.1438	0.309	0.518	0.615	0.638	0.912
B2	0.1254	0.231	0.377	0.552	0.552	0.930
B3	0.1568	0.261	0.443	0.577	0.577	0.982
B4	0.1591	0.306	0.489	0.630	0.630	1.101
F-LSD (0.05)	NS	NS	0.0909*	NS	NS	0.1497*

T1:200Kg/ha NPK + 6t/ha Poultry Manure; T2: 300Kg/ha NPK + 4t/ha PM; WKS: weeks
T3 400Kg/ha NPK + 2t/ha PM; T4: 400Kg/ha NPK only. T5: 8t/ha PM only; T6: control.
B1: pH 5.5; B2: pH 6.0; B3: pH 6.5; B4 pH 7.0

At tasselling stage, soils with pH 5.5, pH 6.0 and pH6.5 were not significant though soil with pH 6.5 had higher LAI value than those of pH 5.5 and pH 6.0. pH 7.0 soil was significant ($p > 0.05$) over pH 5.5 and pH6.0 except for pH 6.5 at the tasselling stage. However, for the field trial, fertilizer application had significant effect on the LAI at 4th and 8th week. Also liming at different pH levels had significant effect on LAI only at 4th week. Soil at pH 7.0 gave the highest LAI value while soil at pH 6.0 had the least value.

Number of Tasselling

In field trial, the tasselling number of maize was significantly affected by fertilizer application as shown in table 7.

Table: 7 Main Effects of treatment combinations on plant height (PHT), leaf area index (LAI) leaf number (LN); number of tasselling (NTS) in the field trial.

Treatment combination	4WKS. PHT	8WKS. PHT	4WK LAI	8WKS LAI	4WKS LN	8WKS LN	8WK NTS
Fertilizer							
T1	16.65	127.7	0.649	2.829	21.75	45.58	1.75
T2	16.57	123.3	0.645	2.538	21.92	44.08	2.00
T3	16.72	119.7	0.594	3.108	21.67	48.08	1.42
T4	14.59	107.8	0.542	2.657	20.83	45.00	1.42
T5	17.93	115.3	0.718	2.474	22.50	42.75	1.92
T6	12.33	49.6	0.329	1.530	19.83	37.00	0.17

F-LSD (0.05)	2.765	24.42	0.1901	0.4309	NS	4.051	1.19
pH(Lime)							
B1	15.34	103.0	0.565	2.540	21.78	45.56	1.39
B2	14.78	97.1	0.489	2.547	20.39	42.33	0.94
B3	14.97	102.7	0.517	2.465	20.56	41.56	1.28
B4	18.10	126.2	0.746	2.537	22.94	45.56	2.17
F-LSD (0.05)	2.258	19.94	0.2328	NS	NS	3.308	NS

T1:200Kg/ha NPK + 6t/ha Poultry Manure; T2: 300Kg/ha NPK + 4t/ha PM; T3 400Kg/ha NPK + 2t/ha PM T4: 400Kg/ha NPK only. T5: 8t/ha PM only; T6: control. B1: pH 5.5; B2: pH 6.0; B3: pH 6.5; B4 pH 7.0. WKS: weeks

The plants treated with 300Kg/ha NPK + 4t/ha PM (T2) had the greatest number of tassels and those treated with 0Kg/ha NPK + 0t/ha PM (T6) had the least tasselling number. Athough liming to different pH levels had no significant effect on mazie leaf number, soils at pH 7.0 gave the greatest tassselling number, while pH 6.0 had the least.

Cob weight

Table 8 shows the effect of combined fertilizer application and pH levels on dry matter and maize yield.

Table: 8 Main Effects of Treatment Combinations on Dry Matter, Cob Weight, Seed Weight

Treatment combination	Cob Wt(kg/plot)	Seed Wt (kg/plot)	Dry matter Field (kg/plot)	Dry matter Greenhouse (g/pot)
	Fertilizer			
T1	0.597	0.0766	1.792	14.74
T2	0.598	0.0687	1.733	14.04
T3	0.567	0.0645	1.808	14.88
T4	0.562	0.0765	1.667	12.92
T5	0.525	0.0700	1.625	13.09
T6	0.238	0.0397	0.775	9.11
F-LSD (0.05)	0.1020*	0.013*	0.216 *	2.021*
			pH(Lime)	
B1	0.554	0.0716	1.728	13.19
B2	0.452	0.0559	1.450	12.26
B3	0.473	0.0548	1.417	13.30
B4	0.578	0.0817	1.672	13.77
F-LSD (0.05)	0.0833*	0.011*	0.177 *	NS

T1:200Kg/ha NPK + 6t/ha Poultry Manure; T2: 300Kg/ha NPK + 4t/ha PM; Wt: weight
T3: 400Kg/ha NPK + 2t/ha PM; T4: 400Kg/ha NPK only. T5: 8t/ha PM only; T6: control. B1: pH 5.5; B2: pH 6.0; B3: pH 6.5; B4: pH 7.0.

Fertilizer application had significant effect on the cob weight, seed weight and dry matter weight. Soil treated with T2 (300Kg/ha NPK + 4t/ha PM) and T3 (400Kg/ha NPK + 2t/ha PM) gave the highest cob weight though they were statistically the same with other fertilizer treatment application except T6 (control) which had the lowest value. Cob weight was highest in soil with pH7 followed by pH 5.5 though the values were not significantly different. Soil of pH 6.0 had least cob weight.

Dry matter yield

Fertilizer application had significant effect on the dry matter both in the field and in the greenhouse trials. In the field trial, fertilizer combinations were significantly different from the control (T6) in the order: T3 > T1 > T2 > T4 > T5 by 133.3%, 131%, 123.6%, 115.1% and 109.7% respectively. Though TI, T2, T3, T4, and T5 were statistically the same, T3 gave the highest dry matter yield. Makinde *et al*. (2001a), had earlier reported that maize yields from sole inorganic fertilizer and a mixture of organic and inorganic fertilizer applications were similar and were significantly higher than yields from organic fertilizer application.

They also found that organic fertilizer application did not benefit the yield of maize significantly. Similarly, lime application had significant effect on dry matter yield only in the field trial. Dry matter yield in pH 5.5 and pH 7.0 soils were statistically the same, but were significantly (P > 0.05)different from pH 6.0 soil by 19.2 % and 15.3% and pH6.5 soil by 22% and 18% respectively. Although dry matter yield in pH 5.5 and pH 7.0 soils were statistically the same, that of pH 5.5 soil was 3.3% higher than pH 7.0. This result is not similar to the findings of Gene, et. al,(2005) that Lint yields from dolomite and calcite lime treatments (including the calcite + Mg mix treatment) were significantly higher than the untreated check for the 3-yr means.

CONCLUSION

It was observed that combination of NPK 15-15-15 and poultry manure at various rates had better amendment effects than sole application of NPK 15-15-15 or poultry manure on maize plant performance in such parameters as plant height, leaf number, leaf area index, number of tasselling, cob weight, chaff weight, and dry matter. Similarly, soil at different pH levels had effect on maize plant performance. The order of performance was as follows: pH 7.0 soils > pH 5.5 soils > pH 6.5 > pH6.0 in plant parameters such as number of tasselling, plant height, cob weight, husk weight, seed weight. except in dry matter yield, where the performance was as follows: pH 5.5 > pH 7.0 pH > pH 6.0 > pH > 6.5.

In conclusion, although soil of pH 7.0 gave higher values in the parameters measured, but it was not significantly higher than the values obtained in pH 5.5 soils. Also, since soil of pH 5.5 had better performance in most parameters measured than those of pH 6.0 and pH 6.5 soils, it is therefore, not economical liming such soils above pH 5.5 for maize production. Nevertheless, there is need for further research on the effect of liming acidic soil to different pH levels on the soil nutrient contents and their availability for sustainable agriculture in an ultisol.

Thus, for better yield and productivity of maize crop, the use of T1 (200Kg/ha NPK + 6t/ha Poultry Manure) in a soil limed to pH 5.5 is recommended.

REFERENCES

Adrien, N.D., 2006. Mixed paper mill sludge effects on corn yield, nitrogen efficiency and soil properties. publications of the European communities. Agron. J., 98: 1471-1478. 26.

Akamigbo, F. O. R. and Igwe, C. A. (1990). Physical and chemical characteristics of four gullied soil location in Anambra state, Nigeria. Niger. Agric. J. 25: 29 – 48.

Anderson, J. M. And J.S.I Ingram (1993). Tropical soils biology and fertility. A handbook of methods, 2nd Ed; CAB International, Wallingford U.K. pp 221

Arunkumar, A (2007). Effect of Different Levels of NPK on Growth and Yield Parameters of Sweet Corn. *Karnataka J. Agric. Sci*.,*20(1): 41 – 43.*

Asadu , C. L. A. (2002). Comparative evaluation of the contributions of soil physiochemical properties to variations in the yield of flour major staple food crops in eastern Nigeria. Soil and Tillage Research 65: 141 – 155.

Ayeni L.S, 2011. Integrated Plant Nutrient management: A Panacea for Sustainable Crop Production in Nigeria.

Ayoola, O.T. and E.A Makinde(2007). Complementary Organic and Inorganic Fertilizer Application: Influence on Growth and Yield of Cassava/maize/melon Intercrop with a Relayed Cowpea. Australian Journal of Basic and Applied Sciences, 1(3): 187-192, 2007. ISSN 1991-8178, INSInet Publication.

Aziz, T., S. Ullah, A. Sattar, M. Nasim, M. Farooq and M.M. Khan, 2010. Nutrient availability and maize (*Zea mays* L.) growth in soil amended with organic manures. *Int. J. Agric. Biol.*, 12: 621–624.

Bray, R. H.and Kurtz, N. T. (1945). Determination of total organic and available form of phosphorus in soil. Soil Sci. 59: 39- 45

Bremner, J. M. (1996). Nitrogen-total. P.1085-1121. In: D. L. Sparks (Ed). Methods of Soil Anaysis, Part III. Chemical methods. SSSABook series No. 5. Am. Soc. of Agron. Madison, W. I.

Crozier, C. R., and D. H. Hardy.(2003). *SoilFacts: Soil Acidity and Liming—Basic Information for Farmers and Gardeners*. Publ. AGW-439-51, North CarolinaCooperative Extension (http://www.soil.ncsu.edu/publications/ Soilfacts/AG-439-51

Gene Stevens, Tina Gladbach, Peter Motavalli, and David Dunn, (2005). Agronomy and Soils. Soil Calcium: Magnesium Ratios and Lime Recommendations for Cotton. The *Journal of Cotton Science 9:65–71*. http://journal.cotton.org

Hoekenga OA, Pineros MA (2004). How do crop plants tolerate acid soils? Mechanisms of aluminum tolerance and phosphorous efficiency.In: Lucia Mattiello, Matias Kirst, Felipe R da Silva, Renato A Jorge, and Marcelo Menossi1 (2010). Transcriptional profile of maize roots under acid soil growth. BMC Plant Biology, 10:196

Johnson JP, Carver BF, Baligar VC (1997). Productivity in Great Plains acid soils of wheat genotypes selected for aluminium tolerance. Bot Rev: 68:235-269.

Kamprath, E.J. and C.D. Foy, (1971). Lime fertilizer plant interactions in an acid soil. In: Oluwatoyinbo et.al, (2005).Response of Okra (*Abelmoschus esculentus*) to Lime and Phosphorus Fertilization in an Acid Soil World Journal of Agricultural Sciences 1 (2): 178-183.

Katerji, N., Van Hoorn, J.W., Hamdy, A., Karam, F., and Mastrorilli, M. (1996). Effect of salinity on water stress, growth and yield of maize and sunflower, Agricultural Water Management 30, 237-249;

Konsler, T.R. and J. E Shelton (1990). Lime and Phosphorus Effects on American Ginseng: I. Growth, Soil Fertility, and Root Tissue Nutrient Status Response *North Carolina State University, Raleigh, NC 27695-7609*. J. AMER. SOC. HORT. SCI. 115(4):570-574.

Lucia Mattiello, Matias Kirst, Felipe R da Silva, Renato A Jorge, Marcelo Menossi1, (2010). Transcriptional profile of maize roots under acid soil growth.. BMC Plant Biology 2010, 10:196 http://www.biomedcentral.com/1471-2229/10/196].

Makinde, E.A., A.A. Agboola and F.I. Oluwatoyinbo,(2001a). The effects of organic and inorganic fertilizers on the growth and yield of maize in a maize/melon intercrop. Moor Journal of Agricultural Research 2: 15-20.

Mbah C. N. and Onweremadu E. U.(2009) effect of organic and mineral fertilizer inputs on soil and maize grain yield in an acid ultisol in abakaliki-south eastern nigeria. American-Eurasian Journal of Agronomy 2 (1): 07-12, 2009.ISSN 1995-896X © IDOSI Publications

Mugendi, D.N., P.K.R. Nair, J.N. Mugwe, M.K. O'Neill and P.L. Woomer, (1999). Calliandra and Leucaena alley cropped with maize. Part 1 Soil fertility changes and maize production in the sub-humid highlands of Kenya. Agrof. Systems, 46: 39-50.

Nwadialo, B. E. (1989). Soil –landscape relationship in the Udi- Nsukka plateau. Catena 16: 111- 120.

Obi, I. U. (1988). Maize production: In food crops production, processing and utilization. Proceedings of a course held at the University of Nigeria Nsukka, 10-22; April 1988.

Obi, M. E. And Asiebgu, B. O. (1980). The physical properties of some eroded soils of South eadtern Nigeria, Soil Science 130: 39- 48.

Oguntoyinbo, F.I., E.A. Aduayi and R.A. Sobulo, (1996). Effectiveness of some local liming materials in Nigeria as ameliorant of soil acidity. J. Plant Nutr., 19: 999-1016.

Parnes, 1990. Fertile soil. A grower,s guide to organic and inorganic fertilizer. Los Angeles University of California Press. P. 80.

Rhoades**,** J. D.(1982). Cation exchange capacity. In: Page, A.L.,editor, Methods of analysis, part II, 2nd Ed. Agron Monograph Vol. 9. Madison, W. I: ASA and SSSA. Pp. 149-157.

Shoemaker, H. E., McLean, E. O. And pratt, P.F.(1961). Buffer methods for determinine lime requirement of soils with appreciable amounts of extractable aluminium. Soil Sci. Soc. Of Am. Proc., 25, 274-277.

Sommers, L. E. and Lindsay W.L (1979). Effect of pH and redox on predicted heavy metal-chelate equilibria in soils. Soil Sci. Soc Am. J. 1979, 43(1):39-47. In: Lucia Mattiello, Matias Kirst, Felipe R da Silva, Renato A Jorge, Marcelo Menossi1, 2010. Transcriptional profile of maize roots under acid soil growth. Mattiello et al. BMC Plant Biology, 10:196 http://www.biomedcentral.com/1471-2229/10/196

Steel, R. G. D. And Torrie, J. H.(1980). Principle and procedures of statistics (2nd Ed.) Megrew-Hill Book Company Inc. N.Y.P. 633

Walkley, A. Black, I. A. (1934). An examination of Degtareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. Soli sci. Journal 37:29- 38