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Granite Dusts and Poultry Manure Effects on Growth Performance and Yield of Maize (Zea Mays L.)

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Abstract.
Poultry manure is rich in organic manure since solid and liquid wastes are excreted together and there is no urine loss. Comparative studies of the effects of various rates of granite dust and poultry manure were tested on maize performance in field trials at Akure, Nigeria between 2011 and 2012 cropping seasons. The treatments involved were: Control(No treatment application), 2tha^{1} granite dust; 3tha^{1} poultry manure + 0.5tha^{1} granite dust; 2tha1 poultry manure + 1tha1 granite dust; 1tha1 poultry manure+ 1.5tha1 granite dust; 4tha1 poultry manure and 200kgha1 of NPK fertilizer. Agronomic parameters observed on maize at 2, 4, 6, 8, 10 and 12weeks after planting were plant height, stem girth, number of leaves. At harvest, cob weight, plant biomass, grains weight per cob and husk weight were also measured. Equally, the ratio of root to stem and leaf of maize were investigated. It was found out that application combined application of granite dust and poultry manure improved the growth and yield quality of maize compared with the control. Maize treated with 3tha^{1} poultry manure + 0.5tha^{1} granite dust promote the growth and yield parameter of maize to a level of the standard recommended fertilizer rate of 200kgha^{1} of NPK fertilizer in the ecological zone of the southwestern Nigeria.
Keywords: Poultry manure, granite dusts, agronomic parameters, ratio, promote

1. Introduction.

The African continent will face unprecedented challenges in food production and increased pressures on its natural resources in the 21st century (Wendt, 2012). Many sub-Saharan Africa (SSA) countries especially Nigeria have agricultural based economies. Agriculture contributes on average 34 percent to the gross domestic product (GDP) of SSA countries and employs 64 percent of the labour force (World Bank 2007a,). Progress in achieving developmental goals (such as cutting hunger and poverty in half by 2015) has been delayed significantly; in fact, the number of food-deficient people actually increased in the past two years by at least 75 million(Chinwe,2010). Most tropical soils are highly weathered and are low in soil organic matter (SOM), nitrogen (N), phosphorus (P), potassium(K), sulphur (S), zinc (Zn) and copper (Cu) (Bationo *et al.,*1987), and as such the soils are often deficient in essential plant nutrients in a few year of cropping (Awodun *et al.,* 2007). These challenges require multifaceted, science-based technological, economic, and political approaches (IFPRI, 2008). Thus, application of inorganic fertilizer is often necessary for crop production in sub-Saharan African soils. But, the use of mineral fertilizer in crop production has not been sustainable due to its high cost, scarcity and nutrient imbalance ((Buresh *et al.,* 1997, Van Straaten, 2002, Awodun, 2007 ; Hellal *et al.,* 2012.). Problems that adversely affected total dependence on either organic or mineral fertilizers have been highlighted by researchers (Adeniyan and Ojeniyi, 2003, Olowokore, 2004; Adeniyan Ojeniyi 2005 and Makinde *et al.,* 2010). Though, mineral fertilizers have sustained world agriculture and thus global population, wealth and growth for more than 100years (Smil, 2001, Stewart *et* al., 2005). The high cost of soluble phosphate fertilizer such as single or triple super phosphate has generated considerable interest in the utilization of rock phosphate (Nnadi and Haque, 1988; Chien and Hammond 1989; Akande *et al.,* 1998; Agyin-Birikorang et al., 2007). Thus, direct application of insoluble rock phosphate had increased globally due to the rapid expansion in the biological organic sector of agriculture and the need for inexpensive phosphate in developing countries (Hellal, *et al.,* 2012).This is because phosphorus inputs are required for sustainable agricultural production in most acid soils of the tropics and subtropics. Also, there is renewed interest in locally available agro -waste by poor resource farmers to fertilize their farms. (Adeleye and Ayeni 2010). In addition, Compost as fertilizer or soil conditioner improves the soil quality by enhancing aeration, water status, macro and micro nutrients and aggregate stability which perk up plant growth (Amlinger *et al.,* 2007). But, concerns are often expressed on the effectiveness of rock phosphate for direct application to soil. Direct application of ground rock phosphate had been proved to be beneficial to crops on acids soils (Nnadi and Haque, 1988). There are only a limited number of climatic and soil situation in which rock phosphate will be sufficiently reactive for use as direct application fertilizer, especially for fast growing annual crops. However, numerous studies have been conducted on amending rock phosphates to increase their immediate phosphorus availability and also to enhance their rate of dissolution after application to soil (Rajan and Marwala, 1993; Chien and Menon 1995; Agyin-Birikorang et., 2007).Also, it was reported that, compositing of rock phosphates with agricultural wastes is known to increase solubility of rock phosphates

(Bangar *et al*., 1985; Mey *et al.,* 1986; Mishra *et al.,* 1984; Mishra and Bangar, 1986; Kothandaraman, 1987; Singh and Amberger, 1990; Akande *et al.,* 1998). The content of P solubility of a given rock phosphate varies with the kind of organic material and the rate of decomposition (Banger *et al.,* 1985).

Maize (*Zea mays* L.) , an important food and feed crop of the world and it is often referred to as "the king of grain crops" (Bukhsh, 2010) respond well to fertilization. It is one of the most crucial and strategic cereal crops of Africa and developing world in general (FARA, 2009). It is produced in different parts of the continents under diverse climatic and ecological conditions. Due to its increasing importance, maize has become a major staple and cash crop for smallholder farmers (CIMMYT and IITA, 2010). Maize, like any cereal crop is high nutrient demanding (especially for N) and these nutrients are limiting in the savanna soils due to intensive cropping and inadequate vegetation cover. The introduction of conventional inorganic fertilizer has drastically reduced the use of organic manures. Organic manures which are from plant and animal origin (green manure, cow dung, poultry manure), play a direct role in plant growth as a source of all necessary macro and micronutrients in available forms during mineralization. Thereby, they improve both the physical and physiological properties of soil (El Shakweer *et al.,* 1998), thus enhancing soil water holding capacity and aeration (Abou el Magd *et al.,* 2005). Organic manures decompose to give organic matter which plays an important role in the chemical behavior of several metals in soil through the fulvic and humic acid contents which have the ability to retain metals in complex and chelate forms (Abou el Magd *et al.,* 2006). They release nutrients rather slowly and steadily over a longer period and also improve soil fertility status by activating soil microbial biomass (Ayuso *et al.,* 1996; Belay *et al.,* 2001). They thus, ensure a longer residual effect (Eghball *et al.,* 2004; Gong *et al.,* 2009; Aguilera *et al.,* 2012; Suthamathy and Seran 2013; Liu *et al.,* 2013), support better root development and this leads to higher crop yields (Abou el Magd et al., 2005).

Fertility improvement by inorganic fertilizer is currently out of the reach of the majority of peasant farmers due to high cost. This situation has forced most of the farmers to grow and produce maize with little or no fertilizer which reduces yield and quantity of maize produced (Onwueme and Sinha, 1991). Granite dusts (Rock dusts), as the term is used in organic agriculture, refers to those granite meals and quarry dusts and rock flours that are derived from very finely ground rock minerals. A common notion among organic farmers is that rock dusts provide key mineral supplementation that enhances the "strength" and "vitality" of plants and thereby increase resistance to insect attack as well as improves the flavor and nutrition of crops. Several alternative approaches have been used or proposed to increase phosphorus(P) availability in rock phosphate (RP) including: (1) incorporation of additives into RP, (2) partial acidulation of RP, (3) compaction of RP with water-soluble P fertilizers, and (4) microbial methods (Van Straaten, 2002). In this situation, the use of poultry litter which is readily available and can supply minimum amount of nutrients for maize production is advisable. Various researches have been conducted on organic fertilizer, rock dust but there is dearth of information on the use of poultry and rock dusts as a complement or substitute for inorganic fertilizer for soil fertility management. Thus, the objective of this study is to investigate the rate of nutrient released, its uptake by maize in rock dusts, and poultry manure and the combination of both poultry manure and granite dusts.

2 Materials and Methods

2.1.1 Description of Location and Experimental Site

Field experiments were conducted at the Teaching and Research Farm of the Federal University of Technology, Akure ($7^0 17^1$ N $5^0 10^1$ E) in the southwest Nigeria between 2011 and 2012 farming season respectively. The soil at the site of experiment is an alfisol (FAO, 1998) derived from the basement complex rock and it is sandy loam. The average annual rainfall range was about 1613mm per annum and the annual mean temperature was 27°C. The vegetation is tropical rain forest with an average relative humidity of between 56 and 59% during the dry season and 51 - 82% during the wet season (IITA, 2002).

2.1.2 Land preparation, sourcing for the materials and planting.

The land for the field trials were prepared with plough and mapped out with the aid of improvised poles to divide the field into plots. Planting was done manually with the use of cutlass. Cured poultry manure was sourced from State Agricultural Development Programme poultry farm and the granite dust from a reputable quarry site at Akure, Ondo State Nigeria.

2.1.3 Determination of soil chemical properties:

Soil samples were collected for the determination of chemical properties before planting and after harvest, Composite surface (0 to10cm) soil samples were collected using auger over each site before commencement of experiment and bulked. The soil samples were air-dried and sieved using a 2mm sieve before making the determinations. Soil organic carbon was determined by the procedure of Walkley and Black using the dichromate wet oxidation method (Nelson and Sommers, 1996), total N was determined by micro-Kjeldahl digestion method (Bremner, 1996), available P was determined by Bray-1 extraction followed by molybdenum blue colorimetry (Frank *et al.,* 1998). Exchangeable K, Ca and Mg were extracted using 1.0 N ammonium acetate. Thereafter, K was determined using a flame photometer and Ca and Mg were determined by atomic absorption spectrometer (AAS). Soil pH was determined in soil-water (1:2) medium using the digital electronic pH meter (Ibitoye, 2006)

2.2.1Treatment and Experimental Design
Six treatments of soil amendments and control were applied as follow: Control; 200kg/Ha of NPK fertilizer; 4t/Ha Poultry manure, 3t/Ha Poultry manure + 0.5t/Ha Granite dusts ; 2t/Ha Granite dusts; 2t/Ha Poultry manure + 1t/Ha Granite dusts; 1t/Ha Poultry manure + 1.5t/Ha Granite dusts. The treatments were arranged in Randomized Complete Block Design (RCBD) with four replications. Data were collected from plants at 2 weeks interval from 2 weeks after planting (WAP).

2.2.2 Data Collection
Growth data were observed on 5 tagged plants selected randomly per plot from 2 weeks after planting (WAP) to 10 weeks after planting (WAP). Plant parameters- Stem girth, number of leaves, leaf length, cob weight, plant biomass, Root/ stem/leaf ratio, number of grain per cob, grain weight per cob, and husk weight.

2.3.1 Statistical Analysis
The collected data were subjected to Analysis of variance using Statistical Package for Social Sciences, (SPSS) and the means were separated using Duncan's New Multiple Range Test (DMRT)

3 Results and Discussions.

Table 1 presents the value of initial soil analysis for the two experiments (2011 and 2012) before planting. The pHs of the soil were observed to be slightly acidic with 5.1 for 2011 and 6.6 for 2012.

Table 1: Pre- cropping physico- chemical properties of test soils.

Parameters	2011	2012
Sand %	56.8	52.6
Silt %	16.1	20
Clay %	27.1	27.4
Bulk Density (gcm-3)	1	1
pH (H2O)	5.13	6.6
Organic Carbon (%)	0.82	0.74
Organic Matter	1.42	2.5
Nitrogen (%)	0.12	0.22
Available P (mg kg-1)	11.12	7.3
Exchangeable K (cmol kg-^{1})	0.32	0.29
Exchangeable Ca (cmol kig-^{1})	2.60	3.1
Exchangeable Mg (cmol kg-^{1})	1.20	1.2

3.1.1 Combined effects poultry manure and granite dust on the leaf numbers per plant
The effects of granite dust and P.M on the number of leaf per plant of maize is presented on tables 2 and 3, monitored at two weeks interval over a period of ten weeks after treatment application in 2011 and 2012 respectively. In both years GD and P.M treatment significantly increased in the number of leaves produced when compared with the control at 8 and10 weeks after treatment. A similar trend was also observed at 8-10 weeks on treatments done with application of NPK. On table 2, at 10 weeks after planting (WAP) the percentage of number of leaves produced were 14.96, 15.45, 13.34, 15.24, 13.27, 14.47 and 13.27 for NPK, PM, ¼ PM + ¾ GD, ½PM + 1/2GD, 3/4PM + ¼ GD, GD and the control respectively. Also on table 3, at 10WAP, the percentage on the number of leaves produced were 15.11, 15, 43, 14.20, 14.07, 14.52, 13.88 and 12.39 for NPK, PM, ¼ PM + ¾ GD, ½PM +1/2GD, 3/4PM + ¼ GD, GD and the control respectively.

Table 2 : Effects of treatments on the numbers of leaves (2011)

Treatments	2	4	6	8	10	12
	Weeks after planting					
1	4.800b	5.950ab	7650b	9.350ab	10.650abc	10.500a
2	4.900b	5.650b	9.300a	0.400a	11.000a	10.300a
3	5.400ab	5.850b	6.350c	8.100cd	9.500bc	8.700b
4	6.350a	5.850b	7.350bc	8.800bc	10.850ab	8.300b
5	6.450a	6.050ab	7.50b	8.650bc	9.450c	8.550b
6	4.400b	5.50b	8.000b	10.400a	10.300ab	9.050b
7	4.800b	6.750ab	7.300bc	7.400d	9.450c	9.000b

Legend.
Treatment 1 = NPK
Treatment 2 = Poultry manure (PM)
Treatment 3 = ¼ Poultry manure + ¾ Granite dust
Treatment 4 = ½ Poultry manure + ½ Granite dust
Treatment 5 = ¾ Poultry manure + ¼ Granite dust
Treatment 6 = Granite dust (GD)
Treatment 7 = Control.

Table 3. Effect of treatments on the number of leaves (2012)

Treatments	2	4	6	8	10
	Weeks after planting				
1	4.950b	9.650ab	10.300a	10.950ab	11.650ab
2	5.300b	10.300a	10.350a	11.150a	11.900a
3	7.750a	9.400ab	10.350a	10.500abc	10.950bc
4	5.650b	9.050b	9.850a	9.850d	10.850bc
5	7.950a	10.150ab	10.350a	10.400abc	11.200abc
6	7.750a	9.700ab	10.100a	10.200bc	10.700c
7	6.050b	7.750c	8.400b	9.450d	9.550d

3.1.2Treatment effect on plant Height

Significant increase in plant height over control was observed for all treatment throughout the period of evaluation (Table 4 and 5). However, no significant differences were discovered in ½ P.M + ½ G.D. Application of ¾ P.M + ¼ GD constantly produced the plant with the highest plant height. On table 4 at 10WAP, the percentage of plant height produced were 15.74, 15.74, 14.41, 14.72, 15.43, 12.31 and 11.64 for NPK, PM, ¼ PM + ¾ GD, ½PM +1/2GD, 3/4PM + ¼ GD, GD and the control respectively. While on table 5, the values produced were 14.96, 14.20, 14.91, 13.64, 13.63, 14.96, 13.65 for NPK, PM, ¼ PM + ¾ GD, ½PM +1/2GD, 3/4PM + ¼ GD, GD and the control respectively.

Table 4. Combined effect of poultry manure and granite dust on the plant height (2011)

Treatments	2	4	6	8	10	12
	Weeks after planting (cm)					
1	1.850a	23.800bc	54.00ab	79.400bc	153.300a	1.450a
2	13300ab	2550b	67.950a	6.250a	153.350a	298.000a
3	11.000b	26.500b	47.200b	79.600bc	140.400ab	164.200a
4	12.700ab	22.850bc	48.950b	81.250bc	143.350ab	166.400a
5	12.200ab	19.700c	46.550b	64.35d	150.300a	156.400a
6	12.200ab	38.550a	66.150a	89.000b	119.900bc	174.500a
7	12.900ab	23.200bc	58.400ab	71.500d	113.400c	173.800a

Table 5: Combined effect of poultry manure and granite dust on the plant height (2012)

Treatments	2	4	6	8	10
	Weeks after planting (cm)				
1	13.750b	35.325ab	50.190b	77.900cd	201.500a
2	16.925ab	39.465a	49.965b	86.650bcd	190.800a
3	20.600a	43.770ab	68.700a	107.500a	200.300a
4	20.350a	34.895ab	63.550a	91.250abc	183.300a
5	15.350b	34.435ab	49.250b	69.400d	183.100a
6	14.400b	33.400b	52.075b	103.800ab	201.000a
7	14.570b	24.920c	40.680c	77.150cd	183.300a

3.1.3 **Treatment effects on Stem girth.**

Tables 6 and 7 presents the combined effect of poultry manure and granite dust on the stem girth of maize. It was observed that, in both years, PM+GD and NPK treatment significantly increased maize stem girth throughout the period of study when compared with the control and granite dust. However, the treatment of 3/4PM + 1/4GD and 1/2PM + 1/2GD produced the highest plant height throughout the period of evaluation. The percentage of stem girth produced (Table 6) by the various treatments at 10WAP were 14.18, 16.36, 13.60, 14.22, 13.93, 14.19, and 12.63 for NPK, PM, ¼ PM + ¾ GD, ½PM +1/2GD, 3/4PM + ¼ GD, GD and the control respectively for 2011. Also on table 7 at 10WAP, it was also found out that the percentage of stem girth produced were 12.23, 15.23, 15.81, 14.76, 13.67, 15.01, 13.27 for NPK, PM, ¼ PM + ¾ GD, ½PM +1/2GD, 3/4PM + ¼ GD, GD and the control respectively for 2012.

Table 6: Combined effect of poultry manure and granite dust on stem girth (2011)

Treatments	2	4	6	8	10	12
	Weeks after planting (cm)					
1	0.3200c	1.3200abc	0.9450a	2.0150a	6.8450ab	7.2500b
2	0.2850c	1.3200abc	1.0700a	1.9950a	7.4400a	8.5450a
3	0.3750bc	1.2350bc	0.8880a	2.0800a	6.1850b	6.9200bc
4	0.2900c	1.0450c	1.4450a	2.1300a	6.4700ab	5.8300d
5	0.2900c	1.1250c	1.0350a	2.1600a	6.3350ab	6.0950cd
6	0.6450a	1.595ab	1.3300a	2.1600a	6.4550ab	74650b
7	0.5150ab	1.7400a	1.0500a	2.1850a	5.7450b	6.5500bcd

Table 7. Combined effect of poultry manure granite dust on stem girth (2012)

Treatments	2	4	6	8	10
	Weeks after planting (cm)				
1	0.2700ab	2.1650bc	836a	3.055b	7.005d
2	0.3210ab	2.7450a	2.930a	3.310a	8.720a
3	0.2980ab	2.1750bc	2.615ab	3.125a	9.050a
4	0.2350b	2.1550bc	2.380bc	2.920bc	8.450ab
5	0.3590a	2.4900ab	2.665ab	3.055b	7.425bc
6	0.3450a	2.8000cd	2.145cd	2.765c	8.595ab
7	0.2950ab	1.7750d	2.030d	2.750c	7.595cd

3.2. Effects of Granite dust and Poultry Manure on the Yield Parameters.

3.2.1 Cob Dry weight.

Significantly differences were observed in cob weight for both treatment applications in both years.(Figure 1) It was observed that cob weight produced were 14.03%, 17.15%, 14.38%, 16.71%, 13.05%,16.18% and8.48% for NPK, PM, ¼ PM + ¾ GD, ½PM +1/2GD, 3/4PM + ¼ GD, GD and the control respectively for 2011. While that of 2012 were 14.85%, 18.56%, 17.23%, 15.78%, 8.58%,15.57% and 9.33% for NPK, PM, ¼ PM + ¾ GD, ½PM +1/2GD, 3/4PM + ¼ GD, GD and the control respectively.

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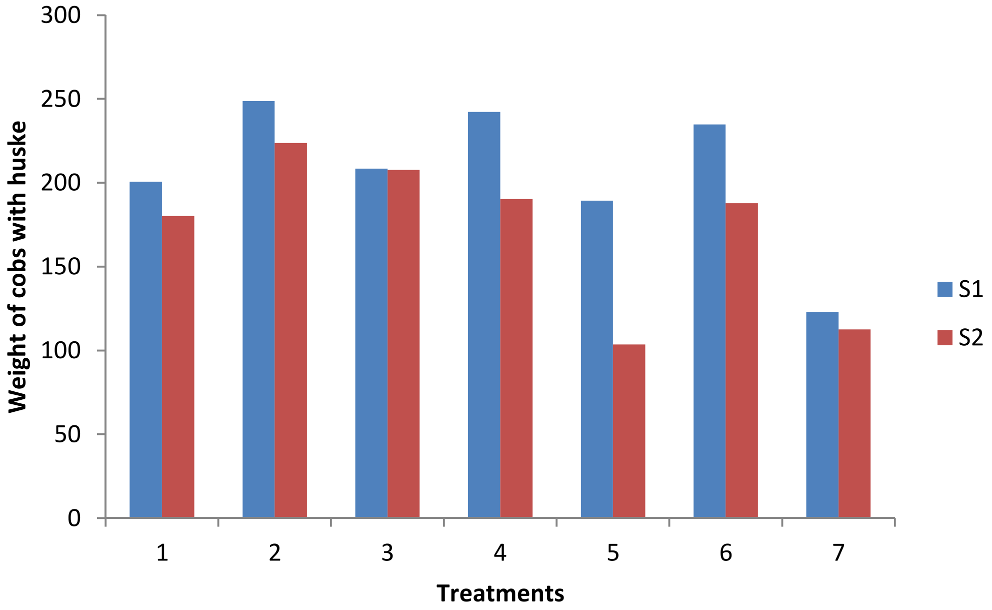

Figure 1. Combined effect of poultry manure and granite dust on weight of cobs with husk
Legend.
S1 – Treatments for the year 2011
S2 – Treatments for the year 2012.

3.2.2 Cob dry weight without husk.

There were significantly difference with PM and Control treatment in the first year of evaluation. While there were no statistical differences observed from both treatment and also the block effects shows no significant differences for both year of evaluation. In the first year of experimentation the cob weight produced without the husks were 14.09%, 17.72%, 15.05%, 16.00%, 11.30%, 17.57% and 8.29 % for NPK, PM, ¼ PM + ¾ GD, ½PM +1/2GD, 3/4PM + ¼ GD, GD and the control respectively(Figure 2). The various cobs weight of cobs of the cobs without the husk produced in the second year of the experiment were as follow 15.15%, 17.79%, 18.15%, 16.03%, 8.85% 15.53% and 8.80% for NPK, PM, ¼ PM + ¾ GD, ½PM +1/2GD, 3/4PM + ¼ GD, GD and the control respectively

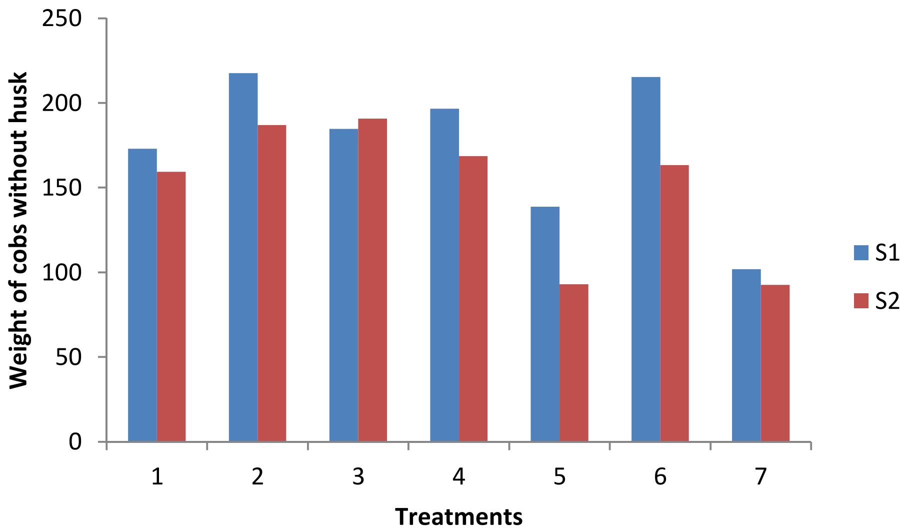

Figure 2. Combined effect of poultry manure and granite dust on the weight of cobs without the husk.

3.2.3 Number of Grains per Cob.

The effect of the different treatments on the number of grains produced is as presented in figure 3.There were no significant differences observed in the NPK, 3/4PM + 1/4GD, ½+ 1/2GD and 1/4PM + 3/4GD treatment but significantly difference were observed between PM and Control treatment. 15.12%, 13.66%, 16.19%, 17.88%, 13.27%, 14.94% and 8.95% 0f grains were produced from NPK, PM, ¼ PM + ¾ GD, ½PM +1/2GD, 3/4PM + ¼

GD, GD and the control respectively for year 2011 while that of 2012 were 12.25%, 18.40%, 17.00%, 14.65%, 11.36%, 18.04% and 8.29 % for NPK, PM, ¼ PM + ¾ GD, ½PM +1/2GD, 3/4PM + ¼ GD, GD and the control respectively.

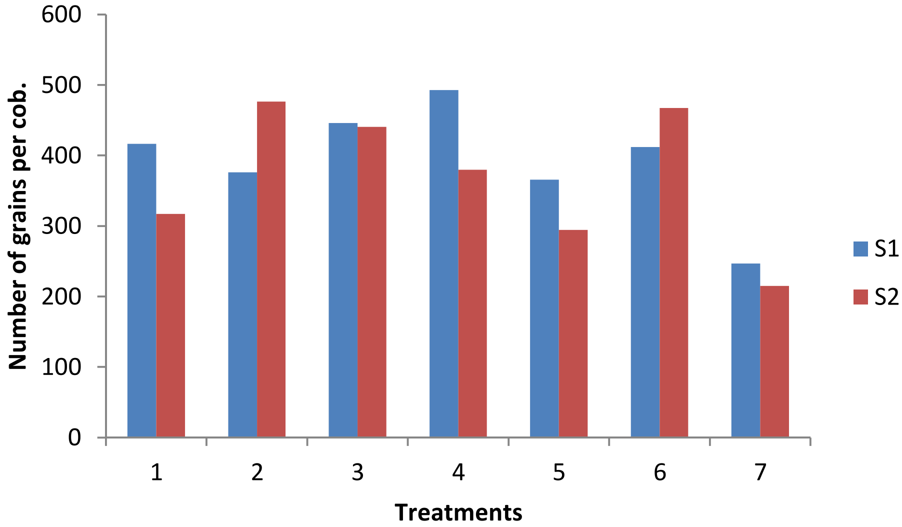

Figure 3. Combined effects of poultry manure and granite dust on the num of grains per cob.

3.2.4 Grains weight.

There were significant difference in grains weight amongst treatment in second year (2012) and no significant difference in the grains weight of the first year (2011) of the evaluation.(figure.4)

14.78%, 15.845, 15.41%, 15.41%, 15.07%, 16.53%, 7.49% weight of grains were produced from the application of NPK, PM, ¼ PM + ¾ GD, ½PM +1/2GD, 3/4PM + ¼ GD, GD and the control respectively for the year 2011 while that of 2012 were12.75%, 21.99%, 15.05%, 14.42%, 9.45%, 16.60% and 9.74% for NPK, PM, ¼ PM + ¾ GD, ½PM +1/2GD, 3/4PM + ¼ GD, GD and the control respectively

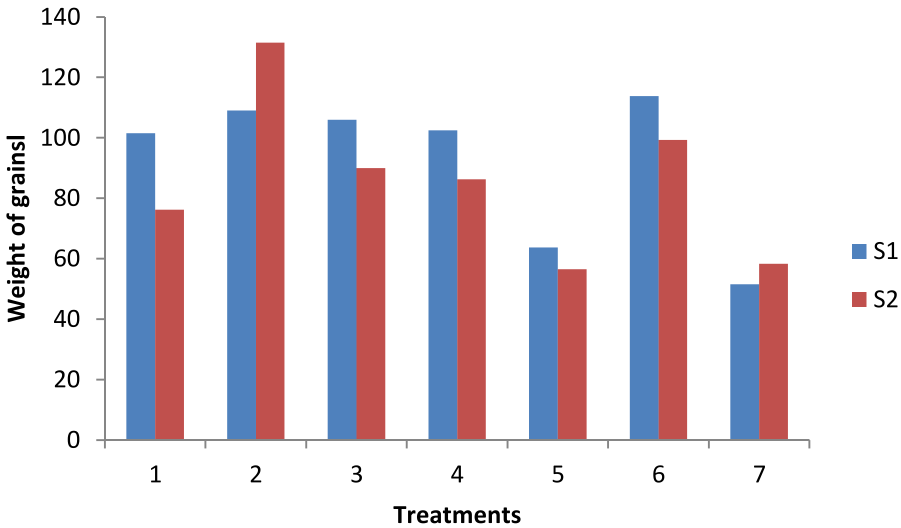

Figure 4: Effect of treatments on the weight of grains.

Increased growth performances were observed on plots treated with the combined use of poultry manure and granite dust over the control plots in the seasons compared. This agrees with the work of Singh and Amberger (1991) and Mahimairaja *et al.,* (1995), where it was stated that composting manure and /or biological waste with rock phosphate has shown to enhance the dissolution of the rock phosphate and it is practiced widely as a low-input technology to improve the fertilizer value of manure. This also corroborate the assertion of Agbede et al. (2008), where undigested poultry manure on sorghum crop in field trials significantly ($P > 0.05$) increased plant height, leaf area, stem girth, number of roots, root weight and shoot weight and grain yield. Poultry manure contains nutrient elements that can support crop production and enhance the physical and chemical properties of the soil (Mohamed *et al.,* 2010). Though, the understanding of the importance of organic matter in the soil informs the use of poultry manure, since organic manures decompose to give organic matter which plays an important role in the chemical behavior of several metals in soil through the fulvic and humic acid contents which have the ability to retain metals in complex and chelate forms (Abou el Magd et al., 2006). They release nutrients rather slowly and steadily over a longer period and also improve soil fertility status by activating soil microbial biomass (Ayuso *et al*., 1996; Belay *et al.,* 2001).Also, mined rocks, including ballast; biotite, mica, feldspars, granite and greensand are added to the soil without restriction. In addition, in the work of Chien and Menon (1995), phosphate rock (PR) for direct application has been tested in tropical acid soils as a potential alternative to conventional water-soluble P fertilizers like single superphosphate (SSP) and triple superphosphate (TSP)

It was observed (Sekhar and Aery, 2001) that farm yard manure (FYM) enriched with high grade (+34% P_2O_5) rock phosphate in fine size (d80 at 23 microns) shows better agronomic efficiency than di-ammonium phosphate when applied on equal P_2O_5 basis. However, in order to apply manure to fulfill the nutrient requirements of a crop, knowledge of the amount of nutrients mineralized following application is needed (Eghball *et al.,* 2002). Though, tremendous variability exists in the K release rate from these mineral sources. Some of them are wholly unsuitable as K sources for plant nutrition due to their limited solubility and their heavy and bulky nature, while others may have value over long periods of time (Mikkelson, 2008) In general; a smaller particle size translates to a greater surface area, reactivity, and weathering rate. An increase in the agronomic effectiveness of rock phosphates or granite dust in phospho-composts over that of directly applied PR can be expected because of its greater water-soluble and citric-soluble P contents, which would be available to plants. Moreover, the soluble P fractions should stimulate root growth and facilitate greater exploitation of P enriched soil (Chien *et al.*, 1987a). Treating rock phosphates with organic materials and composting them is a promising technique for enhancing the solubility and the subsequent availability to plants of phosphorus (P) from rock phosphates. The technology is particularly attractive where: (i) 'moderate to high' reactive rock phosphatess are available but unsuitable for the production of fully acidulated fertilizers such as single or triple superphosphate; (ii) organic manures are applied routinely to maintain the organic fraction of soils and supplement their nutrient requirement (as in most tropical countries); (iii) organic farming is practiced, which excludes the use of chemically processed fertilizers; and (iv) city and farm by-products need to be disposed of in an environmentally friendly manner. The rock phosphates-composted products are usually referred to as phospho-composts (Sekhar and Aery, 2001, Sekhar,*et al.,*2002 Sekhar *et al.,*2005).

4 Conclusions

This study clearly demonstrated that application of granite dust with poultry improved the yield and growth parameters of maize compared with control. It also shows that, the application of ½ PM + ½ GD and ¾ PM + ¼ GD was as effective as the standard recommended (200kgha-^{1}) NPK fertilizer for that ecological zone in improving most of the parameter observed. The study showed that direct application of granite dust co-applied with poultry manure will be a viable option for P replenishment. Thus a combination of granite dust and poultry manure could be a cost-effective means of ensuring sustainable agricultural production in P-deficient, highly weathered tropical soils.

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