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Influence of Organomineral Fertilizer on Some Chemical Properties of Soil and Growth Performance of Rice (*Oryza sativa* l.) in Sokoto, Sudan Savanna Zone of Nigeria

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Abstract
An experiment was conducted to determine the influence of industrially formulated organomineral fertilizer (OMF) on some chemical properties of soil and growth performance of rice (*Oryza sativa* L.) in Sokoto, Sudan Savanna zone of Nigeria. The experiment was carried out at the screen house of the Department of Biological Sciences, Usmanu Danfodiyo University, Sokoto. The organomineral fertilizer used in this experiment was formulated with a grade of 9:3:3 N:P:K using the following materials: urea, rock phosphate, wood ash, neem seed, blood meal, cotton seed cake, cow dung and poultry droppings. The experiment consisted of four levels of organomineral fertilizer (130, 170, 210, 250kg/ha) and control (without fertilizer) as treatments which were laid out in a completely randomized design (CRD). The growth parameters considered for rice performance were plant height, number of leaves and tillers per plant and total dry matter yield. Soil samples were collected from each experimental pot before planting and at harvest for physical and chemical properties determination. The result shows that treatment had significant ($p<0.05$) influence on soil pH, total nitrogen, available phosphorus and rice growth performance. Application of 250 kilogram per hectare (OMF) gave the highest increase in pH, total nitrogen, available phosphorus, number of leaves and tillers per plant, the least values on all the parameters considered were recorded in the control pots. From the findings of this research, it was concluded that application of OMF at 130, 170, 210 and 250kg/ha improved the soil nutrient status and growth and yield of rice. Thus, organic residues fortified with mineral fertilizers have great potential in improving soil fertility status and for high production of rice in Sudan savanna agro-ecological zone of Nigeria.
Keywords: Organomineral Fertilizer, Levels, Soil, Rice and Sudan savanna

1. Introduction

In Nigeria, rice is a major cereal crop consumed by over 150 million population of the country. Despite increasing demands by the populace, production has been limited as a result of low soil fertility (EIARD, 2013). Organic materials have been used by rice farmers in replenishing depleted soil nutrients in the pre-industrial age (Satyanarayana *et al*., 2002). Today however, a handful of traditional or subsistence farmers still adopt this method owing to high cost incurred in the purchase of mineral fertilizer and the difficulty in accessing government subsidized fertilizer in Nigeria (Agbede *et al*., 1995). The Impact of the organic material as fertilizer has been seen overtime in providing growth regulating substances and improves the physical, chemical and microbial properties of the soil (Belay *et al.,* 2001). In spite these, the slow release of nutrients to the soil to support plant growth have proven a major constraint in its use.

In most tropical farming communities, the use of inorganic fertilizers to boast yield of rice cannot be underestimated as they have been found to increase crop performance as well as the chemical properties of soil (Ojeniyi, 2000). Mineral fertilizers which are chemically synthesized fertilizers supplies nutrient to the soil at a faster rate unlike its organic counterpart, yet inorganic (mineral) fertilizer can only support crop growth on a short term basis due to vulnerability to loss. Its continuous use could lead to nutrient imbalance and soil acidity (Doran *et al.*, 1996). Several reports have thus proved that neither the sole use of mineral fertilizer (MF) nor organic fertilizer (OF) is a panacea for soil fertility management in Nigeria (Ayeni *et al.*, 2012). This has therefore prompted the introduction of a combined form of fertilizer (organomineral fertilizer) that would bridge the gap existing between mineral fertilizer and organic fertilizer.

The single use of either organic or inorganic fertilizers in recent years have not really met the expected impact in boasting crop yield to cope with the geometric demand hence, integrated supply have been advocated by the Food and Agricultural Organization of the UN (Olowokere, 2004). Kramer *et al.* (2002) stated that the complementary application of organic and inorganic fertilizers increases the synchrony and reduces losses by converting inorganic nitrogen to organic forms. While synthetic fertilizer is applied to feed the plant on a short term, organic compound are used to feed the soil system that in turn feeds the plant. In summary, the use of organic and inorganic fertilizers has its advantages and disadvantages in the context of nutrient supply, crop growth and environmental quality. The advantages need to be integrated in order to make optimum use of each type of fertilizer and achieve balance nutrient management for crop growth (Saidu *et al*., 2012). Several research has proved that the interaction between organic manure and inorganic fertilizer have synergetic effect on rice productivity. Studies carried out by Pandy *et al*. (1999), Ghosh *et al.* (1999), Dembele (2007) and Bagayoko

(2012) found that yield parameters such as plant height, tiller number, panicle number and number of panicle per m^2 of were influenced significantly by complementary application of organic and inorganic fertilizer compared to sole application of organic fertilizer. Saidu *et al.* (2012) also observed that application of 2t cow dung (CD) + 173kg N recorded the greatest plant height of rice compared to other treatments. It was observed that although the application of 2t CD + 260kg N and 4t CD + 173kg N gave the highest number of tiller count, the values obtained were not significantly ($P<0.05$) difference between the treatments.

This research was therefore, developed to determine the influence of industrially formulated organomineral fertilizer on some chemical properties of soils and the growth of rice in Sokoto, Sudan Savanna agro-ecological zone of Nigeria.

2. Materials and Methods

The trial was conducted during the 2013 dry season at the screen house of the Biological Science Garden of the Usmanu Danfodiyo University Sokoto. Sokoto state is located between Latitudes $11^0 3^1$ and $13^0 7^1$ N and Longitudes $4^0 0^1$and $5^0 12^1$E and at an altitude of 278m above sea level. The state falls within the Sudan Savanna agro-ecological Zone, characterized by a semi-arid climatic conditions involving alternate wet and dry season. The rainy season extends from June to September with an annual rainfall range of 550-750mm while the dry season lasts from October to May (Ojanuga, 2005). Relative humidity ranges from 51-79% during the rainy season and from 10-25% during the dry season (Sokoto Energy Research Centre) (SERC, 2011). Mean monthly temperature varies from 14^0C in December/January to 42^0C in April and wind speed range from 1.9-5Ms^{-1} (SERC, 2011). The treatments consisted of four levels (130, 170, 210 and 250kg/ha) and control (without fertilizer) of formulated organomineral fertilizer (with grade of 9:3:3 NPK) and was laid out in a completely randomized design (CRD) with three replicates. The soil used for this research was sourced from a fallow land at the Usmanu Danfodiyo University Sokoto (UDUS). The soil was collected at the depth of 0-15cm and was analyzed for some physical and chemical properties before the treatment was imposed and some chemical parameters were also analyzed after the experiment. The parameters analyzed in the laboratory were: particle size distribution, pH, organic carbon, total nitrogen, available phosphorus, cation exchange capacity (CEC) and exchangeable bases. Soil pH was determined by pH meter using 1:1 soil-water ratio. The soil organic carbon was determined using the modified Walkley-Black method as described by Nelson and Sommer (1982), total nitrogen was determined by Kjeldahl digestion and distillation procedure as described in Soil Laboratory Staff, Royal Tropical Institute (1984), available phosphorus was determined by Bray's No. 1 method as described by Bray and Kurtz (1945), cation exchange capacity (CEC) and exchangeable bases were determined using 1.0 N neutral ammonium acetate (NH_4OAC) solution.

Data were collected at an interval of four weeks after sowing (4WAS) on the following growth parameters: plant height, leaf number and tiller counts until harvest (14^{th} WAS). Total dry matter yield was recorded at harvest. Data generated were subjected to analysis of variance (ANOVA). Significant difference in the treatment means was further separated using least significance difference (LSD).

3. Results and Discussion

The result of the Initial soil analysis is presented in Table 1 which indicates that the soil was slightly acidic, low in organic carbon, total nitrogen, available phosphorus and calcium contents, based on the standard ratings of Esu (1991). Effect of different rates of oganomineral fertilizer on growth parameters and total dry matter yield of rice is presented in Table 2. The result indicates that treatments had significant ($p<0.05$) effect on all the growth parameters considered and dry matter yield of the rice. The effect of application of OMF at 170, 210 and 250 kg/ha on all plant parameters were statistically the same, indicating that application OMF above 170 kg/ha may no longer be economically effective. Number of leaves and tillers per plant were significantly ($p<0.05$) affected by treatment application. However, application rate at 210 and 250 kg/ha gave the highest number of leaves and tillers per plant with the least value obtained in the control pot. It is evident from the findings of this research that growth parameters of rice increased as fertilizer level increases. Singh and Agarwal (2001) reported an increase in number of leaves due to adequate nutrition that could be explained in terms of possible increase in nutrient absorption capacity of plant as a result of better root development and increased translocation of carbohydrates from the source to the growing tips. Mirza Hasanuzzaman *et al.* (2010) suggested that increase in the number of tillers per square metre might be due to sufficient availability of nitrogen which plays vital role in cell division. In addition, the root may have developed extensively within the soil medium bringing about balanced nutrition via absorption of micronutrients which positively enhanced the number of tillers. This Finding was supported by similar work carried out by Satyanarayana *et al.* (2002).

Effect of different levels of organomineral fertilizer on soil pH, total nitrogen and available phosphorus are presented in Table 3. The result indicated that, there was significant ($p<.0.05$) effect of the treatments on these soil properties. Their application also shows a tendency of increase in pH, total nitrogen and available phosphorus. However, application of 250kg/ha recorded the highest increase at 7.50, 0.71g/kg and 1.26 mg/kg

for soil pH, total nitrogen and available phosphorus respectively, while the control pot (without fertilizer) recorded the least values of 7.23, 0.40 g/kg and 0.89 mg/kg for the respective parameters mentioned. This could be attributed to the inherent quality of organic materials used in the formulation of the OMF which brought about a better soil condition. This was similarly observed by Ayeni *et al.* (2012) that, increase in soil pH might be related to higher amount of N and P in the organic materials. Agbede *et al.* (2008) reported that when poultry manure (PM) decomposes, nutrients (N, P, K, Ca and Mg) are released to soil significantly. Increased in the fertility status of the soil observed in this study concord the findings of previous studies which showed that amendment of soils using poultry manure improved soil organic matter, N, P, K, and Mg (Kingery *et al.,*1993; Adeniyan and Ojenyi, 2005; Akanbi *et al.,* 2005).

Conclusion

The result of this study shows that application of OMF at different levels significantly increased the growth and yield of rice. The growth parameters and dry matter yield of rice increased with increase in fertilizer rate. However, effect of application of OMF at 170, 210 and 250 kg/ha on all plant parameters were statistically the same. Therefore, application of OMF above 170 kg/ha may no longer be economically effective. The chemical properties of the soil considered increased steadily with increase in fertilization rate but application of 250 kg/ha gave the highest value of total nitrogen and available phosphorus. Based on the findings of this research, it could be concluded that, the industrially formulated organomineral fertilizer used in this experiment is an important soil nutrient replenishing material and could be used for rice production in the study area.

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Table 1: Physical and chemical properties of the soil before planting

Soil Parameters	Value
pH (H_2O) 1:1	6.7
Organic carbon (g/kg)	5.0
Total nitrogen (g/kg)	0.63
Available phosphorus (mg/kg)	1.14
Calcium (Cmol/kg)	1.20
Magnesium (Cmol/kg)	0.60
Potassium (Cmol/kg)	0.30
Sodium (Cmol/kg)	0.20
CEC (Cmol/kg)	4.24
Sand (%)	74.71
Silt (%)	17.64
Clay,%	7.65
Textural class	Loamy sand

Table 2: Effect of different levels of organomineral fertilizer on growth and dry matter yield of rice

Treatment (Rates of OMF kg/ha)	Plant height (cm)	No. of leaves /plant	No. of tillers /plant	Dry matter yield (kg/ha)
0	18.33c	5.10b	2.9b	3.17c
130	20.27bc	8.67ab	5.93ab	3.86bc
170	24.4b	13.5a	5.93ab	5.28ab
210	29.5b	15.8a	7.77a	6.14a
250	33.0ab	15.8a	8.07a	5.57ab

Means followed by the same letter(s) within the same row are statistically the same at 5% level of probability.

Table 3: Effect of different levels of organomineral fertilizer on soil pH, total nitrogen and available phosphorus

Treatment (Rates of OMF Kg/ha)	pH	Total nitrogen (g/kg)	Available phosphorus (mg/kg)
0	7.23c	0.40c	0.89c
130	7.33b	0.51b	1.12b
170	7.44ab	0.54b	1.18b
210	7.46ab	0.56b	1.25a
250	7.50a	0.71a	1.26a

Mean followed by the same letter(s) within the same row are statistically the same at 5% level of probability.

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