

Comparative Evaluation of Organo-Mineral Fertilizer (OMF) and Mineral Fertilizer (NPK) on Yield and Quality of Maize (*Zea mays* (L) Moench)

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Abstract

The continuous use of sole mineral fertilizer in tropical soils has been associated with reduced crop yield, increased soil acidity and nutrient imbalance. The combination of both organic and mineral fertilizers (organo-mineral fertilizer - OMF) has been found to be a better fertilizer management for these soils. An experiment was therefore carried out to compare the effect of mineral fertilizer NPK 15:15:15 and a local OMF on yield and quality of maize (*Zea mays* (L) Moench).

OMF at the rates of 3.0 and 1.5 t/ha, NPK 15: 15: 15 at 300 kg / ha and the control (no fertilizer application) were used to plant maize (SUWAN-I-DMR-SR-W) on the field in a randomized complete block design replicated three times. Data collected on plant growth and yield parameters were subjected to statistical analysis using Duncan Multiple Range Test and a simple economic analysis.

Performance of maize as a result of the treatments was in the order of 3.0 t / ha OMF > 1.5 t / ha OMF > 300 kg / ha NPK 15: 15: 15 > control with grain yields of 6.52, 6.06, 5.40 and 2.02 t / ha respectively. Since there was no significant difference ($p < 0.05$) between the grain yields resulting from 3.0 t / ha and 1.5 t / ha of OMF, the use of 1.5 t / ha Pacesetter's OMF grade A was therefore judged more economic than at 3.0 t / ha for tropical soils with similar nutrient status and agro-ecology.

Keywords: Organo-mineral fertilizer, mineral fertilizer, maize, tropical soils.

Introduction

Soil productivity maintenance has been one of the major constraints of tropical agriculture. Each year, Africa's finite capacity to grow food and fiber has progressively decreased, largely because of the decline in soil fertility (Economic Commission for Africa, 2001). A large area of humid and sub humid region is dominated by low activity clay soil characterized by low effective cation exchange capacity (CEC), low available water and nutrient reserve, and are highly susceptible to soil erosion (Kang and Juo, 1981, Department for International Development, 2002).

Earlier approach to soil fertilization was through the use of organic fertilizers, but farmers were discouraged using this due to some problems like bulkiness, cost of

transportation etc. attached to the use of organic fertilizers (Parr *et al.*; 1986, Smil, 2000). Most farmers now use mineral fertilizers to improve the productivity of their soils. However, continuous use of these mineral fertilizers has been found to only increase yield for some years but in the long run leads to decreasing base saturation, acidification, and a drop in soil pH (Phicot *et al.*, 1981, Isherwood, 2000). Currently, the combination of mineral and organic fertilizers termed Organo-mineral fertilizer (OMF) has been found to improve the productivity of tropical soils more than the sole use of either of this type of fertilizers (Agboola and Obigbesan, 1975; Sridhar *et al.*, 1985; Akanbi *et al.*, 2004). Titiloye *et al.* (1985) reported that maize yields obtained from treatments with combination of wastes and NPK fertilizers had better

yields than ones obtained from treatments in which waste material or inorganic fertilizer was applied alone. Murwira and Kirchmann, (1993), also reported that the nutrient efficiency of the plant can be increased through a complimentary application of manure and mineral fertilizers. Since different organic sources could influence plant growth differently, evaluating the performance of different brands / compositions of OMF in relation to the conventional mineral fertilizer is imperative.

Maize (*Zea mays* (L) Moench) is a very important crop in the tropics grown for many uses ranging from direct food for man / livestock to industrial applications (Powell *et al.*, 2004). The purpose of this experiment was to compare the efficiency and economic use of a Pacesetter's OMF grade A (commercial organo-mineral fertilizer) to mineral fertilizer N-P-K.

Materials and Methods

Experimental site

The experiment was carried out at Idioro village, Akobo Ojurin, Lagelu Local Government, Ibadan Nigeria (7°30'N, 3°54'E). Annual mean rainfall is 1,220 mm with bimodal

distribution. The annual mean temperature and sunshine are 21.30°C and 44% respectively while the mean day and night temperature is 28.1°C. The experimental soil is a sandy loam alfisol.

Experimental Design and Treatments

The experiment was a field study laid out in a randomized complete block design replicated 3 times with each plot size of 24 m x 3 m. SUWAN-I-DMER-SR-W maize variety was planted at spacing of 75cm by 60cm on a ploughed field. The total experimental area was 7,200m² (0.72ha). The seeds were sown at the rate of 3 seeds per stand and later thinned to 2 seedlings per stand. Fertilizers were applied 3 weeks after planting in a ring form. The experimental plots were manually weeded.

Four fertilizer treatments were used in this experiment: mineral NPK (15: 15: 15) at the recommended rate of 300kg/ha for maize in the experimental area; OMF (grade A) at 1.5 t/ha and 3.0 t/ha and control (no fertilizer application). OMF is a commercial product of pacesetter Organo-mineral Fertilizer Plant, Ibadan, Oyo state Nigeria. The Grades A and B are the fortified with mineral fertilizer and un-amended products respectively (Table 1).

Table 1: Proximate analysis for Pacesetter's Organo-mineral fertilizer grade A

Nutrient Element	Concentration
Nitrogen [g kg ⁻¹]	44.2
Phosphorus [g kg ⁻¹]	11.0
Potassium [g kg ⁻¹]	6.8
Calcium [g kg ⁻¹]	6.8
Sodium [g kg ⁻¹]	0.8
Zinc [mg kg ⁻¹]	713
Manganese [mg kg ⁻¹]	558
Iron [mg kg ⁻¹]	8153
Cu [mg kg ⁻¹]	257

Source: Pacesetter Fertilizer Company, Bodija Ibadan, Nigeria

Table 2: Soil Physico-Chemical Properties

Soil properties	Value
Soil pH in H ₂ O 1:2	7.1
Soil pH in KCl 1:20	6.5
Organic carbon [g kg ⁻¹]	16.7
Total Nitrogen [g kg ⁻¹]	1.50
Available P [mg kg ⁻¹]	13
Exchangeable Cation (c mol kg ⁻¹)	
Ca	0.6
Mg	0.1
K	0.1
Na	0.2
Acidity	0.8
CEC	1.8
Base Saturation [g kg ⁻¹]	518.0
Available Micronutrient [mg kg ⁻¹]	
Mn	97
Fe	9
Cu	1
Zn	6
Physical analysis [g kg ⁻¹]	
Sand	692
Silt	200
Clay	108
Soil Type:	Sandy loam

Soil sampling and analysis

Soil analyses were carried out using IBSRAM (1994) methodological guideline. The soil samples were taken randomly at the depth of 0-15cm from each of the treatment sub plots. The soil samples were air-dried and pass through a 2mm sieve. Soil pH in both water and KCl was determined, and particle size distribution was determined by hydrometer method. Organic carbon was analysed by the dichromate wet-oxidation method. Total N was determined by macro Kjeldahl. Exchangeable cations were determined by leaching with IN NHOAc.

Micronutrients were extracted with 0.1N EDTA and determined using atomic absorption spectrophotometer.

Growth and yield parameters

Parameters measured included plant height, plant weight, cob weight, grain weight, cob length, number of grains per cob, length of grain filled, number of harvested cobs, diameter of cob, level of grain damage, number of cobs with unfilled cobs and scattered grains, weight of 400 grains, number of rows/cob, number of seed/row, length of cob.

Data analysis

The data collected were subjected to analysis of variance (ANOVA) and treatment means were separated by Duncan Multiple Range Test (DMRT) of SAS (1999). Net income as a result of the various treatments was also used to evaluate and compare the economics of the treatments.

Results and Discussion

The physico-chemical properties of the experimental soil revealed that the soil is moderate in N and P, while the K composition is very low (Table 2), however, the texture of the soil and its pH are suitable for maize production in the study area. The analysis of variance showed that there were significant differences among the plants height ($p < 0.01$) at 8 WAP. Mineral fertilizer NPK 15: 15: 15 gave the greater height values of 269.40 ± 19.71 cm and the least height resulted from application of OMF at 1.5 t/ha. Total plant weight on dry weight basis and the weights of husk also showed significant differences between no fertilizer (control) and other treatments. The OMF applied at 3.0 t/ha gave the highest plant dry weight and the least was found in control. There was no significant difference between weight of stover resulting from the application of OMF at 3.0t/ha and NPK 15: 15: 15, and between 1.5 t/ha and control. Cob yield was significantly different ($p < 0.01$), OMF at 3.0t/ha had the highest value of cob yield followed by OMF at 1.5 t/ha, mineral fertilizer and control (Table 3)

The results of the grain quality parameters are shown on Table 4. There was no significant difference among all the treatments with respect to number of rows per cob, seed per row, and seed per cob except in the control ($p < 0.01$). OMF at 3.0t/ha had the highest and control had the least. However, significant differences among the treatments ($p < 0.01$) were observed in cob diameter, cob length, length of grain filled and percentage grain

filled. OMF at 3.0t/ha resulted in the highest value in all the parameters and the least were found in control treatment. It could be seen that grain under control had the highest grain damaged and OMF at 1.5t/ha had the least grain damaged. OMF at 3.0t/ha had the highest weight of 400 grains while the least was given by control. There was no significant difference in grain yield between OMF at 3.0t/ha and 1.5 t/ha but the highest grain yield was found in OMF at 3.0 t/ha. Grain yield under control was least (Table 4). The net income from grain yield shows that OMF at 1.5 t/ha is more profitable than other treatments used as shown in Table 5.

Conclusion

This study showed that organo-mineral fertilizer OMF at 3.0t/ha gave the best performances in almost all the maize growth parameters. This is probably due to

favourable nutrient mineralization of this fertilizer as a result of the influence of the mineral component on the organic (Sikora and Enkiri, 2000). The performance of Organo-mineral fertilizer at 1.5t/ha in maize growth parameters was also better than that of the mineral fertilizer NPK 15:15:15. This is in line with the reports that the combinations of organic and mineral fertilizers perform better on crop yield than when each of them is solely used (Agboola and Obigbesan, 1975; Levi-minzi et al. 1990; Sikora and Enkiri, 2000 and Sridhar and Adeoye, 2003). Though the yield of maize due to the application of OMF at the rate of 3.0 t / ha was highest, it was more economic to apply 1.5 t / ha OMF, since this gave more returns the former (Table 5). It is therefore reasonable to recommend the use of Pacesetter's OMF grade A at the rate of 1.5 t/ha for maize production in this site and similar type of soil in similar agro-ecology.

Table 3. Effect of different fertilizer treatments on grain/Stover yield as affected by fertilizer treatments

Parameters	Control	Mineral (NPK)	OMF 1.5t/ha	OMF 3.0t/ha
Total plant dry weight (t/ha)	0.53b ± 0.33	2.20a ± 0.27	2.00a ± 0.00	2.50a ± 0.50
Cob yield (t/ha)	2.58d ± 0.09	6.58c ± 0.09	7.29b ± 0.32	8.00a ± 0.00
Weight of husk (t/ha)	0.60b ± 0.32	1.65a ± 0.22	1.50a ± 0.00	1.50a ± 0.50
Weight of Stover (t/ha)	2.20b ± 0.42	5.80a ± 0.66	3.00a ± 0.00	6.50a ± 1.00
Plant height (cm)	191.40b ± 25.29	369.40a ± 19.71	182.10b ± 0.00	236.10a ± 6.33

Mean with the same letter along the row are not significantly different at 5% level of probability, ± is standard deviation

Table 4: Effect of different fertilizer treatments on grain yield and quality as affected by fertilizer treatments

Parameters	Control	Mineral (NPK)	OMF 1.5t/ha	OMF 3.0t/ha
No of rows / cob	11.95b ± 0.30	13.30b ± 0.23	13.22a ± 0.23	13.73a ± 0.19
No of seed/row	19.42c ± 0.96	29.23b ± 0.86	31.02 b ± 0.93	36.43a ± 0.62
No of seed/cob	239.02c ± 13.64	384.93b ± 0.07	411.58b ± 15.04	497.97a ± 9.01
Diameter of cob (cm)	3.08c ± 0.07	3.79b ± 0.07	3.89b ± 0.06	4.18a ± 0.04
Length of grain filled (cm)	9.67c ± 0.35	13.09b ± 0.26	13.66b ± 0.34	16.03a ± 0.21
Length of cob (cm)	11.73c ± 0.37	15.18b ± 0.27	15.89b ± 0.31	17.75a ± 0.19
Grain filled (%)	82.28c ± 1.31	85.05bc ± 1.07	85.83b ± 1.06	90.35a ± 0.86
Grain damaged (%)	15.03a ± 2.73	12.95a ± 2.34	3.78b ± 0.57	5.87b ± 1.68
Weight of 400 grains (g)	100.00	120.00	124.00	130.00
Grain yield (t/ha)	2.02c ± 0.07	5.40b ± 0.07	6.06a ± 0.27	6.52a ± 0.00

Mean with the same letter along the row are not significantly different at 5% level of probability, ± is standard deviation

Table 5: Financial analysis of variable cost and grain yield of maize as affected by fertilizer treatments

Parameters	Control	Mineral (NPK)	OMF 1.5t/ha	OMF 3.0t/ha
Variable input				
Quantity [kg/ha]	0	300	1,500	3,000
Price/50kg (N)	0	1,500	600	600
Amount (N)	0	9,000	18,000	36,000
Grain yield				
Quantity [kg/ha]	2,020	5,400	6,060	6,520
Price/kg (N)	30	30	30	30
Amount (N)	60,600	162,000	181,800	195,000
Net profit (N)				
Gross profit	60,600	162,000	181,000	195,000
Variable cost	0	9,000	18,000	36,000
Net profit	60,600	153,000	163,000	159,600

1USD is approximately N 118.00 (as at Dec, 2007)

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