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*Full Length Research Paper*

# Comparative effect of organic, organomineral and mineral fertilizers on soil properties, nutrient uptake, growth and yield of maize (*Zea Mays*)

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Abstract

**Many Researchers have shown that neither mineral fertilizers nor organic manures are a panacea for soil fertility management in Nigeria. This has led to the innovation of organomineral fertilizer which combines the attribute of both mineral and organic fertilizers. Field experiments were conducted in 2011 and 2012 to compare the effect of industrial manufactured organic (OG) fertilizer and organomineral fertilizer (OMF) at the rate of 0, 2.5 and 10t/ha; and NPK 15:15:15 fertilizer (NPK) at the rate of 300kg/ha on soil chemical properties, nutrient uptake, growth and yield of maize in Ondo, Southwestern Nigeria. The treatments were laid out in randomized complete Block Design with four replications and with plots size of 5m×5m. Compared with control, OG, OMF and NPK fertilizers significantly (P <0.05) increased plant N,P, K, Ca, Cu, Fe, Zn and Mn Also compared with control, Organic fertilizer (OM), Organomineral fertilizer (OMF) and NPK 15:15:15 fertilizer at all rates significantly increased (P <0.05) maize plant height, number of leaves, leaf area, Stover yield, root dry matter and grain yield. The percent increases in cumulative grain yield were 5t/ha OMF (68.31), 2.5t/ha OMF (60.21), 10t/ha OMF (38.72), 10t/ha OG (49.65) 300kg/ha NPK (12.13), 5t/ha OG (9.51), 2.5t/ha OG (5.63) compared with control. Organic and organomineral fertilizers at low level of application could be used to increase plant nutrients as well as maize production in south western Nigeria.**

**Keywords:** Stover yield, macronutrient, micronutrient, cumulative effect, soil.

## INTRODUCTION

Maize is one of the staple food crops that are being competed for by both livestock and man. Maize seems to be useful to livestock than man as all parts of maize including the stover are consumed by animals. Maize stover can be processed into silage or dried into hay for animals to consume while the grains can be used to feed both livestock animals and man. The significant importance of maize for both animal and man call for its improvement both in quality and quantity. Researchers have shown that crops fertilized with organic manures are more naturally nourished, stored longer and do not show susceptibility to rapid mould and rotting (Makinde et al., 2011) unlike mineral fertilizers.

In an attempt to boost crop production, farmers use both mineral fertilizers and organic manures to increase the condition of crop growth. The demerits of both mineral and organic fertilizer lead to the innovation of a new fertilizer called organomineral fertilizers. Many experiments have been conducted with the use of combined agro waste and mineral fertilizers for crop production in different formulations. Makinde et al., (2010) combined kola pod husk with NPK fertilizer for production of *Amaranthus*. Ayeni, (2010) used combined poultry manure and NPK 20:10:10 fertilizer to increase the yield of maize and soil nutrients.

The organomineral fertilizers used by many researchers were individually and manually compounded. This might lead to nutrient imbalance. Recently, governments in some states in Nigeria have embarked on industrial production of organomineral fertilizer. Oyo State manufactured organomineral fertilizer tagged "Pacesetter" while Ondo State manufactured both organic fertilizer derived from household waste materials tagged "Sunshine Organic Fertilizer and Sunshine

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Organomineral Fertilizer" (Ondo State Government, 2012).

Little researches have been conducted on the response of soils and crops to these fertilizers in Ondo, Southwestern Nigeria. Hence, the objective of this study was to compare the effectiveness of Sunshine Organic fertilizer, organmineral Fertilizer and mineral fertilizer on soil nutrients, growth and yield of Maize.

## MATERIALS AND METHODS

Field experiment was conducted between 2011 and 2012 to compare the effectiveness of Sunshine Organic fertilizer, organomineral fertilizer and NPK 15:15:15 fertilizer on soil chemical properties, nutrient content, growth and yield of maize on a sandy loam Alfisol in Ondo ($07^{o}$ $05N^{1}$, $04^{o}$ $55^{1}N$) in southwestern Nigeria. The site was dominated with secondary weeds such as *Tridax procumbens, Euphorbia hirta* and *Calopognium*. The land was mechanically cleared and ploughed but ridges were constructed with hand hoe. There were eight treatments replicated four times. The treatments were 0 (Control), equal rates of organic and organomineral fertilizers at 2.5, 5 and 10t/ha and 300kg/ha NPK 15:15:15 fertilizers. The size of each plot was 5mx5m with maize spacing of 75cm x 30cm. Organic and organomineral fertilizers were incorporated in the soil one week before planting of maize while NPK fertilizer was applied in ring form two weeks after planting. Manual weeding with local hand hoe was carried out at 3 weeks interval after planting.

At 50% flowering, 10 maize stands per plot were tagged for nutrient determination. Leaves were collected from the tagged plants per plot, washed, rinsed in distilled water, air-dried and packed in labeled envelope. The leaves were transferred to laboratory for nutrient analysis. Ninety days after planting, the remaining plants/plot were harvested, shelled and weighed. Maize stalks were cut and sun dried to constant weight to determine the stover yield. The yields were extrapolated to t/ha.

### Soil Nutrient Analysis

Before the conduct of the experiment, surface (0-20cm) soil samples were randomly collected with auger, bulked and sieved through 2mm mesh. Soil pH was determined in 1:2 water ratios with pH meter. Organic matter was analyzed by normal Walkely Black Dichromate Method, N by micro-kjedahl method, available P was extracted with Bray – 1- method (Bray and Kurtz, 1945) and the P in the extract was determined spetrometrically. Exchangeable K, Ca, Na and Mg were extracted with 0.1N ammonium acetate. Potassium (K) and Na were read with flame photometer while Ca and Mg were determined using. Absorption Atomic Spectrophotometer (AAS). Micronutrients (Fe, Cu, Zn and Mn) were extracted with HCl and read on AAS. At harvest, surface soil samples (0-20 cm) were randomly collected on treatments basis and organic matter, N, P and K were determined as done in pretreatment soil samples.

### Leaf Analysis

Willey hammer was used to grind the air dried leaf samples and sieved. The leaf samples were digested with hydrochloric-nitric – pechloric acid (Tel and Hagarty, 1984). The nutrients were thereafter determined as described for soil.

### Statistical Analysis

The means of data collected for the two years were computed and analyzed. Data obtained were subjected to analysis of variance and the means were separated using Duncan Multiple Range Test at 5% level of probability where F ratio is significant.

## RESULT AND DISCUSSION

The nutrient composition of organic, organomineral and NPK 15:15:15 fertilizers (Table 1) were computed from the Agro waste industry from which the fertilizers were purchased. NPK 15:15:15 fertilizer had the highest N, P and K contents among the fertilizers, hence, the need for more quantity of organic and organomineral fertilizers than NPK fertilizer to meet with the crop nutrients requirement.

Agboola and Unamena, 1989) recommended 3% organic matter, 0.15% N, 8-10 mg/kg P, 0.24C mol/kg K, 0.20C mol/kg Ca and 0.26C mol/kg Mg as the nutrient critical level requirements for optimum maize production in southwestern Nigeria as against 1.36%, 0.11%, 6.5mg/kg, 0.11, 2.89, 2.99 and 0.89 C mol/kg recorded for OM, N, P, K, Ca, Mg and Na respectively in table 2. Based on these initial soil values, the soil used for the experiment was deficient in OM, N, P and K and adequate in Ca, Mg and micronutrients; hence, there is need for the addition of fertilizer containing N, P and K. The low nutrient content of the soil used for the conduct of the experiment indicated the low inherent nutrient characteristic nature of Ondo soils. Experiments had been conducted in different locations of Ondo by Odedina et al (2003), Ayeni et al (2008), Ayeni, (2010) and Adeleye et al (2011) showing the chemical and physical characteristics of the soils. According to these researchers, soils of Ondo need N, P and K fertilization.

Compared with control, OG, OMF and NPK fertilizers at

**Table 1.** Nutrient Composition of Organic, Organomineral and NPK 15:15:15 Fertilizers

| Nutrient (%) | N | P | K |
|---|---|---|---|
| Organic Fertilizer | 3.5 | 1 | 2.5 |
| Organomineral Fertilizer | 3.5 | 2.5 | 4.0 |
| NPK 15:15:15 | 15 | 15 | 15 |

*Source: Waste to Wealth, Ondo State Government (2012)*

**Table 2.** Pre-cropping Soil Chemical Properties

| Nutrient | Value |
|---|---|
| pH | 6.2 |
| OM% | 1.36 |
| N (%) | 0.11 |
| C/N | 12.36 |
| P (mg/kg) | 6.50 |
| K (Cmol/kg | 0.11 |
| Ca (Cmol/kg) | 2.89 |
| Mg | 2.88 |
| Na | 0.89 |
| Fe (mg/kg | 0.14 |
| Zn (mg/kg) | 45 |
| Cu (mg/kg) | 0.16 |
| Mn (mg/kg) | 1.20 |

**Table 3.** Effect of OG, OMF and NPK Fertilizers on Growth and Yield of Maize

| Plant Height (cm) | No. of leaves $cm^2$ | Leaf area t/ha | Stover yield t/ha | Grain yield t/ha | Root dry % | Matter | Increase in grain |
|---|---|---|---|---|---|---|---|
| Control | 72.60e | 8.00c | 14d | 3.23c | 2.84c | 0.67b | - |
| 2.5t/haOG | 89.70e | 9.33bc | 20c | 3.59c | 3.00b | 0.93a | 5.63 |
| 5t/haOG | 107.90d | 9.23c | 19c | 3.97bc | 3.11b | 0.97a | 9.51 |
| 10t/haOG | 149.40c | 12.0b | 32b | 4.99b | 4.25a | 0.99a | 49.65 |
| 2.5t/haOMF | 129.40c | 12.20b | 44a | 5.34a | 4.55a | 1.10a | 60.21 |
| 5t/haOMF | 169.20b | 14.59a | 31b | 5.36a | 4.78a | 1.00a | 68.31 |
| 10t/haOMF | 164.10b | 12.4b | 30b | 4.63b | 3.94a | 0.97a | 38.72 |
| 300kg/ha NPK | 194.00a | 12.3b | 24c | 4.23b | 3.44ab | 0.93a | 12.13 |

*Means with the same letter in the same column are not significantly different at 5% using Duncam Multiple Range Test*

all levels significantly increased ($P<0.05$) maize height, number of leaves, leaf area, stover, dry matter and grain yields (Table 3). Application of 300kg/ha NPK fertilizer had the highest plant height, 5t/ha OMF had the highest number of leaves, stover yield and grain yield while 2.5 t/ha OMF recorded the highest leaf area and root dry matter while the control experiment recorded the lowest parameters under study (Table 3).

In this experiment, it was observed that application of 2.5t/ha OMF significantly increased stover yield, grain yield and root dry matter yield compared with 5t/ha OG. Relative to control, all the treatments significantly increased ($P<0.05$) plant N, P and K, Fe, Cu, and Zn (Table 4). Organomineral fertilizer applied at 2.5t/ha had the highest N and Zn, OMF applied at 5t/ha had the highest Fe and Mn while OG applied at 2.5t/ha recorded the highest plant K. OMF applied at 5t/ha had the highest P, .5t/ha OG had the highest Cu and OMF applied at

**Table 4.** Effect of OG, OMF and NPK on nutrient contents of Maize

| | N | P | K | Fe | Cu | Mn | Zn |
|---|---|---|---|---|---|---|---|
| | ----------%--------- | | | --------mg/kg---- | | | |
| Control | 2.99b | 0.03b | 0.05b | 52.50d | 5.50c | 9.50c | 19.48e |
| OG 2.5t/ha | 3.58ab | 0.06a | 0.55a | 99.00c | 12.5b | 11.50c | 18.64c |
| OG 5t/ha | 3.71a | 0.04bc | 0.07b | 113.0b | 28.00a | 12.00c | 38.97d |
| OG 10t/ha | 3.92a | 0.04bc | 0.06b | 131.50a | 13.00b | 12.50c | 54.68b |
| OMF 2.5t/ha | 4.81a | 0.04bc | 0.06b | 131.52a | 7.50c | 18.50c | 69.54a |
| OMF 5t/ha | 3.69a | 0.04bc | 0.06b | 136.50a | 13.50b | 34.00a | 62.44a |
| OMF 10t/ha | 4.02a | 0.07a | 0.05b | 132.50a | 11.50b | 19.50b | 18.98e |
| 300kg/ha NPK | 4.08a | 0.05b | 0.05b | 95.50c | 7.50c | 10.50c | 36.55d |

*Means with the same letter in the same column are not significantly different at 5% using Duncam Multiple Range Test*

10t/ha had the highest P. The finding that the soils fertilized with organic, organomineral and NPK fertilizers increased yield parameters of maize might be as a result of N, P and K present in the treatments. The control experiment had the least N, P, K, Fe, Cu, Mn and Zn.
The lowest nutrients recorded by the control experiment might be the reason why the plant parameters observed such as plant height, leaf area, grain yield and stover yields were very low compared with other treatments.

It was observed that 300kg/ha NPK had the tallest plant without corresponding increase in grain yield. Nitrogen might be adequate for the vegetative growth. The increase in Fe, Cu, Mn and Zn of soils fertilized with OMF and OG might have caused the increase in grain yield over 300kg/ha NPK fertilizer. Iron is known to aid in chlorophyll formation, though it is not integral part of chlorophyll. Along side with N, the deficiency of Cu in maize plants results in stunted growth as well as yellow coloration which might also result in low photosynthesis that led to low grain yield.

Zinc is known to synthesize tryptophan, a protein compound needed for the production of growth promoting hormones called auxins. Manganese (Mn) like Mg promotes enzyme transformations. The result obtained from this work is in line with previous works that manually combined organic manure with mineral fertilizers (Ayeni and Adeleye, 2011; Ayeni, 2010 Akanbi et al., 2000) increase yields of crops over their sole application. Combined organic manures with mineral fertilizers has better effect on the nutrient uptake, growth and yield of maize. The finding that OMF and NPK fertilizers increased the nutrient concentration of maize tissue could be related to earlier finding of Olaniyi et al., (2010) and Ayeni, (2011) that OMF and NPK fertilizers increased N, Ca, Fe, P and K content of okra tissue. Organic, organomineral and NPK fertilizers applied at all levels were found to increase the yield of maize compared with control. This agrees with the work of Olaniyi and Akanbi, (2007) who found that OG and OMF increased the yield of fluted pumpkin (*Telfaira occidentalis*) likewise Makinde et al., (2010) and Gebaly, (2011) found that OG and OMF improved the nutritional quality of amaranthus. Also, Mehasen et al., (2012) observed that organic manure combined with mineral fertilizer enhanced the quality of Egyptian cotton in the experiment conducted to show the effectiveness of organic and inorganic fertilization in the presence of some growth regulators on productivity and quality of Egyptian cotton in Egypt. The balanced nutrition enjoyed by the maize fertilized with OMF ensured high cumulative grain yield than the use of OG and NPK fertilizers. The small quantity of NPK 15:15:15 fertilizer in the organomineral fertilizer might have enhanced earlier mineralization of nutrients such as N and P than OG.

Table 5 presents data on soil organic matter, N, P and K after maize harvest compared with control, all the treatments significantly increased soil pH, OM, N, P and K. Organic fertilizer applied at 10 t/ha had the highest soil pH (6.23), OM (2%) and N (0.14%). Organomineral fertilizer applied at 10 t/ ha recorded the highest soil available P (10.05 mg/kg) and K (0.51 C mol /kg). application of 300kg/ha NPK15:15:15 fertilizer reduced soil pH while OG and OMF increased soil pH the increase in soil pH and OM by OG and OMF might be related to the high amount of N and P in the fertilize formulation. This finding corroborates with the work of Okunlola et al., (2011) who found that organic manures increase soil pH and OM, N, P, K, Ca and Mg.

## CONCLUSION

This experiment shows that organic and organomineral fertilizers compared favourably with NPK fertilizers in terms of nutrient release and yield of maize. Addition of sunshine organomineral fertilizers produced by the Ondo State Government increase maize yield even the yield is

**Table 5.** Effect of OG, OMF and NPK on soil chemical properties

| Treatment | pH | OM | N | P mg/kg | K Cmol/kg |
|---|---|---|---|---|---|
| | | ----------%---------- | | | |
| Control | 6.00b | 1.36d | 0.10a | 3.20c | 0.11c |
| OG 2.5t/ha | 6.10ab | 1.72b | 0.12a | 8.80ab | 0.34b |
| OG 5t/ha | 6.22a | 1.77b | 0.12a | 8.92a | 0.38b |
| OG 10t/ha | 6.23a | 2.00a | 0.14a | 9.00a | 0.49a |
| OMF 2.5t/ha | 6.10b | 1.90a | 0.11a | 8.93a | 0.47a |
| OMF 5t/ha | 6.12b | 1.93a | 0.13a | 8.96a | 0.4.9a |
| OMF10t/ha | 6.20a | 1.94a | 0.13a | 10.05a | 0.51a |
| NPK300kg/ha | 5.92b | 1.55c | 0.12a | 6.78b | 0.45a |

*Means with the same letter in the same column are not significantly different at 5% using Duncam Multiple Range Test*

as low as 2.5t/ha of the fertilizers. According to the findings in this experiment, Organomineral fertilizer can be a substitute for mineral fertilizer in a soil that is impoverished in plant nutrients.

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