

Effect of Organic Fertilizer Produced from Agricultural Wastes on the Growth Rate and Yield of Maize

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Abstract: This research was carried out to study the effect of organic fertilizer produced at different proportions by mass using same substrate made up of Neem seeds, rice husk, blood meal, bone meal, calcium carbonate in five different formulations on the growth and development of maize crop (*zea mays*). The constituents were prepared by mixing and blending using mixer and hammer mill respectively. Physicochemical analysis was carried out to determine the nutritive value of the formulated organic fertilizer for the presence of Nitrogen, Phosphorus and Potassium (N. P. K). The fertilizer was subjected to a pot experiment, using a complete randomized design method, in which each soil was treated with the prepared organic fertilizer formulation at high and low amount of application and planted for a period of 12 weeks. The result of physicochemical analysis of the various proportion of organic fertilizer indicated that formulation type 5 presented the highest percentage of nitrogen content (i.e. 14840 mg/kg). This was due to the increase in proportion of Poultry litters in the formulation type 5. Moreover, the formulation type 3 recorded the lowest percentage of nitrogen (i.e. 4060mg/kg). There was no significant difference ($P < 0.05$) in the vegetative growth of maize for various treatments. However, formulation type 5 at high amount of application gave higher values of plant height, stem girth, leaf area and number of leaves than other formulations. This implies that organic fertilizer could be potentially promising option to chemical fertilizer as a soil conditioner and a good source for plant nutrients.

Keywords: Organic Fertilizer, Formulations, Substrate, Plant, Growth, Yield etc.

1. Introduction

The inadequate availability of affordable and sustainable fertilizers in northern Nigeria create great concern among farmers. The region is popular for its high production of diverse cereal crops: e.g. millet, sorghum, maize, rice and wheat [1]. Fertilizer shortage contribute immensely to the poor quality of the soil and low soil fertility, which consequently result into poor crop yields. Soil with a healthy and high economic crop yield requires the application of organic manures for many years.

However, the high rate of using inorganic fertilizers diminishes the soil values and benefits which resulted in the increase in soil acidity, decline in soil quality, and

unsustainable soil fertility managements [2]. It is therefore imperative to employ the traditional system of fertilizer application by using organic-based fertilizers such as backyard manure. This could help to transform the Nigerian agricultural production systems to become sustainable and achieve significant economic developments [3].

The application of inorganic fertilizers such as Nitrogen, Phosphorus and Potassium (NPK) has polluted surface and groundwater resources. Intensive cropping to feed the ever expanding population coupled with high erosion rates has resulted into severe soil nutrient depletion. Based on these scenarios, there is an urgent need to find ways and means of alleviating these problems by creating new and innovative processes which would enable reduction to environmental impacts caused by the applications of inorganic fertilizers.

Nowadays, organic-based Agricultural production is the rapidly emerging technology in Agricultural sector, which partly solves waste disposal problems through conversion of biodegradable wastes into organic compost ensuring the availability of organic fertilizer subsequently increase crop yields in many African regions [1, 4].

Organic matter were reported to increase nutrient availability of the soils [4]. Application of organic matter to the soil could also improve aggregate stability and resistance to soil compaction, enhanced fertility and reduced nutrient leaching, increased biological activity; enhance water retention capacity and reduction of greenhouse gases by the soil [5].

There are many beneficial values of using organic fertilizer some of which are; soil value, crop production value, biological value, environmental value, economic value, human health and Soil value.

2. Materials and Methods

2.1. Materials

The materials used in this research include Neem seed, rice husk, blood meal, bone meal, poultry litters etc.

2.2. Methods

2.2.1. Sample Collection

Matured Neem seeds were collected from Aliero town, Rice husk was collected from Labana rice mill, Birnin-Kebbi, Blood and bone meals were collected from Aliero Abattoir and Poultry litter was collected from Labana farms in Aliero respectively.

2.2.2. Preparations of Organic Fertilizer Formulations

The formulations were mixed in five various proportions based on a standard proportion obtained at the Technology incubation centre, Birnin Kebbi, Kebbi State. Different sample formulations are depicted in Table 1. As a result of the high composition of Nitrogen in Poultry litters and Blood meal, Poultry litters of formulation type 2, 4 and 5 were increased from 1.3kg to 3kg, 3.3kg and 5.4kg respectively, while Blood meal increased from 0.3kg in formulation type 1 (Standard formulation), to 2.0kg in formulation type 4 in every 10kg of Organic fertilizer. Each formulation was accurately measured using weighing balance and homogenously mixed up together. The homogenous mixtures at different formulations were fed into the hammer mill for crushing and grinding (milling) into a fine powder.

Table 1. Compositions of Organic Formulations.

Formulations	Type 1	Type 2	Type 3	Type 4	Type 5
Neem seed	3kg	1.3kg	1.7kg	0.4kg	0.3kg
Poultry litters	1.3kg	3kg	1.3kg	3.3kg	5.4kg
Rice husk	1.7kg	1.7kg	3kg	0.7kg	0.3kg
Blood meal	0.3kg	0.3kg	0.3kg	2.0kg	0.3kg
Bone meal	0.6kg	0.6kg	0.6kg	0.5kg	0.6kg
Potash	0.1kg	0.1kg	0.1kg	0.1kg	0.1kg
Calcium carbonate	3.0kg	3.0kg	3.0kg	3.0kg	3.0kg

2.3. Characterization of Soil and Organic Materials Used in the Experiments

2.3.1. Physical Analysis of the Soil

The physical analyses of the soil which comprises of particle size distribution (soil only), Soil texture, bulk density and field capacity (soil and organic materials) was determined before planting. Soil texture was determined by the hydrometer method as described in reported literature [6].

2.3.2. Chemical Analysis of Soil and Organic Fertilizers

The soil and organic fertilizer used in the experiment were analysed by determining the pH, Organic carbon, and Nitrogen, Phosphorus, Potassium, Calcium and Magnesium content.

Total nitrogen was determined by micro kjeldahl digestion - distillation method, Potassium content by the flame photometry method, Phosphorus content using Bray's No.1 method, pH using pH meter, Soil organic carbon was determined by the modified Walkley-Black method as described in literature [7].

2.3.3. Pot Experiment

Soil for the experiments was taken from farm at Federal Ministry of Environment, Bulasa, Birnin Kebbi, Kebbi State. The soil was air-dried and 10 kg sample weighed into pots having a volume capacity of 4710 cm³ as shown in Figure 1. Thirty-six (36) pots were used comprising of twelve (12) treatments in 3 replications. The pot experiment was carried out in a Greenhouse using a complete random design (CRD) and treatment of an Organic fertilizer at high and low application rate [8].



Figure 1. Treatment of the soil for CRD Pot experiment.

2.4. Statistical Analysis

All data were subjected to Analysis of Variance (ANOVA) using Gen statistical software. The data obtained was graphically displayed to further illustrate the formulation with the best growth development and yield.

3. Results and Discussion

The effect of organic fertilizer prepared from different formulations of agricultural wastes in the growth rate and yield of Maize (*Zea mays*) was investigated.

3.1. Results

The results obtained on the chemical properties of the soil and organic materials are presented in Table 2. The results

obtained on the mean shoot and root dry matter yield of the various amendment at 10 weeks after planting are presented in Table 3. The results obtained on the effect of fertilizer on yield and yield components are depicted in Table 4.

Table 2. Chemical properties of the soil and organic materials used in the study.

Nutrients	Soil (mg/kg)	Type 1 (mg/kg)	Type 2 (mg/kg)	Type 3 (mg/kg)	Type 4 (mg/kg)	Type 5 (mg/kg)
N	39	4810	7140	4060	7700	14840
P	0.85	4.76	13.83	19.39	19.28	20.10
K	0.38	1166	1250	600	650	680
Mg	0.40	2.20	0.35	2.20	3.10	1.80
Ca	0.85	3.32	3.65	3.32	3.32	2.40
Na	0.26	239	452.5	62.5	239	130
OC	113000	113000	113000	267300	113090	127700
pH.	6.5	6.6	6.3	6.4	6.6	6.6

Key: OC = Organic carbon; Mg = Magnesium; K = Potassium; Ca = Calcium, Na = Sodium; P = Phosphorus; N = Nitrogen.

Table 3. Mean shoot and root dry matter yield of the various amendment at 10 weeks after planting.

Treatment	Dry matter (g) /plant			Root to Shoot
	Shoot	Root	Total Biomass	Ratio
NCTRL	7.27	1.97	9.24	0.27
PCTRL	19.53	4.10	23.63	0.21
F1 (H)	3.50	0.86	4.36	0.25
F1 (L)	7.90	1.30	9.20	0.16
F2 (H)	15.30	2.03	17.33	0.13
F2 (L)	10.00	2.47	12.47	0.24
F3 (H)	10.13	2.56	12.86	0.25
F3 (L)	11.13	1.33	12.46	0.12
F4 (H)	19.43	5.67	25.10	0.29
F4 (L)	20.07	3.50	23.57	0.17
F5 (H)	16.70	4.27	20.97	0.26
F5 (L)	20.50	5.50	26.00	0.27
	Ns 15.18	Ns 4.74	Ns 19.92	ns 0.25

Table 4. Effect of fertilizer on yield and yield components.

Treatment	Grain Yield (g/pot)	Stover Yield (g/pot)	Harvest Index
NCTRL	5.27	9.20	0.36
PCTRL	27.63	34.70	0.44
F1	5.47	4.40	0.55
F1 (L)	5.93	9.20	0.39
F2 (H)	10.20	18.00	0.36
F2 (L)	12.00	12.50	0.49
F3 (H)	10.37	12.70	0.45
F3 (L)	8.60	12.80	0.40
F4 (H)	11.00	25.10	0.30
F4 (L)	12.63	23.60	0.35
F5 (H)	10.67	21.00	0.34
F5 (L)	11.80	26.00	0.31
LSD (0.05)	NS 10.06	NS 19.58	NS 4.35

Key: NCTRL = Negative control; PCTRL = Positive control; F1 (H) = Formulation type 1 high rate; F1 (L) = Formulation type 1 low rate; F2 (H) = Formulation type 2 high rate; F2 (L) = Formulation type 2 low rate; F3 (H) = Formulation type 3 high rate; F3 (L) = Formulation type 3 low rate; F4 (H) = Formulation type 4 high rate; F4 (L) = Formulation type 4 low rate; F5 (H) = Formulation type 5 high rate; F5 (L) = Formulation type 5 low rate; LSD = least significant difference across the column; NS = Not significant.

3.2. Discussion

The result presented in Table 2 indicated an increase in nitrogen content of formulation type 2, 4 and 5 having 7140 mg/kg, 7700 mg/kg and 14840 mg/kg respectively. The result also indicated an increase in phosphorus content in formulation type 2, 3, 4 and 5 having 13.83mg/kg, 13.39mg/kg, 19.28mg/kg and 20.10mg/kg respectively, when compared

with formulation type 1 having 4.76mg/kg. There was a decrease in potassium content from formulation type 5, 4 and 3 which recorded 680 mg/kg, 650 mg/kg, and 600 mg/kg respectively, compared to type 1 having 1166mg/kg, though an increase in formulation 2 having 1250mg/kg was observed. The results in Table 2 also presented an increase in organic carbon from formulation type 4, 5 and 3 having 113090 mg/kg, 127700 mg/kg and 267300 mg/kg respectively.

The results in Table 3 shows the root/shoot ratio which ranges from 0.12 to 0.29 for formulation type 3 (L) to Formulation type 4 (H) respectively. This value implies that the amount of dry matter into the root per plant varies from 12 to 29 percent. Formulation type 5 (H), 3 (H), 2 (H) and 1 (H) had a lower root/shoot ratio compared to positive control which agrees with reported literature that root/shoot dry matter ratio is lower in fertile than infertile soil [9, 10].

However, the results on effect of the prepared organic fertilizer on Maize yield index showed that the grain and Stover yield did not increase significantly ($P > 0.05$) by the application of organic fertilizer (Table 4). The formulation type 5 (H) had a higher grain and Stover yield compared to other formulations. The grain and Stover yields were not significant, thereby having an averagely lower harvest index compared to other treatments.

4. Conclusion

In conclusion, formulation type (5) had the highest composition of nitrogen which is a macro nutrient required by maize plant at high application rate for optimum growth and yield.

Formulation type 5 gave the best yield parameters compared to other formulations. There was no significant difference ($P < 0.05$) in the vegetative growth of maize for various treatments. However, formulation type (5) at high rate gave higher values of plant height, stem girth, leaf area and number of leaves than other formulations. This implies that organic fertilizer could be a better substitute to chemical fertilizer as a soil conditioner and a good plant manure when applied based on the soil nutrient requirements.

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