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Growth of Maize (*Zea mays. L*) In Response to Varying Organic and Inorganic Fertilizer Treatment

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ABSTRACT

The growth of maize (Zea mays .L) in response to varying organic and inorganic fertilizer treatment was investigated in Akure, Nigeria. The fertilizer treatments include cow manure; goat manure; pig manure; poultry manure; cow manure + NPK; goat manure + NPK; pig manure NPK and poultry manure NPK. The experiment was laid out in a completely randomized design (CRD) with five replicate per treatment. Growth data (plant height and collar diameter) were collected at 2 ,4 and 6 weeks after planting (WAP) and analysed by one-way analysis of variance at 5% level of significance. Duncan Multiple Range Test was used to separate the significant means. Growth of maize with respect to height and collar diameter varied significantly with the fertilizer treatment types compared to control and even among the fertilizer type. At 6WAP, application of poultry manure alone resulted to maize plants with significantly higher height (91.80 cm) and collar diameter (19.83 cm) growth compared to all other fertilizer treatments. Consistently, the animal manure applied either singly or combined with NPK resulted to higher plant height and collar diameter than that of NPK fertilizer alone treatment which were 31.40 cm for plant height, 1.46 cm for collar diameter at 4WAP and 61.0 for plant height, 1.69 cm for collar diameter at 6WAP. The control (no input) produced maize plants with significantly lower height and diameter growth which were 18.0 cm for plant height, 0.93 cm for collar diameter at 4WAP and 28.50 cm for plant height, 1.28 cm for collar diameter at 6WAP compared to those that received one form of fertilizer or the other. The future requires that famers will farm the same piece of land continuously and will be faced with the challenge to increase food production on lands that are already in cultivation. This has to be done in a way that does not lead to diminished soil productivity. Combined mineral and organic fertilizer is therefore required for sustainable soil productivity under intensive cultivation.

Keywords:

INTRODUCTION

More scientific and innovative advancements in agriculture show strong potentials to help increase former's yield. It is no secret that the worlds demand for food especially grains is accelerating as population and per capita consumption increases at an unprecedented rate. The quest to grow food to meet that demand and feed the world population will continue to be one of the most important issues of our time. Globally, in order to meet the food and nutrition needs of more than 9 billion people by 2050, famers will have to grow as much food as they have grown in the last 100 years combined (Saginga and Woomer 2009).

In Africa, poor soil fertility and nutrient depletion continue to represent huge obstacles to securing needed harvests (De Vries and Toennissen 2001). Thus, while low input systems may be developed for poor farmers who cannot afford costly inputs such as fertilizers, they may not always be sustainable in the sense of satisfying demands under increasing population pressure. Of all the factors available for agricultural production in Africa, soil appear to be the most important and limiting (Ojeniyi, 2012). The high cost, scarcity and low efficiency of fertilizers make them unprofitable for farmers. Also without adequate supply of organic matter, continuous use of NPK fertilizers leads to soil acidification, nutrient imbalances and degradation in soil physical quality (Fasina, 2013). Better management of soil fertility is imperative for sub-saharan Africa. Saginga and Woomer (2009) reinforced this view by identifying soil fertility depletion in smallholder farm as the fundamental biophysical root course of declining per capita food production in Africa and advocated more integrated problem-solving approaches. Recent development in soil fertility management and plant nutrient supply focuses on integrated nutrient management systems that fully utilize nutrient supply from both organic and inorganic sources (Sanginga and Woomer, 2009). The approach focuses on maintaining or enhancing soil productivity through a balanced use of mineral fertilizers combined with organic sources including green manuring, mulch, animal manure, use of legumes for biological fixation and use of crop residues and domestic wastes. The present study therefore evaluates the growth of maize (*Zea mays .L*) in response to varying organic and inorganic fertilizer treatments in Akure with a view to determining the best organic and inorganic fertilizer combinations for optimum growth and performance of the crop. The study was also designed to proof or otherwise that integrating organic and inorganic fertilizer for crop will result to better crop performance than the use of either inorganic or organic fertilizer alone.

MATERIALS AND METHOD

The Study Area

The study was carried out as series of experiments in a demonstration plot established by the Centre of Excellence (CoE) in Integrated Soil Fertility management under the Capacity 4 Food Project (FED/2013/320-275) at the Teaching and Research farm of the Federal University of Technology, Akure, Nigeria. Akure is located on latitude 7^0 5'N and longitude $5^0$10'E in the rain-forest belt of SouthWestern Nigeria at an elevation of 200 m above sea level. Akure lies in the tropical rain-forest zone with mean annual temperature of about 31^0C (min 26.9^0C and max.34^0C). The relative humidity ranges between 68% to 86% during the rainy season and less than 50% during the dry season. The peak of rainfall occurs in July and/or September while February is the driest month of the year. The soil of Akure is classified as Alfisol with clayey Skeletal Kaolinitic iso-hypertheric Oxic Paleustalf (Ojo- Atere and Oladimeji, 1993) and belongs to the Egbeda series (Ojeniyi, 1990). The soil texture ranges from sandy loam in the topsoil to clayey loam in the sub-soil. Some physical and chemical properties of soil in the Experimental plot are presented in Table 1.

Table 1: Physical and chemical properties of soil at Teaching and Research farm, FUTA

Parameters	Content
Clay	21.56 (%)
Sand	66.44 (%)
Silt	55.88 (%)
p^H	6.50
N	1.18(%)
P	0.02 (%)
K	0.04 (%)
Organic carbon	0.83(%)
Organic matter	1.42 (%)

Soil sampling and analysis

Prior to the start of the field experiment, auger samples of the soil of the experimental site were collected and analysed for particle size distribution, Nitrogen, phosphorous, potassium, organic carbon, organic matter contents and pH. Particle size distribution of the soil samples were determined by hygrometer method (Bouyoucous, 1951). Soil pH was determined in water suspension at 1:1 soil to water ratio using pH meter. Organic matter was determined by dichromate wet oxidation method of Wakley and Black (1934) as modified by Allison (1965). Nitrogen content was determined by kjeldhal method (AOAC, 1990) while phosphorous was determined by Bray P1 method (Bray and Kurtz, 1945) and potassium by flame photometry (AOAC, 1990).

Experimental Methods

Animal wastes (poultry, cow, goat and pig) were collected from the corresponding animal pens at the Teaching and Research Farm of the Federal University of Technology, Akure, Nigeria. The respective animal wastes were sun-dried adequately and separately ground into meals using an electric grinding machine. Thereafter varying fertilizer types were compounded by mixing each of the animal manure with micro- dose of NPK (15-15-15) fertilizer. The treatment combinations were cow manure alone; cow manure + micro-dose NPK; Goat manure alone; Goat manure + micro- dose NPK; poultry manure alone; poultry manure + micro- dose NPK; pig manure alone; pig manure + micro- dose NPK and control (no input). The micro doses of NPK fertilizer were based on 50% of the full dose as recommended for maize production in the south western region of Nigeria. A land area within the demonstration farm site measuring 30m x 30m was cleared, harrowed and ridged. The prepared plot was sub divided into treatment plots (5 m x 5m) with a buffer of 1 m x 1 m between plots. Maize seeds were planted in each of the treatment plots (3 seeds per hole) at a spacing of 30cm x 90cm within and between rows. Prior to seed germination, the whole plots were sprayed with weed control chemical so as to suppress weed invasion in the plots. After germination, the maize seedlings were thinned to two seedlings per hole. Two weeks after germination, the maize seedlings were ring dressed with the respective compounded fertilizer according to the treatments indicated above. The maize seedlings received dosage rate of 40g/planting hole (400kg/ha) for the animal manure based fertilizers which was 75% animal manure and 25 % NPK fertilizer and 20g/planting hole (200kg/ha) for the NPK fertilizer alone. The experiments were laid out in a completely randomized design (CRD) with five replicates per treatment.

At 2, 4, and 6 weeks after planting, growth data were collected by measuring height and collar diameter per sampled plant. The plant height was measured by a meter rule from the ground to the top of the node while the collar diameter was measured using venier caliper at a point on the stem 2.5 centimeter above the ground level. All data collected were subjected to one-way analysis of variance (ANOVA) test at 5% level of significance. Where the treatments means were significant, the treatments were separated using the Duncan Multiple Range Test.

RESULT AND DISCUSSION

Physical and Chemical Properties of Soil

The initial physical and chemical properties of soil at the site of experiment are shown in Table 1. Based on the percentage sand, silt and clay particles, the soil of the experimental site can be described as sandy loam. The pH (6.50) of the soil is slightly acidic and will be adequate and favorable for soil nutrient dynamics. This is because the solubility and availability of many important soil nutrients are closely related to pH. While some nutrients are soluble in acidic soil, others are soluble only in alkaline soil. The nutrient content of the site which includes N (1.18%), P (0.02%), K (0.04%), Organic C (0.83%) and Organic matter (1.42%) is rated low. The findings corroborate the observation of previous study on the site (Oyun, 2001) which also rated the soil of the site as low in fertility. Several authors (Akinpelu and Ojeniyi, 1982; Awodun and Ojeniyi, 1998; Fasina, 2013) had noted that African soils exhibit a range of physical, chemical and nutritional deficiencies. Therefore, management of these soils under increasing population pressure constitutes a major constraint to their suitability in agricultural production. The major constraints include low value of calcium and rapid rates of organic matter decomposition; low inherent fertility and serious salinity problems (Akinpelu and Ojeniyi, 1982).

Growth of Maize in response to NPK fertilizer combined with animal manure

The result of the analysis of variance (ANOVA) for the effect of fertilizer treatments on height and collar diameter growth of maize at 2, 4 and 6 WAP is shown in Table 2. As indicated in Table 2, the effect of fertilizer treatment (fertilizer types and control) on height and collar diameter growth of maize was significantly different. At 2WAP, the plot treated with pig manure lone had the highest plant height (17.5 cm) which was statistically similar with the height growth of maize subjected to goat manure alone, NPK and NPK+ poultry manure but significantly ($P < 0.05$) higher than the height growth of maize under other fertilizer treatments (Table 2). Though the control plot (no input) recorded the lowest plant height (11.0 cm), it was statically similar with some of the fertilizer treatments. The same trend was observed for the collar diameter at the same sampling period (2 WAP). However, at 4WAP, plot treated with goat manure alone produced maize plants with the highest plant heights (46.90 cm) which was not significantly different from the heights of plant subjected to pig manure alone (43.40 cm) and NPK+ poultry manure (44.20) but significantly higher than the heights of plants under other fertilizer treatments (Table 2). For collar diameter, plots treated with pig manure alone produced significantly higher diameter (2.06 cm) than the remaining fertilizer types with the exception of plants treated with goat manure alone. The control treatment recorded the significant lowest height (18cm) and collar diameter (0.93 cm) values at 4WAP. At 6WAP, poultry manure alone yielded maize plants with the highest (91.80 cm) which is statistically similar with the heights of plants under pig alone, goat manure alone, goat manure alone, poultry manure + NPK and goat manure + NPK but significantly higher than plant heights under the other treatments. Collar diameter height growth of the maize plants followed similar trend as the height growth.

Consistently, the animal manure applied either singly or combined with NPK resulted to higher plant and collar diameter than that of NPK fertilizer alone treatments which were 31.40 cm for plant height,1.46 cm for collar diameter at 4WAP and 61.0 cm for plant height, 1.69 cm for collar diameter at 6 WAP (Table 2). Also the control (no input) produced maize plants with significantly low height and collar diameter growth compared to those that received one form of fertilizer or the other which were 18.0 cm for plant height, 0.93 cm for collar diameter at 4WAP and 28 cm for plant height, 1.28 cm for collar diameter 6 WAP (Table 2).

Table 2: Effect of fertilizer application on mean height and collar diameter growth of maize plants.

	Sampling period (weeks)					
	2 WAP		4 WAP		6 WAP	
Treatments	Heights (cm)	Collar diameter (cm)	Heights (cm)	Collar diameter (cm)	Heights (cm)	Collar diameter (cm)
N.P.K + Poultry manure	15.3abc	0.74ab	44.20ab	1.48c	83.90ab	19.67a
Goat manure + N.P.K	12.7de	0.57c	37.00bcd	1.58bc	85.00ab	18.80a
Cow manure alone	13.2cde	0.57c	36.70bcd	1.61bc	77.50b	18.65a
N.P.K + Cow manure	14.9bcd	0.56c	37.80bcd	1.55bc	75.60b	16.32b
Poultry manure alone	14.2bcd	0.63bc	38.70bc	1.73bc	91.80a	19.83a
Goat manure alone	16.3ab	0.62bc	46.90a	1.80ab	82.60ab	2.04c
Pig manure alone	17.5a	0.76a	43.40ab	2.06a	82.70ab	2.33c
Pig manure+ N.P.K	13.2cde	0.56c	30.70d	1.46c	64.70c	1.72c
N.P.K	15.3abc	0.58c	31.40cd	1.46c	61.00c	1.69c
Control (no input)	11.00e	-	18.00e	0.93d	28.50d	1.28c

Consequent upon the peculiar management problems of tropical soils, there is need to evolve indigenous home grown, affordable, adoptable and adaptable techniques to manage the soils for sustainable cropping. Also, the high cost, scarcity and low efficiency make fertilizer unprofitable for farmers. Similarly, without the supply of organic matter, continuous use of NPK fertilizer may lead to soil acidification, nutrient imbalances and degradation in soil physical quality. As revealed by the result of the present study, application of NPK fertilizer alone to maize crops in the humid tropical rain- forest region like our experimental site will lead to lower height and collar diameter growth compared to maize plants treated with animal manure (goat, cow, pig; poultry) used either singly or in combination with micro-dose NPK fertilizer. Similar results have been reported by earlier studies on maize (Ojeniyi, 2012; Wale and Oare, 2013).

The application of NPK fertilizer alone to maize crop particularly under humid rain- forest condition may not be appropriate for adequate crop uptake largely because of leaching of the highly soluble mineral fertilizer and partly because of the timing of application which may not coincide with plant demand resulting to low efficiency of use by the maize crop and hence reduced growth (Oyun, 2008). Animal manure on the other hand stores a high amount of organic matter which positively affects the physical properties of soil. When incorporated into the soil, animal manure makes light textured soils become more cohesive, thus improving their structure, water absorption and retention. Also the organic matter makes heavy soils particular clay become more permeable to both air and water in addition to the power of organic matter to adsorb calcium, magnesium, potassium and ammonium which would have been leached from the soil due to its high ion exchange capacity (Ojeniyi, 2012). In addition, organic matter is a rich source of plant nutrients especially N, P and S. These attributes probably make the plants treated with organic manure either singly of fortified with micro-dose of NPK fertilizer results in greater height and collar diameter growth compared with NPK fertilizer treated plants.

Also in terms of residual effect, the effect of mineral fertilizer may not extend to the crop that follow cereal crop especially with respect to yield whereas the effects of organic manure, such as poultry manure extend to one or two crop crops that follows after application with respect to crop yield, plant nutrients content and soil fertility (Ojeniyi, 2012). Similarly, combined application of organic and inorganic sources of plant nutrients reduces the quantity of either source.

CONCLUSION

Poor management of soil, a delicate natural resource can have serious negative effects on the environment and humans. The future requires that farmers will farm the same piece of land continuously and will be faced with the challenge to increase food production on land that is already in cultivation. This has to be done in a way that does not lead to diminished soil productivity. Combined use of mineral and organic fertilizers is therefore required for sustainable soil productivity under intensive continuous cultivation.

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