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# ASSESSMENT OF DIFFERENT RATES OF POULTRY MANURE APPLICATION ON SOIL PROPERTIES, GROWTH AND YIELD OF MAIZE IN WUKARI, TARABA STATE

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**Abstract:**
Field experiments were conducted to assess the influence of different rates of poultry manure on soil properties, growth and yield of maize at Teaching Research and Farm, Federal University Wukari, Taraba State, Nigeria. Four treatments were used in the experiment (0 t $ha^{-1}$, 5 t $ha^{-1}$, 7.5 t $ha^{-1}$ and 10 t $ha^{-1}$ of poultry manure) used Randomized Complete Block Design (RCBD) replicated three (3) times. The results obtained from the experiment showed that application of poultry manure increased soil pH, available P, available Ca, organic C, CEC, and total N. the rate of 10 t $ha^{-1}$ recorded the maximum plant height, least numbers of days to 50% (60.72 and 61.56) and highest grain yield (3.12 and 3.18 t $ha^{-1}$) in the two cropping seasons. Hence from the field experiment, it can be inferred that the application of 10.0 t $ha^{-1}$ of poultry manure can be used for soil sustainability, growth and yield of maize.
**Keywords:** Poultry Manure, soil pH, organic carbon, plant height, yield and maize.

## Introduction

As the human population continues to grow, it is becoming highly challenging to increase food production without exacerbating environmental problems and increasing agricultural acreage (Xu *et al*., 2020). The production of maize (Zea mays L.) plays an important role in efforts to achieve this goal. Maize (*Zea mays L*.) is an important cereals crop belongs to the tribe *Maydeae*, of the grass family, *Poaceae* and popularly known as the 'queen of cereals' (Dhaka *et al*., 2010). Maize is relatively a short duration crop and capable of utilizing inputs more efficiently and is potentially capable of producing large quantity of food grains per unit area. It can successfully be cultivated twice a year as spring and autumn crop. Maize has greater nutritional value as it contains about 72% starch, 10% proteins, 4.8% oil, 8.5% fiber, 3% sugar and 1.7% ash (Chaudhary, 1993). Maize is one among the world's most important cereal crop after wheat and rice in terms of arable land and total production. Maize (*Zea mays L*.) is one of the members of the cereal family that has added great value to both man and animals. It ranks third following wheat and rice in world production (FAO, 2003). Maize is a very important cereal crop that is a source of food to large number of human population in the world. In developing countries maize is a major source of income to many farmers (Tagne *et al*., 2008). The maize crop serves as a source of food for mankind and feeds for animals and serves as a raw material in many manufacturing industries for the production of substances like; starch, syrup, vegetable oil, and recent uses such as biofuel. It is consumed roasted, baked, fried, boiled or fermented in Nigeria (Agbato, 2003). Maize is cultivated worldwide and represents a staple food for a significant proportion of the world's population. No significant native toxins are reported to be associated with the genus Zea (IFBC, 1990). Maize (*Zea Mays L*), sometimes referred to as corn is rank with wheat and rice as one of the most produced and consumed cereal crop in Nigeria (Vadya, 1986).

Maize (Zea mays L.) is an important crop in the Guinea savanna zone of Nigeria but mean grain yield is less than 2 t $ha^{-1}$ due to numerous biotic, abiotic and management constraints (Kamara, *et al*, 2013 and Ekeleme, *et al*, 2014). Nigeria soil has a high potential for crop production yield, levels obtained under farmer's condition are usually low due to poor soil management and conservation method. The type of problem is solved through the use of either inorganic or organic fertilizer. However, inorganic fertilizers are usually not available and are always rather expensive for the low–income, small scale farmers. Amendment by the use organic manures is considered less likely to have detrimental effect on soil physico-chemical properties compared with mineral fertilizers (Adeleye *et al*, 2010). Therefore, organic amendment is appropriate for soil, crop growth, environment, and economic improvements. Studies have shown that the application of manure has positive effects on the physical and chemical properties of soil mainly due to increase in organic matter (Masto *et al*, 2007 and Yolanda *et al*, 2014). The important roles of organic matter include being a rich source of essential plant nutrients (FAO, 2005), helps in improving moisture holding capacity of the soil, improves soil structure, soil aeration, water permeability, acts as pH buffer, contains metal-organic matter complexes that help in making available micro nutrients to crop (Udoh *et al*, 2005 and Ikeh *et al*, 2013). Nutrient availability to crop is affected by soil physical, chemical and biological properties and these are also influenced by the environmental factors. These properties include soil pH, organic matter content, soil texture, soil water content, nutrient interactions, temperature, and microbial activities (Blank et al, 2007). Many series of reactions and activities, including decomposition, mineralisation, humification, adsorption, desorption, precipitation, immobilization, ligand exchange, leaching, dissolution, diffusion and fixation, could be triggered within the soil environment by addition of organic manure such as poultry manure (Comerford, 2005 and Krull, *et al*, 2003). These inevitably lead to changes in soil physical and chemical properties and resultant effects on the growth of crops. Therefore, this paper rather focuses on the assessment of different rates of

poultry manure application on soil properties, growth and yield of maize.

## Materials and Methods

### *Experimental layout and land preparation*

The field experimental was laid out in a Randomized Complete Block Design (RCBD) replicated three (3) times each plot size was a 3m x 4m with four treatments at the Teaching Research and Farm, Federal University Wukari, Taraba State, Nigeria, located on Latitude 7° 50'N and Longitude 9° 46' E Wukari is situated within the Southern Guinea Savanna zone of Nigeria. The annual rainfall averages around 1,205 mm (World Atlas and Climate Data Organisation, 2015). The soil types are alfisols (FAO), (FDALR, 1990).

The land was occupied by calopo, *Impereta cylnidrica*, and some other common weeds, the land had been under continuous cultivation for the past three years without application of either inorganic or organic fertilizers. The land was cleared and stumps manually and thereafter manually ridged. The experimental land was divided into a 3m x 4m plot with a distance of 0.50m between each plots and 1 m between replications which produced total number 12 plots. The treatments are: 0 t $ha^{-1}$, 5 t $ha^{-1}$, 7.5 t $ha^{-1}$ and 10 t $ha^{-1}$ of poultry manure. The poultry manure was incorporated into the soil 2 week before sowing. Maize seed (sammaz 51 maize cultiver) were sown at a spacing of 25 cm within rows and 75 cm between rows at three seeds per hole and were thinned to two seedlings per hole, two weeks after sowing. Weeding was done manually at 3 and 6 weeks after sowing.

### *Poultry manure and soil analysis*

Poultry manure was obtained from the livestock session of the Teaching and Research Farm, Federal University Wukari, Taraba State, Nigeria. The sample was air dried, crushed through a 2mm sieve and subjected to laboratory analysis following standard procedure in order to determine the chemical properties (IITA 1989). Prior to the commencement of the experiment, top soil samples of 0 - 30 cm deep were collected randomly from five spots using soil auger from the experimental plot and mixed together to form a composite sample. After harvest, top soil samples of 0 - 30 cm deep were collected randomly from five spots within a plot and mixed together to form a composite sample of each treatment. It was air dried, sieved with a 2 mm mesh-size sieve and taken to the laboratory to determine the soil's physicochemical properties using standard laboratory procedures (Olsen *et al*, 1954: Jackson, 1973: Page *et al*, 1982: Dirk and Hargarty 1984 and Okalebo *et al*, 2002).

### *Data collection and statistical analysis*

Five plants were randomly tagged from two middle rows in each plot for sampling and data collection for vegetative growth and yields assessment. The following data on vegetative growth (plant height) and yield attributes (days to 50% tasseling and grain weight) were collected at crop maturity and harvest. Data collected from the experimental field were subjected to analysis of variance (ANOVA) and significantly different mean values were compared using Duncan Multiple Range Test (DMRT) at 5% probability level.

## Results and Discussion

Table 1 shows the nutrient analyses for poultry manure used. The routine analysis reveals that poultry manure used was rich in all elements analysed.

**Table 1: Poultry manure analysis.**

| Properties | Poultry manure |
|---|---|
| pH (water) | 6.98 |
| Organic Carbon (%) | 10.8 |
| Total Nitrogen (%) | 0.34 |
| P(mg $kg^{-1}$) | 0.97 |
| K (cmol $kg^{-1}$) | 4.32 |
| Ca (cmol $kg^{-1}$) | 3.98 |
| Mg (cmol $kg^{-1}$) | 4.41 |
| Na (cmol $kg^{-1}$) | 2.51 |

Table 2 and 3 show the result of initial and after harvest soil analysis for the two cropping seasons. The initial soil analyses indicate that the soil is low in nitrogen content, organic matter, available phosphorous exchangeable base, organic carbon and effective caution exchange capacity. This implies that the soil is poor in nutrients and of low productivity. Hence response to organic manure would be encouraged Agbogidi and Okonmah (2012).

**Table 2: Effect of treatment on physical and chemical properties of the soil in 2021**

| Rates | pH | OC | N | P | K | Ca | Mg | Na | CEC | Exch Acidity | Sand | Silt | Clay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $H_2O$ | —(%) — | | mg $kg^{-1}$ | ——— cmol $kg^{-1}$ ——— | | | | | | ———% ——— | | |
| Initial | 6.69 | 0.11 | 0.03 | 7.76 | 0.30 | 3.71 | 0.74 | 0.31 | 5.06 | 0.08 | 7.65 | 18.40 | 5.10 |
| | | | | | after harvest | | | | | | | | |
| 0.0 t $ha^{-1}$ | 6.22 | 1.09 | 0.02 | 7.35 | 0.29 | 3.65 | 0.72 | 0.24 | 4.90 | 0.08 | 76.61 | 18.21 | 5.18 |
| 5.0 t $ha^{-1}$ | 6.98 | 1.47 | 0.11 | 12.72 | 0.42 | 4.52 | 1.22 | 0.81 | 6.97 | 0.12 | 62.45 | 27.72 | 9.83 |
| 7.5 t $ha^{-1}$ | 7.01 | 1.82 | 0.14 | 15.18 | 0.43 | 5.31 | 1.32 | 0.81 | 7.67 | 0.14 | 69.57 | 20.21 | 10.22 |
| 10.0 t $ha^{-1}$ | 7.02 | 1.88 | 0.17 | 16.87 | 0.46 | 5.32 | 1.33 | 0.84 | 8.15 | 0.18 | 66.41 | 21.18 | 12.41 |

**Table 3: Effect of treatment on Physicaland Chemical properties of the soil in 2022**

| Rates | pH | OC | N | P | K | Ca | Mg | Na | CEC | Exch Acidity | Sand | Silt | Clay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $H_2O$ | —(%) — | | mg $kg^{-1}$ | ——— cmol $kg^{-1}$ ——— | | | | | | ———% ——— | | |
| Initial | 6.71 | 0.11 | 0.03 | 7.76 | 0.30 | 4.02 | 0.78 | 0.31 | 5.41 | 0.08 | 7.65 | 18.40 | 5.10 |
| | | | | | after harvest | | | | | | | | |
| 0.0 t $ha^{-1}$ | 6.03 | 1.07 | 0.04 | 8.03 | 0.25 | 4.01 | 0.72 | 0.23 | 5.21 | 0.06 | 73.60 | 19.40 | 7.00 |
| 5.0 t $ha^{-1}$ | 6.78 | 1.48 | 0.16 | 13.71 | 0.38 | 4.32 | 1.21 | 0.81 | 6.72 | 0.10 | 69.20 | 22.35 | 8.45 |
| 7.5 t $ha^{-1}$ | 6.99 | 1.63 | 0.18 | 16.78 | 0.46 | 5.29 | 1.37 | 0.80 | 7.74 | 0.14 | 69.81 | 20.20 | 9.99 |
| 10.0 t $ha^{-1}$ | 7.01 | 1.85 | 0.18 | 16.89 | 0.45 | 5.30 | 1.38 | 0.83 | 7.96 | 0.19 | 66.60 | 21.40 | 12.00 |

The control (0 t $ha^{-1}$) had lower values of pH (6.22 and 6.03) than initials pH (6.69 and 6.71). The pH values at initial soil were lower than plots that received organic manure. The highest pH values (7.02 and 7.01) were obtained at 10.0 t $ha^{-1}$. The application of poultry manure resulted in an increase of soil pH in both years which is in accordance to Petek *et al.* (2008). The higher pH in plots that were treated with poultry manure was due to neutralizing effect of the available exchangeable cations. This is in agreement with Asmare *et al* (2015) that organic manure (wood ash) increased soil pH as it contained high composition and release of calcium and magnesium.

The increase of soil organic carbon with addition of organic amendments to soil is caused by high organic matter content of poultry manure (Table 2 and 3). The application of organic amendments led to a significant increase in organic carbon content, compared to its initial level. Organic carbon increased with increase in poultry manure as 10. 0 t ha-1 recorded the highest values (1.88 and 1.85%) and the control recorded the lowest values (1.09 and 1.07 %). The soils treated with poultry manure exhibited a higher organic content than the control. Therefore, the addition of poultry manure was able to affect the soil organic matter content, as this is in agreement with Messiga *et al* (2013) also indicated that organic carbon tends to rise with increased Organic manure application.

The experimental results showed that the addition of poultry manure has effect on total N (Table 2 and 3). Treatment 10.0 t ha-1 had the highest value of N (0.17%) in 2021 while in 2022 treatments 7.5 and 10.0 t ha-1 had same value of N (0.18%). This was followed by treatment 5.0 t ha-1and lowest values (0.02 and 0.03%) were obtained at the controlled plot. The increase in total N due to the increase in organic amendment dose was caused by the addition of N derived from the decomposition of the organic matter. The higher the organic amendment dose added, the higher the N released. Syukur and Harsono (2008) reported that the provision of cow manure increased the total N-level and soil available N.

Application of poultry manure exhibited higher the available phosphorous than the control. The highest value for available phosphorous was scored at poultry manure 10.0 t $ha^{-1}$ application (16.87 and 16.89 mg $kg^{-1}$) (table 2 and 3) while control (0.0 t $ha^{-1}$) had the lowest (7.35 and 8.03 mg $kg^{-1}$) this might be due to the fact that poultry manure is rich in phosphorous, potassium, magnesium and calcium and the significant proportion of phosphorus in manure mineralize slowly and gradually to release plant available phosphorous ( Benke et al 2009 and Manitoba 2013). The increased amount of available phosphorus after harvest observed might be attributed from the release of soluble humic material or organic acids from the

decomposing of the organic manure contribute greatly to decrease P adsorption capacity and increased available P that occurs in soils (Easter and Sartain 1990)

Applications of the organic manure increased the exchangeable magnesium, Ca and other cations than the control in both cropping seasons. Treatments 7.5 and 10.0 t $ha^{-1}$ had similar values of exchangeable cations followed by 5.0 t $ha^{-1}$ and control recorded lowest values. This was due to the soil highest composition of organic carbon and total nitrogen of the organic manure contributed to increase the cation exchange capacity of the soil to hold higher nutrients (Manitoba, 2013). Suntoro *et al.* (2018) reported that application of organic manure increased available Ca and Na in the soil compared to controls. Agbede (2010) also reported that application of organic manure which contains high exchangeable calcium; potassium, magnesium and sodium, and the presence of these exchangeable bases in soil tend to increase soil acidity value. The CEC of the soil increased with the applications of all the organic manure above the control, where 10 t $ha^{-1}$ recorded the highest values (8.15 and 7.96 cmol $kg^{-1}$). In this study, the cation exchange capacity (CEC) of soil increased due to organic manure incorporation; the same finding by Ouédraogo *et al.* (2001) and Cooper *et al*. (2020) studies that the increase in CEC with organic fertilizer application could be attributed to an increase in total organic carbon.

**Table 4: Effect of treatments on Plant height (cm)**

| Treatments | 4 WAS | | 6 WAS | | 8 WAS | |
|---|---|---|---|---|---|---|
| | 2021 | 2022 | 2021 | 2022 | 2021 | 2022 |
| 0.0 t $ha^{-1}$ | 40.39[b] | 39.88[b] | 72.31c | 68.46[c] | 137.70[c] | 139.01[c] |
| 5.0 t $ha^{-1}$ | 52.34[ab] | 51.98a | 115.52[b] | 116.72[b] | 163.31[a] | 179.04[b] |
| 7.5 t $ha^{-1}$ | 55.16[a] | 54.15[a] | 126.66[ab] | 123.84[ab] | 192.50[a] | 194.32[a] |
| 10.0 t $ha^{-1}$ | 55.18[a] | 56.85[a] | 139.41[a] | 138.40[a] | 206.60[a] | 214.61[a] |

Mean followed by the same letter(s) within each column are not significantly different at P=5% WAS=Weeks After Sowing

Poultry manure application had a significant effect on plant height (Table 4). In the first year (2021), application of poultry manure 10.0 t $ha^{-1}$ gave the tallest plants of 55.18 cm at 4 weeks after sowing which was statistically similar with 5.0 and 7.5 t $ha^{-1}$ but only significantly (P=0.05) taller than plants (40.39 cm) treated with no organic manure. In 2022 cropping season at 4 weeks after sowing all plots treated with poultry manure were significantly (P=0.05) taller than the control. At 6 weeks after sowing in the two cropping seasons were similar as the shortest plant was obtained at the control and significantly lower than all plots that received poultry manure. Treatment 10.0 t $ha^{-1}$ had the tallest plant height 139.41 and 138.40 cm in 2021 and 2022 respectively but same statistically with plant height at 7.5 t $ha^{-1}$ (126.66 and 123.84 cm). This trend was maintained through at 8 weeks after sowing. All the fertilized plots had plants comparable in height, but were significantly taller than plants from the control plots. The observation of this research is similar with that of Premsekhar and Rajashree (2009), and Tiamiyu *et al* (2012) who observed that the organic manures recorded the maximum plant height. Our results were as par previous findings. In maize, the application of manures, i.e., PM and FM tend to promote higher plant height (Iqbal *et al*., 2013; Mohsin *et al.*, 2012; Gul *et al.*, 2021).

**Table 5: Days to 50% Tasseling and grain yield**

| Treatments | Days to 50% Tasseling | | Grain yield t $ha^{-1}$ | |
|---|---|---|---|---|
| | 2021 | 2022 | 2021 | 2022 |
| 0.0 t $ha^{-1}$ | 68.53[a] | 66.41[a] | 0.76[d] | 0.69[d] |
| 5.0 t $ha^{-1}$ | 64.51[a] | 65.37[a] | 2.14[c] | 2.18[c] |
| 7.5 t $ha^{-1}$ | 61.83[b] | 62.82[b] | 2.54[b] | 2.68[b] |
| 10.0 t $ha^{-1}$ | 60.72[b] | 61.56[b] | 3.12[a] | 3.18[a] |

Mean followed by the same letter(s) within each column are not significantly different at P=5%

Days to 50% flowering was significantly accelerated by poultry manure, which was significantly rapid than the control. This is a profound phenomenon exhibited for a longer in determinant reproductive growth which ultimately aids to the overall grain yield. Moreover, treatments 7.5 and 10.0 t ha-1 was statistically similar and produced the flowers significantly earlier than that by 5.0 and control. The reduced period of flowering and podding from the time of sowing in plants supplied with organic manure only may be due to the ready availability of some plant nutrients (Egbe *et al*. 2022). The use of organic manures accelerated the flowering than chemical fertilizer and control was also reported by Abu-Zahara (2012).

Table 5 shows the grain yield of maize as affected by poultry manure. The result revealed that treatment 10.0 t ha-1 of poultry manure gave the highest grain yield of 3.12 and 3.18 t $ha^{-1}$ in the two cropping seasons and significant difference ($p<0.05$) among the treatments. The lowest grain yield (0.67 and 0.69 kg ga-1) was recorded at the control. This also indicated that there were significant difference ($p<0.05$) among the treatments. However, this was in line with the finding of many researchers (Ali *et al*., 2011; Hadayatullah *et a*l., 2013) reported that poultry manure significantly increased the grain yield in maize and biological yield (Iqbal *et al*., 2013; Sharma *et al.*, 2019). The application of increasing levels of organic manure increased the maize growth, which might have been due to the balance availability of nutrients to the plants that resulted in a favourable soil environment. These favourable conditions increased the nutrient availability and water holding capacity of the soil resulting in enhanced growth and yield (Rashid *et al*., 2013).

**Conclusion**

The study indicates that poultry manure is a valuable fertilizer whose use needs to be encouraged. Among the different levels of poultry manure applications, 10.0 t $ha^{-1}$ showed significantly the highest vegetative growth parameter i.e. plant height. The lowest vegetative growth parameters were recorded with the control. Similarly, 10.0 t $ha^{-1}$ of poultry manure recorded the highest yield attributing characters such as days to 50% flowering and the highest grain yield as compared to other rate of poultry manure. The application of poultry manure increased soil pH, available P, available Ca, organic C, CEC, and total N. Optimal soil conditions also increase soybean production to reach 3.18 t $ha^{-1}$. So, the application of 10.0 t $ha^{-1}$ of poultry manure is an alternative for soil sustainability, growth and yield of maize.

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