Comparative Effect of Organomineral Fertilizer and Poultry Dung on the Growth of Maize

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Abstract

Integrated soil fertility management is an ecological approach that uses organic amendments and organic fertilizers in an integrated way. This study evaluated the complementary use of poultry manure, N.P.K 20:10:10 and organo-mineral (a combination of organic and inorganic fertilizer) in the greenhouse. There were 10 treatments replicated three times for three soil series namely Iwo, Apomu, and Jago series. Maize was used as the test crop. Results of the experiment showed that plant uptake of N, P, and K in Iwo and Jago series were significantly increased by the application of 10t ha^{-1} PD + 10t ha^{-1} OM. In Apomu series, uptake of N and P were significantly increased by the sole application of 10t ha^{-1} PD while uptake of K was significantly increased with the application of 5t ha^{-1} OM. Uptake of Ca and Mg were significantly increased with 5t ha^{-1} PD + 10t ha^{-1} OM in Iwo and Jago series while 10t/ha PD increased Ca and Mg uptake in Apomu series. Soil pH was significantly increased in Iwo soil with the application of 5t ha^{-1} PD + 10t ha^{-1} OM but in Jago series, there was no significant difference among the treatments. Cation exchange capacity, OC, total N and available P significantly increased with 10t ha^{-1} PD + 10t ha^{-1} OM in Iwo and Apomu series. These were increased with the application of 5t ha^{-1} PD + 5t ha^{-1} OM in Jago series. This study, however revealed that the effects of the applications of poultry manure, NPK 20-10-10 and organomineral fertilizers differed with the different soil series.

Introduction

Most soils contain an abundance of elements necessary for the growth of plants but most of these elements are not available for plant use due to nutrient loss. Nutrient depletion and soil degradation have become serious threat to agricultural productivity in Nigeria (Mbagwu and Obi, 2003). In order to address this issue, much attention has been paid to the application of macronutrients, particularly, N, P and K and the use of organic fertilizers which leads to good crop yields. The use of organic matter in form of organic manures as a means of maintaining and increasing soil fertility has long existed (Alasiri and Ogunkeye, 1999). Lombin et al (1991) reported that soil fertility and productivity can only be maintained through the use of organic or inorganic manure, but the combination of organic and inorganic fertilizer gives a better result. Titiloye (1982) also reported that maize yields obtained from treatments with combinations of waste and NPK fertilizer were higher than yields obtained from treatments in which waste materials or inorganic fertilizer was applied solely. Recently in Nigeria, the use of organominerals, a combination of both organic and inorganic manure is becoming popular and gradually being adopted. A study was conducted on the effects of N and P supplemented organomineral fertilizers on maize performance. The results showed that they have complementary roles and play very important roles in the quality of the finished product (Adeoye, 1998). This study was conducted to study the effect of poultry droppings, organomineral fertilizer and N.P.K. 20:10:10 solely and in combinations on the nutrient concentration of maize and its residual effects in the soil.

Material And Methods

A greenhouse experiment was carried out at the Institute of Agricultural Research and Training, Ibadan, Nigeria located at 7° 56'N and 3° 45'E at an altitude of 240 m above sea level. Surface soil sampling of 3 soil series was done at a depth of 0 – 30 cm, air-dried and later sieved with a 2 mm sieve. The soil series studied included Iwo (ferric Luvisol), Apomu (Eutric Cambisol) and Jago (Eutric Fluvisol) series. Treatments were arranged in a completely randomized block design and replicated thrice.

The treatments included: 5t/ha of poultry manure, 10t/ha of poultry manure, 5t/ha of organomineral, 10t/ha of organomineral, 5t/ha of poultry manure + 5t/ha organomineral, 10t/ha of poultry manure + 10t/ha of organomineral, NPK 20:10:10 at 100kg/ha and control. Pacesetters organomineral fertilizer was used and compounded from poultry waste, cow dung, saw dust, water hyacinth and sorted city refuse and then applied to each of the soil series. Maize was used as the test crop and four seeds per pot were planted and latter thinned to 2 plants after 2 weeks. Pre-cropping soil analysis was done. The plants were allowed to grow for 8 weeks, harvested and analyzed for macro and micro – nutrient concentrations. Chemical analyses were carried out on the pre- planting and post- harvest soil samples. Soil Nitrogen (N) was determined using the micro-kjedahl method according to Bremner (1960) while organic carbon determination was by oxidation with sulphuric acid using the method of Walkey and Black (1965). Exchangeable cations were leached from soil with 1 N ammonium acetate before determination on Energy Emitted Lithium flame photometer (Instrumentation Laboratory, Inc., Lexington, MA) while Na and K were read using a flame photometer; Ca, Mg, Zn using atomic absorption spectrophotometer. Available P was extracted with the Bray I extractor (Bray and Kurtz, 1954) and measured on a spectro-20 electro-photometer following the procedure described by Jackson (1958) .ECEC was determined by summation of the acidic and basic cations. The plant samples were digested with the binary mixture of HNO_3 and H_2SO_4 and later analysed for Na and K using a flame photometer; Ca, Mg, and Zn using atomic absorption spectrophotometer. Phosphorus in the samples was analysed using the vanado – molybdate method. The data were subjected to analysis of variance and means separated using Duncan's multiple range Test.

Results

Pre – cropping analysis

The chemical properties and textural class of the soils used for the experiment are shown in Table 1. The concentrations of the basic cations were generally low, while calcium dominated the exchange sites. The soils were low in organic carbon, nitrogen and phosphorus. The pH of the soil was slightly acidic. The textural classes of the soils were sandy loam for the Apomu and Jago series and sandy clay loam for the Iwo series. The low fertility indices of the soils suggested that there was likely to be positive crop response to the application of fertilizer.

Tissue N contents

In Iwo series, it was observed that the application of PD and OM at 10t ha^{-1} had similar tissue N concentrations and were higher than that in PD_5 OM_{10}. However, the contents in the PD_5 OM_{10}, NPK and PD_5 treatments were significantly higher than in the control in Jago series. However, joint application of PD_{10} and OM_5 gave a significantly higher tissue N concentration than other treatments. On the contrary, in Apomu soil series, singular application of PD at 10t ha^{-1} or OM at 5t ha^{-1} produced significantly higher tissue N concentration. The applications of PD at 5t ha^{-1}, NPK had similar values compared to the control but were significantly higher than in applying PD_5 OM_{10}.

Tissue contents of phosphorus

It was observed in Table 2 that there was a significant increase in the concentrations of P in the plant tissues with the addition of either poultry droppings (PD) or organomineral (OM) fertilizer either singly or in combination. Application of PD or OM at 5 and 10 tons per hectare increased the P concentration in maize plant in Iwo and Jago series. The effects of the singular application of these materials were complemented when both were applied jointly. Application at 10t ha^{-1} of both poultry droppings and organomineral led to a significantly higher tissue P concentrations, compared to the application of NPK 20-10-10 fertilizer. A similar observation was recorded in Jago series. However, in Apomu soil series, singular application of either poultry droppings or organomineral at 5 or 10t ha^{-1} produced the higher P concentration. Combined application of PD and OM had similar P concentration with NPK treatment.

Tissue K contents

Table 3 shows that there were significant increases in the tissue K concentrations in all the soils as a result of the addition of the fertilizer materials. The applications of PD_{10} OM_{10} and PD_5OM_{10} increased the concentration more than the other treatments. Similar results were noted in Jago series. On the contrary, at Apomu singular application of OM at 5t ha^{-1} gave the highest tissue K concentration, this was closely followed by the application of PD at 5 and 10t ha^{-1}. These singular applications were statistically higher than those from their joint applications and the application of NPK 20-10-10.

Tissue Zn contents

There were significant increases in the tissue Zn with the application of either PD or OM in all the soils used in the experiment. The trend in the soils varied widely; there were no distinct complementary effects when both materials were applied either singly or jointly. In Jago series, however, the application of NPK fertilizer led to significantly higher tissue Zn concentration compared to other treatments.

Tissue Ca and Mg contents

In Iwo soil series, the tissue Ca and Mg contents obtained with PD_5OM_{10} and NPK 20-10-10 were similar but were significantly higher than in the remaining treatments. The results in Jago series was similar to that observed in Iwo series. However, the values from the joint application of PD and OM were significantly higher that those from their singular applications. This was however, contrary to the trend recorded in Apomu series. Here, application of PD at 10t ha^{-1} and OM at 5t ha^{-1} had significantly higher Ca and Mg concentrations compared to their joint applications.

Tissue Na contents

In table 4, it was observed that the tissue Na contents in in Iwo series did not reflect any clear. In Apomu soils series PD_{10} gave the highest Na concentration. This is significantly higher than other treatments. Tissue Na concentration was significantly higher in treatments that has PD_{10} OM5 compared to other treatments.

Exchangeable soil Na, K, Ca and Mg

The residual amounts of Na and Ca in all the soils (Table 5) were increased by the treatments. Increment in exchangeable Na in Iwo series was significantly higher in treatments where PD and OM were applied jointly at 10t ha^{-1}. This was significantly higher than all other treatments. This is closely followed by these treatments PD_5OM_{10} > PD_5OM_{10} > PD_5 > OM_{10} and least in the control and NPK 20-10-10 treatments. There was no significant difference among the treatments in Apomu series, but the trend of treatment effect in Jago series showed decrease in exchangeable Na in all treatments with PD and OM applied jointly and NPK fertilizer treated soils. The effects of singular applications of either PD or OM at all rates were not significantly different.

The exchangeable potassium content in Iwo series revealed that the combined application of PD and OM resulted in significantly higher residual K compared to the singular application of either material. This trend was also observed in Jago series, though the application of PD_5 gave the highest soil K. This was however not significantly higher than some treatments where PD and OM were jointly applied. The treatment effects on residual exchangeable K in Apomu series was similar to that observed in Iwo and Jago series. Residual exchangeable Ca in Jago series showed that there was no significant difference among all the treatments. However, in Iwo series, all the treatments were similar, except PD_5, which was significant lower than PD_5OM_5, $PD_{10}OM_{10}$. The highest amount of residual Ca was recorded with PD_5OM_{10} in Apomu soil and the significantly lower amount was observed in PD_5OM_{10}. Table 7 shows that there is no significant treatment effect on soil magnesium in Iwo and Apomu soil series. However, at Jago series, the singular application of PD_5, OM_5 and the combined application of PD and OM at 5 and 10t ha^{-1} respectively, had the highest residual amount of Mg.

Soil pH, avail, P and Zn

Application of NPK20-10-10, PD_5OM_{10} and OM_5 had similar pH values. Similar results was observed in Jago series where PD_5OM_{10}, PD_5OM_5, OM_5 PD_5 had significantly higher pH values compared to other treatments. No treatment effect was recorded in Apomu soil series .Available phosphorus of the soils revealed that PD_5OM_{10}

Table 2: Effect of poultry manure (PD), organomineral (OM)and N.P.K. on maize plant tissue P, N and Zn concentration (%)

	P			N			Zn		
	Iwo	Jago	Apomu	Iwo	Jago	Apomu	Iwo	Jago	Apomu
Control	0.30^{e}	0.33^{h}	0.46^{cd}	0.60^{e}	0.76^{f}	0.59^{bc}	122.00^{e}	114.00^{f}	119.00^{d}
PD_5	0.40^{ab}	0.34^{g}	0.53^{ab}	0.66^{bc}	0.76^{f}	0.63^{b}	128.00^{b}	113.00^{g}	123.00^{b*}
PD_{10}	0.38^{c}	0.34^{g}	0.56^{a}	0.69^{b}	0.66^{h}	0.69^{a}	124.00^{d}	124.00^{b}	120.00^{c*}
OM_5	0.36^{bc}	0.39^{ab}	0.49^{bc}	0.66^{bc}	0.77^{e}	0.64^{ab}	126.00^{c}	120.00^{e}	124.00^{a*}
OM_{10}	0.30^{e}	0.38^{d}	0.38^{ef}	0.66^{bc}	0.88^{b}	0.61^{bc}	126.00^{c}	113.00^{g}	116.00^{e}
PD_5OM_5	0.36^{bc}	0.36^{f}	0.38^{ef}	0.82^{c}	0.76^{e}	0.56^{c}	129.00^{a*}	116.00^{e}	115.00^{f}
$PD_{10}OM_5$	0.46^{a}	0.39^{c}	0.39^{ef}	0.80^{d}	0.56^{c}	0.73^{a*}	124.00^{d}	116.00^{d}	123.00^{c*}
PD_5OM_{10}	0.40^{ab}	0.37^{e}	0.38^{ef}	0.72^{ab*}	0.76^{f}	0.63^{b}	119.00^{g}	119.00^{d}	120.00^{c*}
$PD_{10}OM_5$	0.30^{ab}	0.48^{a}	0.36^{f}	0.69^{b*}	0.93^{a}	0.50^{d}	126.03^{c}	110.00^{h}	110.00^{g}
NPK_{201010}	0.36^{bc}	0.40^{b}	0.43^{de}	0.70^{b}	0.69^{g}	0.60^{bc}	120.09^{f}	128.00^{a*}	119.00^{d}

Table 3: Effect treatments of poultry manure, organomineral and N.P.K on maize plant tissue K, Ca and Mg concentration (%)

	K			Ca			Mg		
Treatments	Iwo	Jago	Apomu	Iwo	Jago	Apomu	Iwo	Jago	Apomu
Control	0.96^{e}	1.22^{b*}	1.16^{f*}	0.63^{de}	0.50^{f}	0.68^{c*}	0.69^{d}	0.96^{f}	0.78^{de}
PD_5	1.03^{bcd}	1.00^{h}	1.24^{b}	0.73^{b*}	0.50^{f}	0.74^{b*}	0.94^{ab}	0.69^{f}	0.89^{b*}
PD_{10}	1.03^{bcd}	1.00^{h}	1.24^{e*}	0.76^{abc}	0.59^{c}	0.80^{a*}	0.91^{b}	0.70^{e}	0.94^{a*}
OM_5	0.99^{de}	1.14^{g}	1.29^{a}	0.69^{dc}	0.54^{e}	0.80^{a*}	0.83^{c}	0.70^{e}	0.90^{ab}
Om_{10}	1.00^{cde}	1.20^{c}	1.20^{h}	0.63^{de}	0.55^{de}	0.63^{cd}	0.77^{c}	0.72^{d}	0.73^{gf}
PD_5OM_5	0.06^{bc}	1.18^{e}	1.09^{g}	0.63^{de}	0.59^{c}	0.63^{cd}	0.78^{c}	0.70^{e}	0.75^{ef}
$PD_{10}OM_{10}$	1.80^{a*}	1.16^{f}	1.16^{f}	0.60^{e}	0.60^{c}	0.67^{c}*	0.99^{a*}	0.73^{c*}	0.76^{def*}
PD_5OM_{10}	1.16^{a*}	1.19^{d}	1.18^{e}	0.83^{a*}	0.56^{d}	0.68^{c}	0.95^{ab*}	0.61^{g}	0.80^{dc}
$PD_{10}OM_5$	1.09^{b*}	1.28^{a*}	1.00^{i}	0.69^{dc}	0.68^{a*}	0.59^{d}	0.76^{c}	0.78^{b*}	0.69^{g}
NPK_{201010}	0.03^{bcd}	1.00^{h}	1.20^{d}	0.77^{ab*}	0.63^{b*}	0.79^{ab}	0.92^{ab}	0.80^{a*}	0.83^{c}

Values in a row with the same letters are not significantly different (DMRT at 5% level of probability)

resulted in a significantly higher residual soil P compared to treatments OM_{10} and NPK 20-10-10. There were no significant differences among other treatments. On the contrary, the combined application of PD and OM reduced the residual soil – P in Jago series. These were significantly lower than the value observed in the treatment where 5 ton PD ha^{-1} was applied. In Apomu series, poultry dropping and organo mineral fertilizer applied jointly at 10t ha^{-1} each had the significantly higher available P compared to other treatments. Soil available P was similar in NPK 20-10-10 and PD_{10} treatments. There were no significant treatment effects on soil residual Zn in Jago series, however, singular application of OM_5, PD_5, and OM_{10} gave significantly higher soil Zn content. The differences between the three treatments were significant. Similar results were observed in Apomu series.

Soil H and CEC

The residual amount of residual soil hydrogen was not significantly affected by the treatments in Iwo and Jago series. Similarly, there was no treatment effects in Apomu series except at the application of OM_5, that was significantly higher than other treatments in terms of residual H. The CEC of the soils was significantly higher in $PD_{10}OM_{10}$ and least in the control. Generally, combined application of OM and PD resulted into significant increases in the soil CEC. Similar results were recorded in Apomu soil series.

Soil Organic carbon and total nitrogen

Table 6 shows that the soil organic carbon contents were increased by the addition of NPK, OM, and PD either singly or in combination. In Iwo series, the highest amount of organic carbon was

Table 4: Effect of poultry manure (MD), organimineral (OM) and N.P.K on tissue Na concentration (%)

Treatments	Iwo	Jago	Apomu
Control	0.63^{a}	0.52^{d}	0.63^{c}
PD_5	0.53^{bc}	0.59^{c}	0.39^{i}
PD_{10}	0.59^{ab}	0.69^{a}	0.40^{h}
OM_5	0.46^{c}	0.61^{b}	0.59^{d}
OM_{10}	0.53^{bc}	0.46^{f}	0.58^{e}
PD_5OM_5	0.58^{ab}	0.48^{e}	0.49^{f}
$PD_{10}OM_{10}$	0.63^{a}	0.48^{e}	0.64^{b}
PD_5OM_{10}	0.60^{ab}	0.59^{c}	0.59^{d}
$PD_{10}OM_5$	0.56^{ab}	0.38^{g}	0.68^{a}
NPK_{201010}	0.59^{ab}	0.59^{c}	0.43^{g}

Table 5: Effect of poultry manure, organomineral and N.P.K on the soil Na, k, and Ca, (cmol kg^{-1})

	Na			K			Ca		
	Iwo	**Jago**	**Apomu**	**Iwo**	**Jago**	**Apomu**	**Iwo**	**Jago**	**Apomu**
Control	1.80^{e}	1.50^{ab}	1.83^{a}	0.26^{h}	0.50^{bc}	0.56^{bc}	1.06^{ab}	1.18^{a}	1.04^{bcde}
PD_5	1.83^{c}	1.53^{a*}	1.83^{a}	0.31^{d}	0.88^{a*}	0.58^{b}	1.85^{b}	1.31^{a}	1.07^{bc}
PD_{10}	1.83^{c}	1.49^{ab}	1.88^{a}	0.33^{c*}	0.78^{bc}	0.70^{ab}	1.10^{ab}	1.20^{a}	1.09^{b}
OM_5	1.80^{e}	1.50^{ab}	1.86^{a}	0.29^{bc}	0.54^{bc}	0.54^{ab}	1.10^{ab}	1.26^{a}	1.00^{de}
Om_{10}	1.80^{e}	1.53^{a*}	1.88^{a}	0.28^{g}	0.82^{abc}	0.68^{a*}	0.98^{ab}	1.18^{a}	1.10^{b}
PD_5OM_5	1.82^{d}	1.43^{ab*}	1.86^{a}	0.30^{e}	0.76^{c}	0.68^{a*}	1.13^{a*}	1.26^{a}	1.08^{bc}
$PD_{10}OM_{10}$	1.88^{a*}	1.46^{ab}	1.89^{a}	0.39^{a*}	0.79^{c}	0.73^{a*}	1.22^{a*}	1.29^{a}	1.20^{a}
PD_5OM_{10}	1.84^{b*}	1.46^{ab}	1.86^{a}	0.35^{b*}	0.83^{ab*}	0.51^{c}	1.18^{a*}	1.24^{a}	0.99^{e}
$PD_{10}OM_5$	1.83^{c*}	1.48^{ab*}	1.88^{a}	0.30^{e}	0.79^{bc*}	0.69^{a*}	1.03^{ab*}	1.20^{a}	1.02^{cde}
NPK_{201010}	1.80^{e}	1.48^{ab}	1.89^{a}	0.31^{d}	0.77^{bc}	0.69^{a*}	1.08^{ab}	1.26^{a}	1.06^{bcd}

Values in a row with the same letters are not significantly different (DMRT)at 5% level of probability)

Table 6: Effect of treatment on soil Organic Carbon, total N contents (%)

	Organic Carbon (%)			Total N (%)		
	Iwo	Jago	Apomu	Iwo	Jago	Apomu
Control	0.92^{h}	0.89^{bcd}	0.80^{cd}	0.09^{c}	0.09^{b}	0.08^{b}
PD_5	0.98^{d}	0.98^{a*}	0.78^{de}	1.00^{a*}	1.00^{a*}	0.08^{b}
PD_{10}	0.94^{f}	0.85^{bcd}	0.89^{b}	1.00^{c}	0.09^{b}	0.09^{b}
OM_5	0.93^{g}	0.92^{ab*}	0.78^{de}	0.09^{c}	0.09^{b}	0.08^{b}
OM_{10}	0.94^{f}	0.86^{bcd}	0.88^{b}	0.09^{c}	0.09^{b}	0.09^{b}
PD_5OM_5	0.99^{b}	0.82^{d}	0.86^{bc}	1.00^{a*}	0.08^{b}	0.09^{b}
$PD_{10}OM_{10}$	0.06^{a*}	0.84^{cd}	0.99^{a*}	0.11^{b}	0.08^{b}	1.00^{a*}
PD_5OM_{10}	0.98^{c}	0.90^{bc*}	0.68^{f}	1.00^{a*}	0.09^{b}	0.07^{b}
$PD_{10}OM_5$	0.98^{c}	0.88^{bcd*}	1.72^{ef}	1.00^{a*}	0.09^{b}	0.07^{b}
NPK_{201010}	0.95^{c}	0.86^{bcd*}	0.91^{b}	0.10^{a*}	0.09^{b}	0.09^{b}

Values in row with the same letters are not significantly different (DMRT at 5% level of probability)

recorded in $PD_{10}OM_{10}$ and least in the control. Generally, the combined application of OM and PD gave significantly higher organic carbon compared with their singular application and NPK treatments. Similar result was recorded in Apomu series. However, in Jago series, $PD_{5\ and}$ OM_{10}, produced the significantly higher residual soil organic carbon compared to other treatment.

The residual soil N in all the soil series was similar to the trend observed in the organic carbon. In Iwo soil, the combined applications generally resulted into higher soil N than singular applications except when PD was applied at 5 tons per hectare. This same treatment had the significantly higher soil N in Jago series compared to all other treatments. There was no significant difference among other treatments. Similar trend of result was recorded in Apomu series; however, the significantly higher soil N was recorded in PD_5OM_{10}, while there was no significant difference among the other treatments.

Discussion

The joint application of poultry droppings and organo-mineral fertilizer increased the plant uptake of N, P,K, Zn, Ca, Mg, and Na, than their singular applications. This is expected, since poultry manure generally increases soil organic matter content and micronutrients. There is a complementary effect of the organic material in the organomineral fertilizer (OMF) on this increase in organic matter contents. The high uptake of these nutrient elements was due to the high organic matter contents of the soil. Organic matter shows greater capacity than inorganic fertilizers in retaining nutrients in forms that can easily be taken by plants over a longer period. The inorganic component of the organommineral fertilizer however, satisfies the immediate nutrient requirement of the crop, hence the combination is superior to PD alone which might not meet immediate nutrient needs of the crop. For NPK fertilizer alone, the nutrients are leached with increase in time of application. The application of inorganic fertilizers does not always improve soil organic matter content. Conversely, nutrients released from the NPK fertilizers were only for a short period of time. Adeniyan and Ojeniyi (2003) reported that the combined use of NPK fertilizer and poultry manure increased maize yield and nutrient uptake. They also suggested the combined use of 3t/ha poultry manure and 200 kg/ha NPK

fertilizer with respect to dry matter and grain yield and nutrient uptake by maize. Findings by Tejada *et al* (2005) also revealed that organo-mineral fertilizer had lower inorganic N, P, and K losses that organic fertilizer.

The treatments, PD + OMF showed a greater capacity to retain nutrients in forms that can easily be taken up by plants over a long period. The effective residual effect of poultry manure combined with OMF compared to either PD or NPK fertilizer along accounts for the high fertility and nutrient uptake in the soils. Similar findings were reported by Antoun *et al* (1985). The finding that the application of PD with or without OMF increased uptake of some nutrients indicated that poultry manure was a good source of the nutrients (Adeniyan and Ojeniyi, 2003). Hence, its ability to retain these nutrients for a long period due to its slow rate of decomposing over a longer period of time. In general, the nutrient uptake and their residual soil amounts were better with the combined application of poultry manure and organo-mineral fertilizer.

The increasing response in plant nutrient uptake with increased levels of PD and OMF implies a direct relationship between available soil nutrients and plant uptake of these nutrients.

Conclusion

The study shows that the application of PD + OMF increased the residual fertility of the soil. Poultry droppings increased the availability of nutrients to the maize plant more than the use of NPK fertilizer alone. Application of 10t ha^{-1} PD and 10t ha^{-1} OMF is recommended for maize production.

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