



## COMPARATIVE EVALUATION OF ORGANIC MANURES, NPK FERTILIZER, AND THEIR INTEGRATION ON MAIZE NITROGEN UPTAKE AND YIELD

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### ABSTRACT

A field experiment was conducted at the Oyo State College of Agriculture Research Farm, Igbo-Ora, during the 2022–2024 cropping seasons to evaluate the effects of different nitrogen sources on soil nitrogen status, nitrogen uptake, and maize yield. The experiment followed a randomized complete block design with three replications. Treatments included a control, sole applications of compost, poultry manure, pig manure, cow dung (all at 5 t/ha), NPK fertilizer (120 kg/ha), and their integrations (2.5 t/ha organic manure + 60 kg/ha NPK). Data were collected on soil nitrogen, plant N uptake, grain yield, and residual effects. The result revealed that in the first planting season, NPK and its integrations produced the highest grain yield and N uptake. However, residual effects in the second planting season showed superior performance of sole compost (6.0 t/ha), followed by poultry and pig manures, while NPK alone produced lower residual yield (3.6 t/ha). Nitrogen uptake patterns at 4, 8, and 12 weeks after planting reflected similar trends, with compost consistently enhancing soil N levels. The study concludes that while integrated NPK and compost applications improve short-term maize performance, sole compost and other organic manures provide better residual soil fertility and sustainable yield benefits. Application of compost at 5 t/ha, or integration of compost at 2.5 t/ha with 60 kg/ha NPK, is recommended for resource-poor farmers.

**Keywords:** Soil, Nitrogen, Uptake, Yield, Residual, Fertility

### INTRODUCTION

Maize is one of the top three grains crops grown in West and Central Africa in recent years (IITA, 2022). The crop responds well to high soil fertility and maximum yield potential is possible with high level of fertility. However, adequate soil fertility is one of the requirements for profitable maize production (Davis and Westfall, 2009). Similarly, options for yield increase are becoming limited since marginal lands conversion into arable land is diminishing. The challenge of producing large quantities of biomass required to support the teeming population, while maintaining adequate level of food production, and also converting natural resources and preserving environmental quality, should not be understated (Cassman and Liska, 2007). However, the introduction of high yielding fertilizer responsive varieties has given boost to fertilizer input in Maize crop production. Also, lower organic carbon in inadequate fertilization will be recovered with adequate fertilizer application. Thus, long term, high input agriculture has a strong positive effect in improving agronomic properties of soil (Okunlola, *et al.*, 2011). The reduction in organic matter with continuous use of mineral fertilizer at times give rise to erosion and loss of top soil. Also, Farmers cannot afford them due to their high cost and scarcity (Adediiran, *et al.*, 2009). Organic materials (FYM, crop residues, city wastes *e.t.c.*) are suitable substitute for inorganic fertilizers to maintain sustainable crop production and environmental quality (Pawar *et al.*, 2003). Organic manures are released more slowly and are stored for a long time in the soil, thereby ensuring a long residual effect (Okunlola, *et al.*, 2011).

Although, the use of organic manure alone, to sustain cropping has been inadequate due to unavailability in the required quantities and their relatively low nutrient content (Olaniyi, *et al.*, 2010). Thus, more strategies using farmer available resources are needed to increase yield. Recycling wastes for farm inputs is a viable farm option (Shridhar and Adeoye, 2004). Maize crop requires heavy



fertilizer for optimum yield in terms of nitrogen derived from chemical/ or organic manure (Awotundun *et al*, 1994). Hence, increasing nitrogen levels in the natural composts then become a challenge and supplementing with natural sources is more environmentally friendly than opting for mineral source alone. Thus, this study aimed at assessing the integrated nitrogen sources on soil nitrogen, uptake and yield of maize.

## **MATERIAL AND METHOD**

Experiment was conducted at Oyo State College of Agriculture Igbo-Ora during 2022 to 2024 cropping seasons. Igbo-Ora, is in Ibarapa zone; the northern part and derived Savannah Zone of Oyo State. The region has two rainy periods and had between 1000 to 1600mm of rainfall and temperature between 22°C and 38°C. The soils of the experimental site were randomly sampled at depth 0-30cm before planting using auger. The samples were bulked, air-dried and sieved through 2mm mesh before physical and chemical analysis. The experiment was laid out in a randomized complete block design (RCBD) with three replicates having plot size 3 x3 m with treatments; No fertilizer (control), NPK (20-10-10) at 120kg/ha, Compost (cm), Poultry, Pig and Cow-dung manures all at 5t/ha and their organo-minerals (cm +NPK, pm + NPK, pi + NPK and NPK) using 2.5t/ha for manures and 60kg/ha for NPK respectively.

The Poultry manure (PM) was the droppings from chicken that had been left to decompose for about five months on farm while both Cow-dung (CD) and Pig manures (PGM) were evacuated from the College farm during daily cleaning and deposited outside the ranch. Maize based compost was done and left to mature for two months in pile form of 1.5m by 1m size. It was made in ratio 3:1 of animal manure (CD, PGM and PM) and plant material (maize left over) by heap method.

The nutrient composition of the organic manures was analysed before addition and presented in Table 1. The land was ploughed and harrowed. The maize variety ACR.91 SWAN1.SRCI was planted. All the manures were applied a week before planting to enhance nutrient use efficiency by the crop while NPK was applied three weeks after planting. The plots were weeded manually whenever necessary throughout the experimental period. Maize was harvested at 14 (weeks after planting) WAP and was sun-dried to 14% moisture content. Soil nitrogen uptake was taken at 4, 8 and 12WAP while the yield characters were also considered.

For the residual effects, the experiment was repeated with no treatment application. The blocks with treated soils were left untouched for a year for the second planting. The tallies for the treatment's identification were kept intact to avoid mix up. After planting all post planting and data collection were similar to that previous planting. Final soil analyses were carried out after harvest. Data were analysed using ANOVA and the means were separated using Duncan multiple range test at 5% level of probability.

## **RESULT AND DISCUSSION**

The base line result (Table 2) of the soil analysis reveals that the soil N (0.14%) is below the Critical value and this justified the use of farmyard manures, NPK and their integration in enhancing soil restoration. Also, the total nitrogen content of the compost is highest (2.65% while the maize residue gave the least value (0.38%). Compost should be expected to provide the soil and plant with higher quantity of N than other treatments. However, the ability of the compost to perform better may be due to appropriate decomposition of the composting materials and mineralization of N (Eusuf Zai *et al*. 2008).

**Table 1:** Chemical Properties of Organic Materials Used for the Experiment

Nutrient element (Units)	Pig manure	Compost	Cow dung	Maize residue	Poultry manure
N (%)	1.53	2.65	1.65	0.38	1.67
Av. P (mg/kg)	320	240.18	389.85	108.54	345.98
K (cmol/kg)	5.6	4.6	7.6	3.5	6.5
Ca ( cmol/kg)	8.2	5.6	9.1	4.4	7.2
Na (cmol/kg)	2.68	2.58	7.08	2.58	0.50
Mg (cmol/kg)	37.21	32.46	36.52	26.15	34.15
pH	8.06	8.29	8.74	8.14	9.32
Temperature (°C)	27.2	27.2	27.4	26.8	27.1

The treatment application had significant influence on Nitrogen uptake from four weeks after planting (WAP) to the point of harvesting as presented in Table 2. Throughout the growing period , NPK had the highest N-uptake followed by NPK + compost and NPK + manure while the control gave the least N- uptake. There was rapid uptake of N at 4WAP but this was slowed down at 8WAP but the N-uptake rose up after 8WAP till 12 WAP respectively. This trend of N absorption dicates the three phases of uptake of N for vegetative development at early period , diapause the resting stage while the up take is reduced while the third stage is the reproductive phase. The N-uptake pattern in compost integration with NPK is higher than the manures while the lowest uptake of N was produced by the control.

**Table 2:** Effect of Organic and Inorganic Fertilizer Treatments on Nitrogen Uptake, Grain Yield (2022–2023), and Soil Nitrogen After First Planting

Treatment	4	N-uptake (g/kg) 8	12	Grain wt/ha (2022)	Grain Wt/ha (2023)	Soil N after first Planting N%
CO	0.54d	0.55c	1.05d	1.20h	1.86	0.06i
CD	0.61c	0.84b	1.21cd	2.40e	6.86	0.11f
PM	0.79c	1.08ab	1.50bcd	2.40e	6.52	0.21b
PGM	0.76c	1.01ab	1.49bcd	1.80f	6.42	0.21c
CM	0.83c	1.04ab	1.68bcd	1.40g	5.72	0.22a
NPK + CD	0.94b	1.09ab	1.72abc	5.80a	4.28	0.09h
NPK + PM	1.06ab	1.13ab	1.81ab	6.20a	5.20	0.19e
NPK + PGM	1.01ab	1.26ab	1.75abc	5.20ab	4.92	0.09h
NPK + CM	1.17a	1.41a	1.84a	4.20cb	4.52	0.20d
NPK	1.19a	1.44a	1.86a	3.60cd	4.00	0.10g

Means followed by the same letters in the same columns are not significantly different at 5% level of probability by DMRT Where: CO = control, CM = compost, PM = poultry manure, PGM = Pig manure CD = Cowdung

Application of the manures and NPK 20-10-10 fertilizer significantly increase the N-uptake and grain yield of maize after harvest (Table 2). There was direct relationship between N-uptake and grain yield of maize after harvest. The highest N-uptake and grain yield were given by NPK + compost and this was closely followed by NPK. The lowest N- uptake and yield were recorded from the control. A wide gap exists between the N-uptake of the NPK and manure integration with NPK compared with that of sole application of manures which implies rapid release of nutrients from organo-minerals than any of the manures respectively.

Therefore, the richer the organic manure combined with the NPK the better the response and this corroborated with the findings of Bello and Adekunle, (2013) who recently concluded that the fortification of poultry manure with urea fertilizer is found to be more effective source of maize plant nutrients than separate use of either poultry or swine manure.

The combined treatments produced yields which were significantly higher than those produced by organic and inorganic fertilizers separately with the exception of NPK 20-10-10 applied



at 120kg/ha. Maize yield was observed to be more favoured by the enriched amended compost than other manures. Thus, ascertained the work of Oke *et al.*; (2011) who viewed that enrich amended compost to be more favoured than sole compost application in maize production. Similar findings were also confirmed by Bello, *et al.*; (2013) who confirmed the use of plant waste, animal manure and or with reduced amount of urea is a way to organic farming and an attempt to sustainable agriculture with less threat on the environment. This observation is similar with the work of Bello and Adekunle, (2013) who recently concluded that the fortification of poultry manure with urea fertilizer is found to be more effective source of maize plant nutrients than separate use of either poultry or swine manure. The highest result was produced by NPK + CM of 6.0t/ha while the control gave the least (1.2t/ha) of grains. Grain yield was highest at a combined application of 2.5t/ha compost and 60kg NPK 20-10-10 which produced the highest.

Changes in the N status of soils after one year of cropping presented in Table 2. Significant ( $P > 0.05$ ) treatments were obtained on N content after repeated cultivation of maize without fertilizer application. The variation in soil N value differed among the treatments applied. Similar trend was also noticed with grain yield. For soil N evaluated, the highest value of residual N effect was obtained from plot treated with compost fertilizer at 5t/ha. The organic manure (CM, PM, PGM and CD), treated plots gave greater N content than the integration with NPK (CM + NPK, PM + NPK, PGM + NPK and CD + NPK) while control gave the lowest nutrient content. The higher amount of N recorded by the organic plots compared with either the integration or NPK plots after one year of cropping could be properly be as a result of high amount of soil N in them with slow releasing nature of the manures.

## CONCLUSION AND RECOMMENDATIONS

The study demonstrated that integrating organic manures with NPK fertilizer enhances soil nitrogen availability, nitrogen uptake, and maize yield during the first cropping cycle. However, sole application of compost and other organic manures provided superior residual effects, resulting in higher soil nitrogen levels and increased maize yield in the subsequent planting. While integrated nutrient management improves short-term productivity, organic manures, particularly compost at 5 t/ha, offer more sustainable soil fertility benefits. For resource-poor farmers, applying compost at 5 t/ha or combining 2.5 t/ha compost with 60 kg/ha NPK is recommended to achieve both immediate yield improvement and long-term soil quality enhancement.

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