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# Effect of Crop Residues on Soil, Plant Nutrient and Yield of Maize *(Zea mays)*

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**Abstract**
Field experiments were conducted at Oyo State College of Agriculture, Igboora Research Farm on the effect of crop residues management (*Parkia biglobosa* (PKR), maize stover (MR) and NPK 15:15:15 fertilizer (NPK) on soil nutrient content, uptake and yield of maize. The experiments were arranged in a Randomized Complete Block Design (RCBD). There were six (6) treatments replicated three (3) times and these include; control (0.0t/ha), PKR (15t/ha), MR (15t/ha), NPK (120kg/ha), NPK (60kg/ha) +PKR (7.5t/ha) and NPK (60kg/ha) +MR (7.5t/ha). The effects of PKR, MR and their combinations on soil OM, N, P, K, Ca, Mg, CEC and leaf N, P, K, Ca and Mg were verified. All the treatments increased soil and leaf content of N, P, K, Mg and Ca relative to control. NPK (60kg/ha) + PKR (7.5t/ha) significantly ($P<0.05$) improved the grain yield value (6.63kg/ha) than others and with 283.24% better than the control. The order of response of most parameters considered were NPK (60kg/ha) +PKR (7.5t/ha) >NPK (120kg/ha) >NPK (60kg/ha) +MR (7.5t/ha)>PKR (15t/ha)>MR (15t/ha) and the control. Maize yield obtained by using NPK (120kg/ha) gave 5.6kg/ha which performed better than NPK (60kg/ha) +MR (7.5t/ha) with 5.43kg/ha. While, PKR (15t/ha) had grain yield of 2.5kg/ha significantly increased ($P<0.05$) than the use of MR (15t/ha) with 2.3kg/ha and the control, the least (1.73kg/ha). The combination of NPK fertilizer and leguminous crop waste is recommended for their optimum and sustainable productivity.

**Key words:** NPK, crop residues, soil-nutrient, plant uptake, maize yield.

## Introduction

Low soil fertility is one of the major yield limiting factors for cereal production in many developed and developing countries including Nigeria. Also, continuous crop production without external nutrient input rapidly depletes the soil and thus, the soil suffers multi-nutrient deficiencies. Therefore, application of mineral fertilizers has become mandatory to increase crop yields [1]. However, the effects of long-term and continuous use of mineral fertilizers, in decreasing soil productivity due to soil mining, environmental pollution and their high costs compel farmers to considering the recycling of organic manures [2].

Crop residues, are parts of plant left in the field after the economic yield had been harvested and threshed as it is done for cereals. The major disadvantage of incorporation of cereal straw is the immobilization of nitrogen and its adverse effect occurring from N-deficiency. The faster decomposition and release of nitrogen to soil is possible if it is treated with N-fertilizer and applied during field preparation [3]. Also, plant residues with high chemical potential will provide positive effects on soil and crops. The crop yield enhancing potentials of an indigenous tree species (*Parkia biglobosa*) which is prominent in savannah and maintained by farmers on farms and homesteads as source of soil organic amendment are yet to be fully explored. Findings have also showed that biomass production by the tree is about 8-10t/ha annually.

The recycling of crop residues has the advantage of converting the surplus farm waste into useful product for meeting nutrient requirement of crops [4]. The residue also maintains the soil physical and chemical conditions and thus, improves the overall ecological balance of the crop production system [5]. The use of farm residues when

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compared with inorganic fertilizer would be cheaper, readily affordable and sustainable. However, high cost, scarcity of resources, nutrient imbalance and soil acidity are problems associated with the use of mineral fertilizer while bulkiness, low nutrient quality and late mineralization were the bottle neck to the sole use of organic manures for crop production in the tropics [6]. Some studies confirmed that combined application of organic manures and mineral fertilizer gave superior effects in terms of balanced plant nutrition and improve soil fertility [7-9].

Positive reports were recently produced with the use of crop residue wastes like saw dust ash and mulch on cassava [10] and Oil palm Bunch ash and their combinations with NPK on Maize yield [11] when the soil and plant nutrients and yield of the crops were evaluated. The chemical composition and the extent to which these residues (Parkia and maize) increase the efficiency of applied inorganic fertilizer and enhanced the potential of the soil to support increased maize production have not been fully exploited. The present study was, therefore, conducted to evaluate the effect of crop residues on soil, plant nutrient and yield of maize (*Zea mays*).

## Materials and Methods

Field experiments were conducted in two cropping seasons (March and September, 2011) at Oyo State College of Agriculture, Igboora Research Farm on the effect of crop residues management *Parkia biglobosa* (PKR), maize stover (MR) and NPK 15:15:15 fertilizer (NPK) on growth and yield of maize. Igbo-ora, is in Ibarapa zone; the northern part and derived Savannah Zone of Oyo State. The region has two rainy periods and has between 1000 to 1600mm of rainfall and temperature between 22$^{o}$C and 38$^{o}$C. The test crop, Suwan yellow maize variety was obtained from Oyo State Agricultural Development Programme (OYSADEP) store in Oyo town.

The soil used for the experiment was randomly sampled at depth 0-30 cm before planting and after using soil auger. The soil samples were bulked, air-dried and sieved through 2mm mesh before physico and chemical analyses. The parameter that was measured includes the pH taken in a 1:25 solution of 10g air-dried soil + 25 ml distilled water or 1m KCl solution. Texture was determined by the pipette method. Samples were fractionated using [12] method.

Olsen-P was measured to determine the available phosphorus. Percentage total nitrogen was measured by the Kjeldahl digestion method while, the Amato method was used to measure the percentage total soil carbon [13]. The experiment was laid out in a randomized complete block design (RCBD) with three replicates, each plot size being 3 x3m. The treatments includes; control (0.0t/ha), PKR (15t/ha), MR (15 t/ha), NPK (120kg/ha), NPK (60kg/ha) +PKR (7.5t/ha) and NPR (60kg/ha) +MR (7.5 t/ha). The sole organic fertilizers were applied a week before planting while NPK 15:15:15 was applied two weeks after planting respectively. The plots were weeded manually whenever necessary throughout the experimental period. Maize was harvested at 14WAP and was sun-dried to 14% moisture content. Maize yield characters evaluated were weight of grain, number of seeds per cob, cob weight and cob diameter.

Ear leaf samples were collected per treatment each site, bulk, oven-dried at 70$^{0}$C for 24hrs, milled and ashed for 6hrs at 500$^{0}$C. Nutrients were extracted using nutric-perchloric acid mixture[14] and N was determined by Kjeldahl method. The P in the extract was determined using molybdenum blue colorimetry and read on spectrometer. The EDTA titration method was used to evaluate Ca and Mg while K and Na was analysed using flame photometer.

The analysis of variance (ANOVA) procedure was used to evaluate the treatment effects. Mean values were separated using Duncan multiple range test (DMRT) at 5% level of probability.

## Result and Discussion

The used soil had organic matter content of 1.56%, total N 0.11%, available P 16.9mg/kg

exchangeable K 1.14cmol/kg; Ca 0.16cmol/kg; Mg 0.38 Cmol/kg, sand 78.4%, salt 11.6% and clay 10.0%. The soil is low in OM, N, and exchangeable Ca. The low level of these nutrients justified the need for restoration. Chemical analysis of the residues indicated that *Parkia biglobosa* had higher values of total nitrogen content (2.76%), Av. P (1.125cmol/kg), K (72.73cmol/kg), Ca (6.07cmol/kg) and 0.58cmol/kg) Mg compared with maize stover residues which had TN of 0.06%, Av. P (0.18 Cmol/kg), K (0.22 Cmol/kg), Ca 0.81 Cmol/kg),and Mg (0.31cmol/kg) . The N% indicated that Parkia had a better quality than maize waste and considering the magnitude of the essential nutrients in these residues, it can be deduced that each crop residue has a potential with variation between them as a source of soil amendment.

The crop residues, NPK and their integrations increased N, P, K, Ca and Mg concentrations in the plants significantly (Table 1). Although, there was no significant effect in the P value produced from the use of PKR and NPK while other characters follow same pattern as expressed by the soil. The response of the soil characters to the applied treatments inferred that crop residues and or their combinations were effective sources of nutrient to maize plants. The soil and plant nutrients considered to increase with type of crop residue incorporated and or its integration with NPK. Hence, NPK must have rapidly released its nutrients accompanied with the nutrients derived from the crop residues (PKR and MR) enhanced more nutrients availability to maize during growth and development compared with separate use of crop residues alone. The integration of NPK and PKR gave the highest tissue N, P, K, Ca and Mg followed by NPK + MR with the exception of NPK, whose N value is higher than those of NPK +MR.

**Table 1: Maize Tissue Nutrients contents as Influenced by the Application of Crop Residues and NPK Fertilizer**

| Treatments | N | P | K | Ca | Mg (%) |
|---|---|---|---|---|---|
| Co | 0.52d | 0.22c | 0.58cd | 0.64d | 0.06d |
| PKR (15t/ha) | 1.43b | 0.33abc | 0.66c | 0.88bc | 0.10c |
| MR(15t/ha) | 0.96c | 0.28bc | 0.58cd | 0.74cd | 0.07cd |
| NPK (120kg/ha) | 1.60ab | 0.37abc | 0.78b | 0.94b | 0.15b |
| NPK (60kg/ha) + PKR (7.5t/ha) | 1.82a | 0.49a | 0.91a | 1.16a | 0.20a |
| NPK (60kg/ha) + MR(7.5t/ha) | 1.52ab | 0.41ab | 0.82ab | 1.04ab | 0.16b |

Co = control PKR = Parkia residue MR = maize residue, NPK = 15 15 15

Means followed by the same letter in the same columns are not significantly different at 5% level of probability by DMRT

The crop residues (PKR & MR), NPK and their integrations significantly increased OM, N, P, K and Ca with the exception of Mg that shows significance between NPK and their combinations compared with the remaining treatments (MR, PKR, and Co). The N fertilizer gave the highest soil N, P, Ca and Mg compared to other treatments. The NPK and its combinations with PKR gave the highest value of OM while higher values of N, P, Ca and Mg were recorded by the treatment followed by NPK integrated with maize residue (Mr); (Table 2). The trend of response of the treatments to soil N, P, Ca

and Mg is NPK> NPK+ PKR > NPK + MR > PKR > MR and the control the least. This implies that NPK are rapidly released compared with others while the combination enhanced the release of nutrients from the crop residues. The use of PKR and or its combination with NPK performed better than the use of MR and or its combination with NPK for OM, N, P, Ca and Mg respectively. The performance of Parkia residue (PKR) compared with maize residue (MR) corroborated with the findings of [15] who ascertained that organic wastes differ in their ability to provide nutrients and enhance soil qualities due to the difference in their rates of decomposition and nutrient release.

Crop residues (MR and PKR) presence along with NPK and its usage alone significantly increased soil pH. This implies that an organic material added to the soil improves the soil acidity. The work confirmed the result of [16] who explained that improved availability of Cations might lead to higher soil pH. The improvement in soil pH of organic wastes, amended soil to the supply of basic elements such as K, Ca and Mg. Although, maize residue (MR) and its combination with NPK had higher value of K compared with Parkia (PKR) residue.

**Table 2: Soil Nutrient Contents as Affected by the Application of Crop Residues and NPK**

| Treatments | PH | OM(%) | N(%) | Pmg/kg | KCmol/kg | CaCmol/kg | MgCmol/kg |
|---|---|---|---|---|---|---|---|
| Control | 5.45b | 1.56e | 0.08e | 12.60f | 0.18d | 1.86f | 0.78c |
| Pkr(15t/ha) | 6.20a | 2.45c | 0.16c | 28.50d | 0.38a | 3.94d | 14.41ab |
| Mr(15t/ha) | 5.65b | 1.82d | 0.12d | 23.30e | 0.43e | 3.44e | 0.93bc |
| Nfert(60kg/ha) | 5.83ab | 3.00b | 0.23a | 40.90a | 0.23cd | 8.15a | 1.66a |
| Nfert(60kg/ha) + Pkr (7.5t/ha) | 6.20a | 3.71a | 0.20ab | 35.60b | 0.28bc | 6.78b | 1.58a |
| Nfert(60kg/ha) + Mr (7.5t/ha) | 5.93ab | 2.65c | 0.18bc | 32.50c | 0.32b | 5.58c | 1.52a |

Co = control PKR = Parkia residue MR = Maize residue, NPK = 15: 15: 15

Means followed by the same letter in the same columns are not significantly different at 5% level of probability by DMRT

Table 3 result shows the comparative effect of crop residues and NPK fertilizer on maize yield (number of seeds per cob, grains weight with cob, weight of grains, and cob diameter) respectively. Treatment NPK (60kg/ha) + PKR (7.5t/ha) had the highest number of seeds per cob (676), grains weight with cob (0.60kg), weight of grains (6.63kg/ha) and cob diameter (27.33cm) respectively (Fig. 1). The result is in line with [17] findings that organo-mineral fertilizer application enhanced fertilizer use efficiency and with better economic response. It is also in accordance with [18] that an integral use of organic manure and in-organic fertilizer will support the supply of adequate quantities of plant nutrient required to sustain maximum crop production. Similar result was also confirmed by [19] who combined locust bean (*Parkia biglobosa*), neem (*Azadirachta indica*) and NPK fertilizer and achieved positive result.

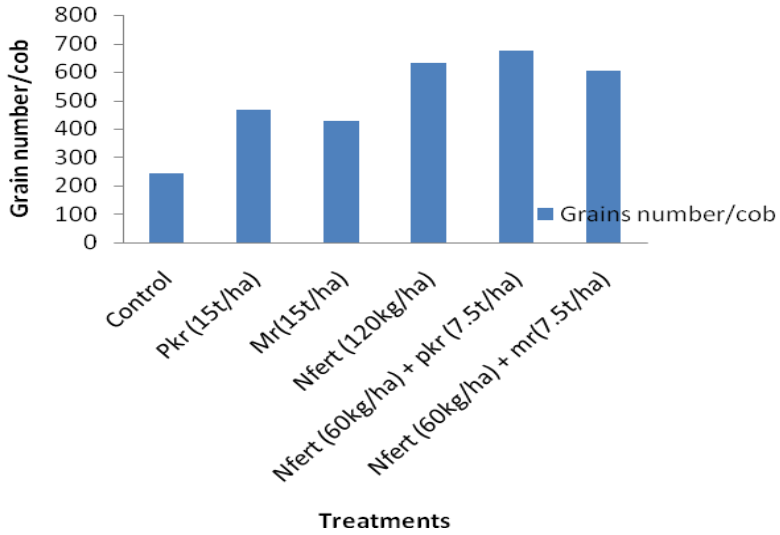


**Fig 1:** Effect of crop residues on grain number/cob of maize (*Zea mays*).

**Table 3: Effect of Crop Residues and NPK Fertilizer on Yield of Maize**

| Treatment | Cob wt (kg) | Cob diameter (cm) | Grains number/cob | Grains wt/kg/ha |
|---|---|---|---|---|
| Control | 0.21d | 12.10c | 244.00f | 1.73d |
| PKR (15t/ha) | 0.34Bcd | 17.00bc | 465.00e | 2.53c |
| MR(15t/ha) | 0.26cd | 13.67c | 426.00e | 2.33c |
| NPK (120kg/ha) | 0.49ab | 22.50ab | 632.00b | 5.63b |
| NPK (60kg/ha) + PKR (7.5t/ha) | 0.60a | 27.33a | 676.00a | 6.63a |
| NPK (60kg/ha) +MRr(7.5t/ha) | 0.43abc | 22.50ab | 602.00c | 5.43c |

Co = control PKR = Parkia residue MR = maize residue, NPK = 15 15 15
Means followed by the same letter in the same columns are not significantly different at 5% level of probability by DMRT.

## Conclusion

Crop residues are effective sources of nutrients for optimum maize production. This study indicated that the integration of maize residues (MR) or Parkia residue (PKR) combined with NPK are effective sources of N, P, K, Ca, Mg and organic matter in maize cultivation. The addition of crop residues or NPK alone or their combination increased soil and plant tissue nutrients, and yield of maize. Although, *Parkia bigloboasa* (PKR) integration gave highest values of soil, plant nutrients and yield, thus the combinations of PKR + NPK at 60kg/ha (NPK) + 7.5t/ha (PKR) and MR + NPK at 7.5t/ha (PKR/MR) and 60kg/ha (NPK) are recommended.

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