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THE EFFECT OF KITCHEN RESIDUE ASH, POULTRY MANURE AND GOAT DUNG ON SOIL PROPERTIES AND YIELD OF COWPEA (*Vigna unguiculata*) IN A TYPIC KANDIUDULT OF SOUTHEAST NIGERIA

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Abstract
A pot experiment was conducted at Michael Okpara University of Agriculture Umudike to determine the effect of kitchen residue ash, poultry manure and goat dung on soil properties and yield of Cowpea (Vigna unguiculata) on Typic Kandiudult of Southeastern Nigeria. Six levels of the treatments; 0t/ha (control), 2t/ha of kitchen residue ash, 2t/ha of goat dung, 2t/ha of poultry manure, 1t/ha of kitchen residue ash + 1t/ha of poultry manure and 1 t/ha kitchen residue + 1t/ha goat dung were applied, replicated three times in a Completely Randomized Design (CRD). At the end of the experiment, plants agronomic parameters and soil chemical properties were measured. The result obtained showed that the application of kitchen residue ash, poultry manure and goat dung significantly (P<0.05) increased soil pH, available phosphorus, total nitrogen, soil carbon, exchangeable calcium, exchangeable potassium and magnesium over the control. The applied manure and ash increased the cowpea height, root length, root branching and grain yield more than the control. The combination of 1t/ha kitchen residue ash and 1t/ha goat dung gave the overall best performance in terms of increasing plant height, root length and number of root branching. Among the amendments tested, 1t/ha kitchen residue ash + 1t/ha poultry manure significantly (P<0.05) increased the soil pH, exchangeable calcium, exchangeable potassium, percentage base saturation and reduced exchangeable acidity more than the other treatment. Further research is recommended for the field application of the treatment on cowpea production.
Key Words: *Kitchen residue ash, goat dung, poultry manure, cowpea*
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Introduction
The demand for cowpea crop as protein supplement is very critical, especially in the Southeastern part of Nigeria, where carbohydrate base stable food is the major food source (Iyayi and Losel, 2001). Cowpea is a legume that can be consumed as processed grain and green vegetable. It could also be use as folders for livestock and acts as a cover crop. The grains are high in protein and are good supplement for animal protein which is usually expensive (Awurum, 2000). It also increases the available nitrogen content of the soil by fixing the atmospheric N. As a legume, the crop is sensitive to soil acidity and low soil fertility. Cultivating cowpea in the South East Nigeria, where the soil had been found to be low in fertility and high in acidity (Enwezor *et al.,* 1989) may pose a

serious threat to the survival of the crop in the region. This is because the area receives heavy precipitation which is one of the causes of soil acidity (Mahler and Hardy 1984).

Kitchen residue ash is obtained from the fire place in homes especially in the rural areas where it is produced in large quantities. This material has been found to reduce soil acidity (Onwuka and Ogbonna, 2009) release some nutrients like, potassium, calcium and enhanced the availability of phosphorus for plant uptake.

The use of nutrient boasters in the form of organic and inorganic manures is one way of improving the soil fertility status. The use of organic manure is becoming more popular in the Southeastern Nigeria. This is because of the unavailability and unaffordable of the mineral fertilizers. Organic manure has also been found to increase the soil nutrients and help to improve the physical properties of the soil.

Kitchen residue ash and organic manure especially animal manure are readily available in the Southeast Nigeria, as almost every household unit has small livestock farm and also produce kitchen ash .There is need to harness the potentials in these organic materials in the cultivation of cowpea which is earnestly needed in Southeast Nigeria. The present study therefore has an objective of finding the influence of kitchen residue ash, poultry manure and goat dung on soil chemical properties and on the growth of cowpea in an Ultisol in Southeast Nigeria .

Materials and Methods

Composite soil samples were collected from the Research Farm of Michael Okpara University of Agriculture Umudike located by latitude 05° 29` N and longitude 07° 33` E, with an elevation of 122m above sea level. Umudike is located within the Tropical rainfall zone of Nigeria. The mean rainfall of Umudike is 2117mm, distributed over nine to ten months in a bimodal rainfall pattern (NRCRI, 2008). The soil of Umudike is well-drained sand and originates from the coastal plain sand and is classified as Typic Kandiudult (Lekwa and Whiteside 1986).

Soils were sampled from the depth of 0-15 to give a composite soil samples which, were air dried, sieved through 2mm sieve and a sub sample of ten kilograms (10kg) weighed and placed into 12 liter capacity plastic pots. The treatments consisted of two organic amendments, an ash and a control. The amendments were: 2t/ha of Kitchen residue ash (KRA), 2t/ha of Goat dung (GD), 2t/ha of Poultry manure (PM), 1 t/ha of kitchen residue ash + 1t/ha of poultry manure, 1t/ha of kitchen residue ash + 1t/ha of Goat dung.

The treatments were laid out in a completely randomized design, replicated three times to give a total of eighteen experimental pots. The treatments were applied a week before planting the test crop, which was cowpea (IAR 48 variety). Two seeds were sown per pot and later thinned down to one plant per pot given a population of eighteen plants. The plants were allowed to grow for 70 days and the following plant parameters were measured; plant height (cm) at two weeks interval for 10 weeks after planting, number of fine branching roots, roots length and grain weight at the 70 days after treatment application. Soil chemical analyses were carried out before treatments application and after plant harvest. The soil parameters determined included soil pH which was determined in 1:2.5 soil to water suspension using the glass- electrode pH meter (Mclean 1982); exchangeable acidity was determined by the method of Peech (1965) using 1N KCI and titrating with 0.05 NaOH. Organic carbon was determined by wet oxidation method of Walkley and Black as modified by Nelson and Sommer (1982). Total nitrogen was determined by the semi-micro Kjeldahl method. Available phosphorus was determined by Bray 1 method (Bray and Kurtz 1945). Exchangeable bases were extracted with IN NH_4OAc buffered at pH 7.0; potassium and sodium were read with flame photometer while calcium and magnesium were determined by EDTA titration (Lanyon and Heald 1982).

Effective cation exchange capacity was calculated through the summation of exchangeable bases and exchangeable acidity, while the percentage base saturation was calculated from the summation of the total exchangeable bases divided by the effective cation exchange capacity multiplied by hundred. The data generated were subjected to analysis of variance (ANOVA) for CRD while the means were separated using the Fisher's Least Significant difference (LSD) at 5% level of probability.

Results and Discussion

The pre-planting properties of the soil used for the experiment are shown in Table 1: The soil is sandy loamy with a pH (H_2O) of 5.17 and this is below the pH requirement for cowpea production which is between pH 5.5-6.5 (Vanderborght and Baudion 2001). The phosphorus level was 10.34mg/kg, which was lower than the critical level of 12-15mg/kg for most crops (Enwezor, 1977).

Table 1: Some physical and chemical properties of the soil used for the experiment.

Properties	Value
Sand (%)	78.40
Silt (%)	9.40
Clay (%)	12.20
Textural Class	Sandy loam
Soil pH (H_2O)	5.17
Exchangeable Acidity (Cmol /kg)	2.17
Organic Carbon (%)	1.80
Total Nitrogen (%)	0.09
Available Phosphorus (mg/kg)	10.34
Exchangeable Calcium (Cmol /kg)	2.01
Exchangeable Potassium (Cmol /kg)	0.09
Exchangeable Magnesium (Cmol /kg)	0.94
Exchangeable Sodium (Cmol /kg)	0.98
ECEC (Cmol /kg)	5.87
TEB (Cmol /kg)	4.02

ECEC = Effective cation exchange capacity, TEB= Total exchangeable bases

Effect of amendments on soil acidity indices at the end of the experiment

The result of the amendments on soil acidity indices (pH and exchangeable acidity) at the end of the experiment is shown in Table 2. All the amendments significantly ($p < 0.05$) increased the soil pH over the control. Among the amendments tested, the application of 1t/ha KRA + 1t/ha PM gave the highest significantly ($p < 0.05$) value of the soil pH over the other amendments. On the same Table 2, all the amendments significantly ($p < 0.05$) reduced exchangeable acidity over the control. Soils that received a continual application of 1t/ha KRA + 1t/ha PM significantly ($p < 0.05$) lowered exchangeable acidity values.

Table 2: Effect of amendments on soil acidity indices at the end of the experiment.

Treatment	pH (H_2O)	Exchangeable acidity (coml./kg)
0t/ha	5.20	2.01
2t/ha KRA	7.01	0.44
2t/ha PM	6.88	0.55
2t/ha GD	6.34	0.66
1t/ha KRA + 1t/ha PM	7.42	0.32
1t/ha KRA + It/ha GD	7.08	0.48
Lsd (0.05)	0.43	0.14

KRA= Kitchen residue ash, PM = Poultry manure, GD = Goat dung

Effect of amendments on soil available phosphorus, total nitrogen and soil organic carbon at the end of the experiment

The application of the amendments significantly ($p < 0.05$) increased the soil available phosphorus, total nitrogen and organic carbon over the control (Table 3). The highest available phosphorus value was obtained when 1 t/ha KRA + 1 t/ha PM was applied. The percentage increase in available soil phosphorus due to the application of 1 t/ha KRA + 1 t/ha PM over the other treatments were, 44.77%, 86.94%, 86.19%, 67.16 % and 68.66% respectively for 0 t/ha (control), 2 t/ha KA, 2 t/ha PM, 2 t/ha GD and 1 t/ha KRA + 1 t/ha GD. The highest significant value for total nitrogen was recorded by the application of 2t/ha GD significantly ($p < 0.05$) as shown in Table 3. Also on that same Table 3, 2t/ha PM significantly ($p < 0.05$) increased organic carbon over the other treatments applied.

Table 3: Effect of amendments on soil available phosphorus, total nitrogen and soil organic carbon at the end of the experiment

Treatment rate	Available phosphorus(mg/g)	Total Nitrogen (%)	Soil organic carbon (%)
0t/ha	12.00	0.06	1.02
2t/ha KA	23.30	0.13	2.01
2t/ha PM	23.10	0.23	3.41
2t/ha GD	18.00	0.28	2.24
1t/ha KA + 1t/ha PM	26.80	0.23	2.00
1t/ha KA + It/ha GD	18.40	0.19	2.11
Lsd (0.05)	1.24	0.03	0.23

KRA= Kitchen residue ash, PM = Poultry manure, GD = Goat dung

Effect of amendments on exchangeable calcium, magnesium, sodium, potassium, total exchangeable bases, effective cation exchange capacity and percentage base saturation

Generally, there was significant effect of the amendments on exchangeable calcium, magnesium, sodium, potassium, effective cation exchange capacity and percentage base saturation over the control (Table 4). The combination of 1t/ha KRA + 1t/ha PM significantly ($p < 0.05$) increased the levels of exchangeable calcium, potassium and percentage base saturation in the soil, while 2t/ha KRA significantly ($p < 0.05$) increased exchangeable magnesium, exchangeable sodium, and effective cation exchange capacity over the other treatments tested.

Table 4: Effect of amendments on soil exchangeable bases, effective cation exchange capacity and percentage base saturation at the end of the experiment

Treatment rate	Ex. Ca (cmol kg^{-1})	Ex. Ma (cmol kg^{-1})	Ex. Na (cmol kg^{-1})	Ex. K (cmol kg^{-1})	ECEC (cmol kg^{-1})	% Base Sat. (%)
0t/ha	1.52	0.76	0.62	0.03	4.94	59
2t/ha KRA	8.03	4.02	1.79	0.18	14.46	97
2t/ha PM	7.72	3.90	1.60	0.16	13.93	96
2t/ha GD	7.06	3.40	1.24	0.12	12.48	95
1t/ha KRA + 1t/ha PM	8.07	3.94	1.68	0.20	14.21	98
1t/ha KRA + It/ha GD	7.54	3.42	1.54	0.14	13.12	96
Lsd (0.05)	0.36	0.19	0.23	0.04	0.36	4.01

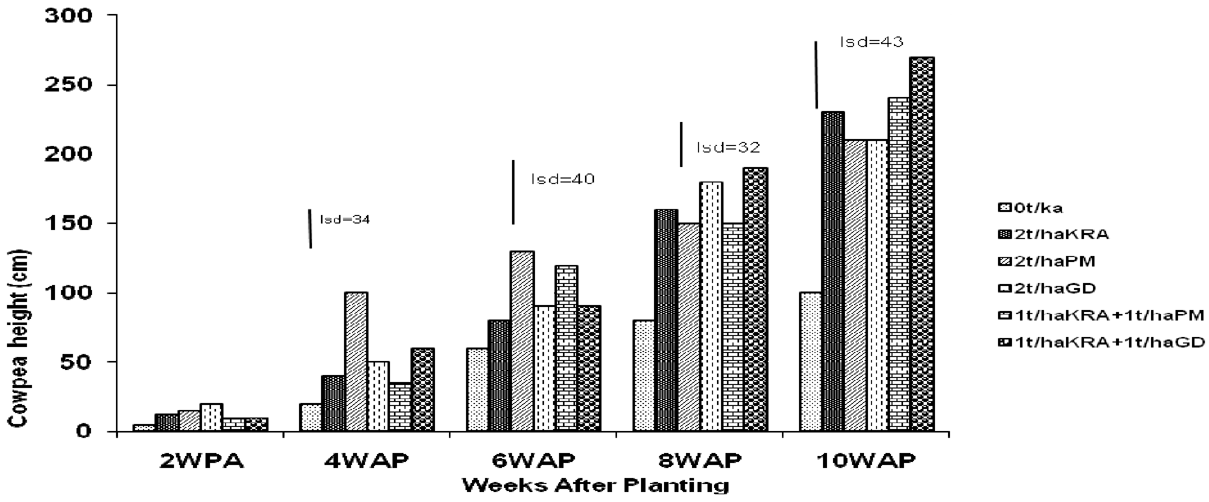
KRA= Kitchen residue ash, PM = Poultry manure, GD = Goat dung, Ex.Ca = exchangeable calcium, Ex. Mg = exchangeable magnesium, Ex. Na = exchangeable sodium, Ex. K = exchangeable potassium, TEB= total exchangeable bases, ECEC= effective cation exchange capacity, %Base Sat= percentage base saturation.

Effect of soil amendments on plant height, root length, root branch and crop yield

Data on plant height, root length and root branching are shown on Fig 1. It was observed that maize height increased with weeks after planning and shows significant increases over the control with the application of the amendments. At 4 and 6 weeks after planting, 2 t/ha PM significantly increased the plant height while the application of 1 t/ha KRA + 1t/ha GD significantly ($p < 0.05$) increased the plant height at 8 and 10 weeks after planting.

The application of the amendments to the cowpea significantly increased the root length and the number of root branching over the control as shown in Fig 1. The result of the analysis showed that kitchen residue ash applied at 1t/ha in combination with 1 t/ha of goat dung had significantly higher root length and root branching when compared to the other treatments although it was statistically at par with 2t/ha GD.

(a)



(b)

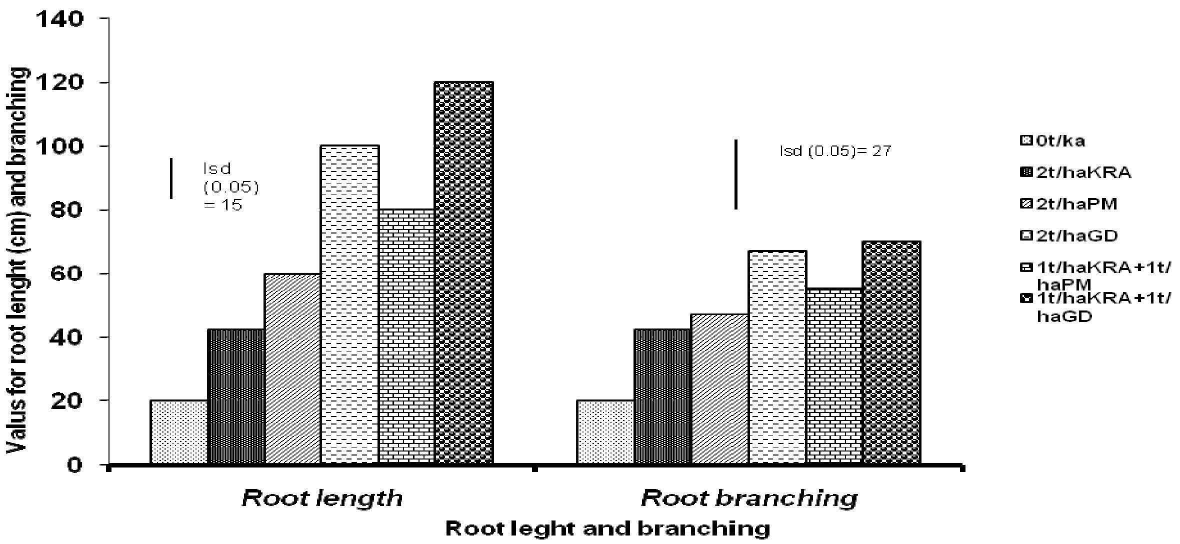


Fig 1: Effect of amendements on plant heigth (a) and root length and branching (b). Vertical bars represent LSD at 0.05.

The effect of the treatment on cowpea grain yield is shown on Fig 2. The control had significantly lower grain yield as compared to the amendments. There was a significant difference among the organic amendments with 2 t/ha GD and 1 t/ha KA +1t/ha GD emerging with the highest significant values of 120g/pot and 116 g/pot respectively.

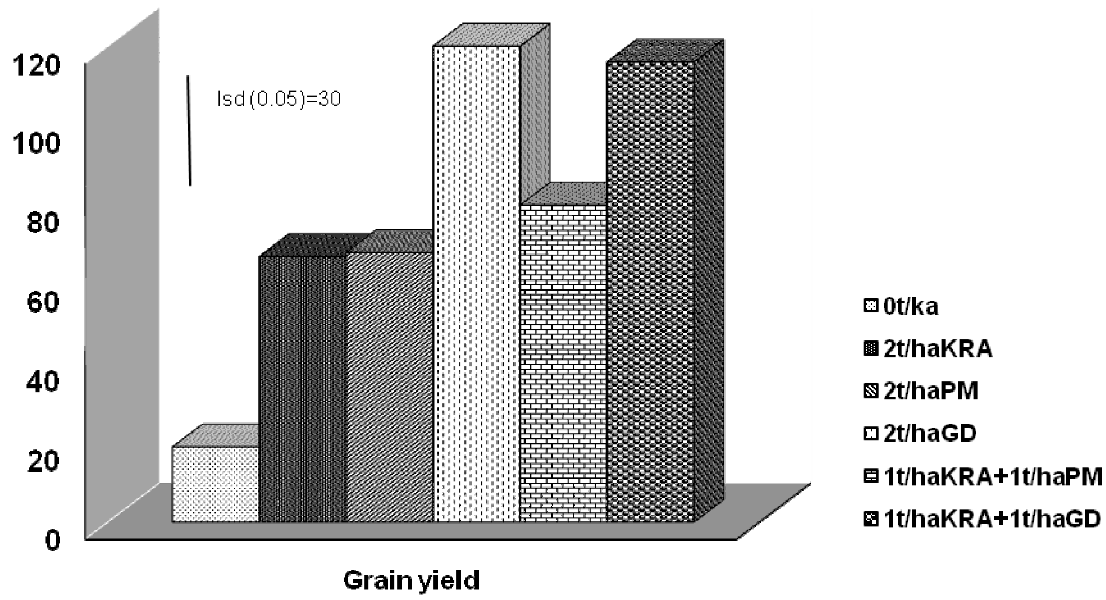


Fig 2: Effect of amendments on cowpea grain yield . Vertical bars represent LSD at 0.05

Discussion

The pre-cropping soil pH was 5.17 and this shows that the soil used for the experiment was acidic. According to Ahn (1993), any soil with pH below 5.5 is acidic. Raising the pH above 5.5 by the application of the amendments, could have led to the release of other nutrients that are unavailable and this in return, increased the grain yield of cowpea; probably that was why the pots that received the amendments had greater grain yield than the control. The level of the organic carbon in the soil could have been increased by the application of the amendment especially those of organic origin. These amendments decomposed, mineralized and increased the level of organic matter in the soil (Obi and Ebo 1995). The increased soil pH resulted to a corresponding reduction in soil exchangeable acidity by the application of the amendment. This is because the kitchen residue ash and the animal manure contained basic cations (Fageria, *et al.,* 2007) and basic anions CO_3^{-2} (Hue, *et al.,* 1986) that are able to remove hydrogen ion and aluminum ion from the soil exchange sites to form hydrogen, carbon dioxide and aluminum oxide. Franco and Muns (1982) reported that the application of materials containing basic cations, released cations especially calcium that suppressed the toxicity of aluminum in the soil and this enhanced the activities of the roots by creating a better environment for the release of phosphorus, which helps in the root development and growth. That may be the reason while there were some increments in the root number of the pots that received the amendments.

Phosphorus is critical to cowpea yield; this is because of its multiple effects on cowpea nutrition (Muleba and Ezumah 1985), increase seed yield, nodulation (Kang and Nangju 1983) and N fixation. The result of the analysis showed that the phosphorus level of the experimental soil was

10.34mg/kg, which was lower than the critical level of 12-15mg/kg for most crops (Enwezor, 1977). Addition of the amendments increased the phosphorus level of the soil of the experimental site.

The increase in plant height by the application of the poultry manure at the first few weeks after planting of the maize could be attributed to the quick mineralization of poultry manure as compared to goat dung which later gave higher plant heights at 8 and 10 weeks after planting. When the manure is mineralized, it makes nutrient available in inorganic forms that are easily assimilated by plants. Similar result was observed by Adekunle *et. al.,* (2009), who recorded that the application of poultry manure increased plant parameters at 4 weeks after planting. The application of the amendment resulted in increased grain yields, which could be as the result of harnessing of all the nutrients in the amendments, to produce the grain yield which is the focus of the farmers in embarking on cowpea production, to increase the protein nutrient intake of the populaces in Southeast Nigeria.

Conclusion

The application of the amendments increased the soil pH, available phosphorus, total nitrogen, organic carbon, exchangeable calcium, potassium, magnesium. The amendment also improved cowpea root number, height and grain yield. Among the amendment tested the combination of 1t/ha KRA +1t/ha PM on the average increased the soil pH, exchangeable calcium, exchangeable potassium, percentage base saturation and reduced exchangeable acidity more that the others, while 1t/ha KRA+1t/ha GD significantly increased the plant parameters determined. The work showed that amendments mostly poultry manure, goat dung and kitchen residue could be used as an alternative to commercial fertilizer as nutrient source for cowpea production in the Southeast Nigeria. Further research is recommended for the field application of the treatments on cowpea production.

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