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The Effect of Soil Treated With Charcoal and NPK Fertilizer on the Minerals and Vitamin Content of the Fluted Pumpkin Leaf

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ABSTRACT
The study investigated the effect of soil treated with charcoal and NPK fertilizer on the minerals and vitamin content of the fluted pumpkin leaf. More attention was given to quantifying nutrient leaching from agricultural soils treated with charcoal despite the fact that a lot of plant and soil scientists' have recommended the use of charcoal for soil improvement, and to achieve better plant growth vis-à-vis minerals and vitamin content of the fluted pumpkin leaf**.** The field experiment was conducted, the experiment was done on split plot design arranged in a randomized complete block design (RCBD) replicated three times. The factors of the experiment are; charcoal, N P K and fluted pumpkin. Chlorine (Cl) determination in pumpkin leaf using thiocynate colorimetric method was also used. Data collected and summarized were subjected to inferential statistical tool of linear regression using SPSS software 19th edition. Mean separation using the SPSS software 19th edition. From the results of analyzed data, the following conclusion was drawn; charcoal and NPK fertilizer positive influenced the physio-chemical properties of the soil that develop the plants vis-à-vis the fluted pumpkin leaf. The following recommendations are made: proper management practices meant for fluted pumpkin should be upheld by farmers to enhance quality fluted pumpkin leaf, farmer should choose nutrients sources that are of high quality to enhance the productivity of fluted pumpkin and there should be further study on effect of charcoal and NPK fertilizer on the fruit and seed yield of fluted pumpkin.
Keywords: Charcoal, NPK Fertilizer, Minerals and Vitamin Content of the Fluted Pumpkin Leaf

INTRODUCTION

In most Nigerian farming communities, vegetable farming is practiced under a continuous cropping, mixed farming, crop rotation, monocropping and mixed cropping systems. These cropping systems and other soil management strategies affect the soil properties and crop yield differently. Some of these cropping systems like continuous cropping and mono-cropping or any other which do not allow for a fallow period and fertility restoration lead to soil degradation and poor crop yield. Soil organic matter level depend upon factors such as crop rotation, tillage methods, fertility management including use of organic and inorganic manure and other components of cropping system (Purakayastha *et al.,* 2008). There is no strict paradigm recommended for soil fertility management to enhance crops yield in particular region of the world, neither solely organic nor inorganic manure. Sharma *et al*. (2003); Manna *et al*. (2005) and Kaur *et al*., (2008) are of the opinion that judicious combination of organic amendments and inorganic fertilizers is widely recognized strategy of integrated nutrient management to sustain agronomic productivity and improve soil fertility.

In view of the fact that fluted pumpkin (*Telfairia occidentalis*) is a nutrient demanding vegetable crop, soil nutrient depletion is expected under a continuous cropping system without any farm practices that replaces such nutrient (Oke *et al.*, 2015). Oloyede *et al*. (2013) reported that as a way of maintaining the soil productivity as to achieve the expected yield of fluted pumpkin crop, farmers in Nigeria have realized the need for the use of materials of organic origin which will serve as soil amendments. Maller *et al*. (2013) reported that photo assimilates production which is usually the resultant effect of transpiration and photo-energy interception is the responsibility of the plant leaves. According to Ndor *et al*, (2010), arable lands all over Nigeria have seen an alarming decline in soil productivity as a result of continuous agricultural practices without application of adequate restorative measures to revitalize the soil. It is on this background that charcoal and NPK 15:15:15 fertilizers are combined to stabilize the soil nutrient with the intent to increase the growth of fluted pumpkin (*Telfairia occidentalis*).

Farm system has to do with methods or strategies of cultivating crops and rearing of animals adopted by farmers. Concept of farming systems is relative and each method has major paradigms, merits and demerits. With the increase in the use of agricultural lands for the purpose of building other infrastructures, and with small lands left for the cultivation of crops farmers continue to farm continuously on a piece of land, plant growth , yield and quantity of soil are greatly reduced. After experiencing the continuous years of planting, the same species of crops or closely related species in the same land, there will low plant growth, serious disease and insect pest, yield reduction and quality deterioration phenomenon which is a result of continues cropping obstacle. The continuous cropping problem brought with it plant diseases, insect pests, decrease of plant resistance, decrease of yield and quality and even severe plant death. The reasons for the formation and aggravation of continuous cropping obstacles are complicated and various factors are interrelated and influenced to each other. According to Wang (2017) continuous cropping obstacle is the result of the cumbered effects of many factors in plant soil system including soil infection diseases, physical and chemical deterioration and so on. According to Hou (2016), continuous cropping of plants leads to the destruction of soil aggregate structure, soil composition, pore ventilation and deterioration of physical properties of soil. According to him soil physical properties are influenced by many factors such as climate, biology, topography, parent material and time, tillage and cultivation measures. A large number of studies as reported by Guoyin *et al*, (2012), have shown that because of the partial depletion of soil nutrients continuous cropping causes uneven changes in soil nutrients, and hence directly affects the normal growth and development of the next crop. The study of Salvia Miltiorrhiza and Alonite as reported by Zhuang *et al*, (2015) showed that the acidic substances secreted by its roots affected the soil microbial community especially the number of fungi. To them, continuous cropping of medicinal plants has a great influence on soil enzyme activity and microbial flora in rhizosphere soil which may be one of the main reasons for the continuous cropping obstacle. Evils of continuous cropping can be prevented and avoided using the following preventive measures as reported by Wang (2017). These include as follows:

a) Reasonable rotation – Rotation is an important measure used in restoring soil fertility, reduction of diseases insects' pest and removal of continuous copping obstacles of pants. Crops are rotated with a specified period to ensure that soil nutrient is replenished.
b) Soil sterilization - one of the important ways to overcome continuous cropping obstacles is the soil sterilization, especially for plant soil borne diseases, exacerbation of continuous copping. Chemical fumigation is a commonly used method of soil sterilization.
c) Addition of beneficial micro-organisms or nutrients – supplementing and adding beneficial micro organisms' or nutrients in the continuous cropping obstacle of plants is often the results of synergistic effects of many factors. It is difficult to achieve good governance effect by adopting the above single prevention and cure measures. Wang (2017) reported that at present, the comprehensive measures – such as physical measures, chemical measures and agronomic measures

are adopted to deal with the continuous cropping soil with the intent to achieving good results of improving the continuous cropping obstacles of the soil.

Charcoal and Plant Growth

Charcoal works as a highly effective slow release fertilizer. According to Keller (2017), the type of charcoal used, however, is important; emphasizing that natural charcoal formed from biomasses such as wood will give the best results. This natural charcoal from natural alternative outlets or made by slow - burning wood will release vital nutrients into the soil aiding the growth of plants (Keller, 2017). The importance of charcoal dates back to its use as fuel for cooking and steam engines etc. However, Glaser *et al*, (2001), reported that charcoal apart from its primary function as fuel, it has long ago been used as a soil improver in many parts of the world. But Nishio and OKano (1991) reported that only recently was the application of charcoal to the soil practiced. According to Ogawa and Okimori (2010), the effects of charcoal vary according to the raw materials, production methods and types of charcoal and the period of its application to the soil. For them bio-char shows a positive effect on certain physical, chemical and biological properties of soils. Laird et al. (2010), reported the advantages of charcoal, emphasizing that because charcoal been a porous material with high water and air retention capacities, its addition to agricultural soils leads to increases in water holding capacity and decreases in nutrient leaching. Steiner et al, (2007) reported that less attention was given to quantifying nutrient leaching from agricultural soils treated with charcoal despite the fact that a lot of plant and soil scientists' have recommended the use of charcoal for soil improvement, and to achieve better plant growth.

According to Steiner *et al, (*2007), a review of literature showed no previous comparative study of the most suitable quantity of charcoal grains to simultaneously promote plant growth and reduce nutrient leaching. Major *et al* (2009), nutrient leaching and retention of agricultural land is greatly influenced by soil texture. Ketterings and Bigham (2000), reported that charcoal addition to the soil have positive effect on soil properties and enhance soil fertility and productivity. For Glaser *et al,* (2002), increased soil acidity pH, addition of free bases such as ca, k, and mg and enhancement of the cation exchange capacity showed that added charcoal is not only a soil conditioner but also acts as a fertilizer. In addition, putting charcoal to the soil will positively affect seed germination, crop growth and yields (Ketterings and Bigham 2000). Glaser *et al*, (2002), in a recent review demonstrated that crop yields can be increased when chemical is added to the soil especially in the tropics. The significance of charcoal to plant growth is so much that apart from increasing the amount of water a soil can hold and improvement to soil acidity (pH) so that plants can get more nutrients from the soil, evidences show that charcoal which has tiny pores that looks like sponge can equally absorbs pesticides and chemicals secreted from the roots of anxious weeds and enhance special fungi that infect a plant root and assist the plant to get more nutrient from the soil. Notwithstanding, the present study dealt with the effect of soil treated with charcoal and NPK fertilizer on the minerals and vitamin content of the fluted pumpkin leaf.

Statement of the Problem

It becomes necessary to find ways that its production will be increased in order to meet up with the increased demand for its products. To increase the growth yield of fluted pumpkin, there are the needs for the stabilization of soil nutrients through the application of charcoal as soil amendment and NPK fertilizer to the soil. In Rivers State the problem of soil nutrients lost through nutrients uptake by crops is usually compounded by leaching and erosion due heavy and excessive rainfall. Nottidge *et al*. (2005) asserted that the use of inorganic fertilizer has not been able to sustain high productivity due to increase in soil acidity; nutrient leaching and degradation of soil organic matter and physical conditions.

There was the need for the application of fertilizers to the soil for easy nutrient intake and seed development of fluted pumpkin. Both organic and inorganic fertilizers are involved. Ogbonna (2008) reported that release if nutrient is slow in organic and more lasting compared to the faster release of nutrients by inorganic fertilizers which are often lost rapidly by leaching in porous soils and heavy rainfall areas. The problem of this study therefore include; What is the effect of charcoal and NPK on soil physio-chemical properties, growth of fluted pumpkin, and proximate composition of fluted pumpkin leaf. It is also necessary to determine the best quantity of charcoal and NPK treatments as soil nutrients enhancers that will give the best growth yield of fluted pumpkin (*Telfairia occidentalis*) under continuous cropping.

Purpose of the study

The purpose of the study is to investigate the effect of soil treated with charcoal and NPK fertilizer on the minerals and vitamin content of the fluted pumpkin leaf.

METHODOLOGY

The field experiment was conducted, the experiment was done on split plot design arranged in a randomized complete block design (RCBD) replicated three times. The factors of the experiment are; charcoal, N P K and fluted pumpkin. The experiment shall be a split plot factorial experiment. The main plot shall be charcoal rates while the NPK rates shall be in split plot replicated three times in a randomized complete block design. Thus a 3*5 factorial replicated three times to give to give 45 experimental units, 15 plots per block. The treatments were applied to fluted pumpkin and arranged as follows: Charcoal; a) Zero application 2 tons, b) 4 tons application of charcoal /16m^2 c) 6 tons application of charcoal /16m^2 d) 8 tons application of charcoal /16m^2 while NPK fertilizer are; a) zero application of NPK/ 16 m^2 b) 20 kg of NPK /16 m^2 c) 40 kg of NPK/ 16m^2

Chlorine (Cl) determination in pumpkin leaf using thiocynate Colorimetric Method

This method depends on the liberation by chloride ions from mercuric thiocyanate which is very largely dissociated. Thiocyanate then reacts with excess ferric iron to give red color. The method is primarily intended for water analysis and soil extracts but many also applied to total soil and plant materials after fusion of the sample with sodium carbonate. The substrate must be neutralized with H_2SO_4. Mineral soils – 0.005-0.05% and Plant materials -0.04-0.4%

Reagents: Chloride Standards

1. Standard (1ml=1mg Cl)- dissolve 1.6484g dry Nacl in water and dilute to 1 litre
2. Sodium Acetate –Acetic acid buffer. Dissolve 30g NaOAc $3H_2O$ in 500ml water. Add 1ml glacial HOAc and dilute to 1 litre
3. Ferric Alum –Nitric acid reagent. Dissolve 30g Fe $NH_4(SO_4)_2$. $12H_2O$ in 350 ml H_2O.Add 95ml conc. HNO_3. Bring to boil , cool and filter .Dilute to 500ml

   MercuricThiocyanate Solution

   Suspend 0.5g Hg (SCN) in 250ml water. Stir for 12 hours at room temperature and filter.

Procedure

Prepare the sample solution as ash solution and dilute to volume where appropriate. Water samples do not normally require prior treatment. Pipette 0-10ml standard into 50ml volumetric flask to give a range from 0-10mg cl. Add acid or soil extractant comparable to sample aliquots. Measure not more than 15ml sample solution into 50ml volumetric flask. From this pt treat standards and samples in the same way. Add 20ml buffer solution and mix. Add 10ml acid ferric alum solution and mix. Add 4ml mercuric thiocyanate reagent, dilute to volume and mix.

Measure the optical density at 460mm or with a green filter using water as a reference. Prepare a calibration curve from the standard solutions and use it to obtain MgCl in the sample aliquot. Carry out the blank determinations in the same ways and subtract where necessary.

Calculation:

If C=Mg Cl obtained from the graph then for:

Plants materials

$$Cl\ (\%) = \frac{C(mg) \times \text{solution volume (ml)}}{10 \times \text{aliquot (ml)} \times \text{sample wt (g)}}$$

Data collected and summarized were subjected to inferential statistical tool of linear regression using SPSS software 19th edition. Mean separation using the SPSS software 19th edition.

RESULT AND DISCUSSION

Table 1. Effect of charcoal and NPK treated soil on proximate on composition of fluted pumpkin leaf

		Season 1						**Season 11**				
Charcoal Rates	Protein	Lipid	Ash	Moisture	Fibre	CHO	Protein	Liquid	Ash	Moist	Fibre	CHO
0Tonsha^{-1}	13.26^{b}	**1.64^{c}**	4.53^{a}	81.04^{a}	3.29^{a}	6.00^{a}	13.50^{a}	1.67^{a}	4.61^{a}	79.68^{a}	2.98^{a}	4.95
2	10.43^{b}	1.53^{b}	5.06^{a}	86.44^{a}	3.31^{a}	6.28^{b}	8.55^{a}	1.57^{a}	4.77^{a}	82.65^{a}	3.62^{a}	5.05
4	8.65^{a}	1.37^{a}	5.53^{a}	89.29^{a}	3.29^{a}	6.56^{b}	8.38^{a}	1.71^{a}	5.11^{a}	83.08^{a}	3.65^{a}	4.95
6	8.65^{a}	1.35^{a}	5.67^{a}	89.40^{c}	3.32^{a}	5.94^{a}	8.03a	2.39^{a}	4.94^{a}	88.40^{a}	3.69^{a}	3.68
8	10.71^{a}	1.35^{a}	5.60^{a}	89.40^{c}	3.29^{a}	7.04^{c}	10.01^{a}	2.03^{a}	4.30^{a}	80.99^{a}	3.49^{a}	4.40^{a}
SE	2.07	0.059	0..42	1.94	0.42	0.719	2.927	0.256	0.95	0.447	0.311	1.762
NPK												
0Kgha^{-1}	5.94^{a}	1.39^{a}	5.29^{a}	88.62^{a}	3.29^{a}	5.63^{a}	5.32^{a}	1.69	5.90^{a}	84.15^{b}	2.99a	5.24^{a}
20	13.95^{b}	1.44^{a}	5.11^{a}	84.5^{a}	3.38^{a}	6.06^{a}	12.26^{b}	1.69^{a}	4.35^{a}	77.72^{a}	3.02^{a}	5.37^{a}
40	11.06^{b}	1.58^{a}	5.47^{a}	86.11^{a}	3,21^{a}	7.45^{b}	11.51^{b}	2.11^{a}	4,72^{a}	84.11^{b}	3.37^{a}	5.29^{a}
SE	1.57	0.046	0.33	1.50	0.18	0.56	1.65	0.22	0.72	0.35	1.37	0.241

Mean with San = Super script is not significant $P \geq 0.05$. SE is standing error charcoal d = N and NPK = 8 total 22

The Table shows the effect of charcoal and NPK fertilizer on proximate composition of fluted pumpkin leaf. In the first growing season, protein for charcoal treated fluted pumpkin are 13.26, 10.57, 8.65, 8.05 and 10.71% for 0, 2, 4, 6 and 8tonsha^{-1}. There is significant different among treatments. Lipid is 1.64, 1.53, 1.37, 1.35 and 1.46% for 0, 2, 4, 6 and 8 tons ha^{-1}. There is significant different among treatments. Control differs from 2, 4, 6 and 8tonsha^{-1} of charcoal carbohydrate content are 6.00, 6.25, 6.56, 5.94 and 7.09 for 0, 2, 4, 6 and 8 tons ha^{-1}of charcoal respectively. There is significant ($p < 0.05$) difference among treatments. 0tonsha^{-1} differs do not differ from 2, 6tonsha^{-1} of charcoal but significantly different from and 8tons of charcoal. Ash of fluted pumpkin is 4.58, 5.06, 5.53, 5.67 and 5.60% for 0, 2, 4, 6 and 8tons ha^{-1} of charcoal respectively. There is no significant ($p< 0.05$) difference among treatments. It means that charcoal application does not influence the ash content of fluted pumpkin.

The moisture content recorded is 81.04, 86.44, 89.26, 89.40 and 89.69% for 0, 2, 4, 6 and 8tonsha^{-1} of charcoal respectively. There is significant ($p< 0.05$) difference among treatments. The moisture content of control differs from that 2, 4, 6 and 8tonsha^{-1} of charcoal treatments. 4, 6 and 8tonsha^{-1} of charcoal do not differ significantly from one another.

Fibre content of fluted pumpkin is 3.29, 3.31, 3.27, 3.32 and 3.29% for 0, 2, 4, 6 and 8 tons ha^{-1}. There is no significant difference among treatments. It implies that charcoal has no effect on the fibre content of fluted pumpkin. In another, NPK fertilizer effect the on protein recorded 5.74, 13.95 and 11.06% for 0, 20 and 40kgha^{-1}. There is significant ($p < 0.05$) difference among treatments. The control differs from 20 and 40kgha^{-1} of NPK fertilizer 20 and 40kgha^{-1} do not differ from one another. Lipid content recorded are 1.39, 1.44, and 1.59% for 0kg, 20 and 40kgha^{-1} of NPK fertilizers. The lipid recorded is not significant ($p \geq 0.05$). NPK fertilizer has no effect on lipid content of fluted pumpkin. Carbohydrate recorded is 5.63, 6.06 and 7.459, for 0, 20 and 40kgha^{-1} of NPK fertilizer. Treatments show significant difference ($p < 0.05$), the control differs from 40kgha^{-1} but not from 20kgha^{-1} of NPK fertilizer. It shows that application of NPK fertilizers positively influenced the carbohydrate content of fluted pumpkin, 5.29, 5.11 and 5.47 of ash are recorded for D, 20 and 40kgha^{-1} of NPK fertilizer. There is no significant difference among treatments. It implies that application of NPK fertilizer do not influence the ash content during the first going season.

Moisture recorded is 88.62, 84.05 and 86.11% for 0, 20 and 40kg ha^{-1}. There is no significant ($p > 0.05$) difference among treatments. Fibre content recorded are 3.29, 3.38, and 3.21% for 0, 20 and 40kgha^{-1} of NPK fertilizer. The fibre contents are not significantly different ($p > 0.05$) among treatments. The proximate composition of fluted pumpkin leaf for grown on soil treated with charcoal and NPK fertilizer show numerically difference among treatment means. Some of the treatment means are not significant ($P \geq 0.05$) at a particular treatment level in the first growing season. Protein and carbohydrate are positively influenced by application of charcoal and NPK. In another hand, lipid, carbohydrate, ash, moisture and fibre have little or no influence on application of charcoal and NPK fertilizer.

The proximate composition of fluted pumpkin leaf due to application of charcoal and NPK fertilizer during the second growing season is in Table 4.5 protein recorded are 13.51, 8.55, 8.33 and 8.03 for 0, 2, 4, 6 and 8tonsha^{-1} respectively. There is significance different ($P \geq 0.05$) among treatments 1.67, 1.87, 1.77, 2.13 and 2.03 of lipid, 4.61, 4.77, 5.11 and 4.94 ash; 79.68, 83.08, 83.40 and 80.99 % moisture; 2.98 3.02, 3.05, 3.09 and 3.49 % fibre and 4.95, 5.05, 4.95, 3.68 and 4.4 % carbohydrate for 0, 2, 4, 6 and 8tons ha^{-1}. Lipid, ash fibre and carbohydrate do not differ significantly ($p \geq 0.05$) among treatments. Protein and moisture differ among treatments. It could deduced that application of NPK fertilizer mobilizes the formation of protein enhances the absorption of soil water into the fluted pumpkin tissues.

DISCUSSION OF FINDINGS

The proximate composition of fluted pumpkin leaf harvested from c NPK fertilizer and charcoal treated soils show increase in protein, lipid, ash, moisture, fibre and carbohydrate. The highest percentage of protein was recorded at 6 tons ha^{-1} and 8tonsha^{-1} charcoal and 20kgha^{-1} NPK fertilizer in both seasons. Similarly, lipid, ash, carbohydrate, moisture and fibre were highest at 6tonsha^{-1} and 40kgha^{-1} of NPK fertilizer respectively. The nutrients available in the soil are up take by fluted pumpkin of build protein, lipid, ash, moisture, fibre and carbohydrate. The variations in amount of protein, lipid, ash moisture, fibre and carbohydrate among NPK and charcoal blend treated soils are due to the constituent substances in them. The seasons of planting also account for their variations in proximate composition.

These results are in consonant with the findings reported by Akanbi, (2006) that fluted pumpkin leaf is rich is protein (79%) and fat 18%. The results are in tandem with Ameo *et al.* (20O8) who reported that fluted pumpkin is rich in essential amino acid. The results are in consonant with Nwite *et al. (*2013) who reported that NPK or combined with some organic (rice husk, brand, ash and poultry) enhanced the nutrient composition of fluted pumpkin regardless of treatment at 6 to 10 weeks after planting.

Data on minerals, and Vitamins show increase in Ca, Na, P, Fe Mg and K as the quantity of charcoal and NPK fertilizer applied increased. The best result on these minerals was at 6tonsha^{-1} and 40kgha^{-1}. Increased in quantity of charcoal to 8tonsha^{-1} negatively influence Na. this could be as a result of preferential discharge of K due to its high concentration in charcoal. Also the Vitamin A, C, Niacin and Chlorophyll show increase as the quantities of charcoal and NPK increased in both growing seasons. The highest results were obtained from fluted pumpkin, leaves from 6tonsha^{-1} and 8tonsha^{-1} of charcoal while that NPK fertilizer was highest at 40kgha^{-1}. The nutrients content of charcoal and NPK fertilizers are essential building block for available Ca, Na, P, Fe, Mg, K Vitamin A, Vitamin C, Niacin and Chlorophyll.

These results are in tandem with the findings of Amao *et al*. (2018) that fluted pumpkin supply necessary nutrients like vitamins and minerals to aid balance diet. The results are also in consonant with the report of Agbede *et al.,* (2008). That fluted pumpkin leaf is of nutrients value and high leaf protein.

CONCLUSION

From the results of analyzed data, the following conclusion was drawn; charcoal and NPK fertilizer positive influenced the physico-chemical properties of the soil that develop the plants vis-à-vis the fluted pumpkin leaf. The application 6tonsha^{-1} of charcoal and 40kgha^{-1} of NPK fertilizer as main and sub plot were the highest in growth parameter of fluted pumpkin. Application of 6tonsha^{-1} of charcoal positively influenced the growth the fluted pumpkin 20kgha^{-1} and 49kgha^{-1} gave highest growth influence on fluted pumpkin. 6tonsha^{-1} of charcoal and 40kgha^{-1} of NPK gave the best result on proximate composition and characterization of fluted pumpkin leaf.

RECOMMENDATIONS

The following recommendations are made

1. Proper management practices meant for fluted pumpkin should be upheld by farmers to enhance quality fluted pumpkin leaf
2. Farmer should choose nutrients sources that are of high quality to enhance the productivity of fluted pumpkin
3. There should be further study on effect of charcoal and NPK fertilizer on the fruit and seed yield of fluted pumpkin.

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