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Influence of Soil Amendment Practices on Soil Physicochemical Properties, Growths and Edible Leaf Yield of Fluted Pumpkin (*Telfairia occidentalis*) in Enugu South Eastern Area of Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Author OEN designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors OEN and VNE managed the analyses of the study. Author VNE managed the literature searches. Both authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

The effect of inorganic fertilizer (NPK 15-15-15), mulching materials (plant residue), poultry manure (droppings) and lime ($CaCO_3$) on soil physicochemical properties, growth and edible leaf yield of fluted pumpkin it was studied in 2019 in farming seasons at the Teaching and Research Farm of the Faculty of Agriculture and Natural Resources Management Enugu State University of Science and Technology. A Randomized Complete Block Design with five (5) treatments and four (4) replications were used for the experiment. The result of this experiment showed that inorganic fertilizer (NPK 15-15-15), produced significantly (P=0.05) 250 kg/ha, increased leaf area index (LAI), higher number of branches, highest fresh weight and gave longer vine length than line (CaCO3) 250 kg/ha, mulching materials (plant residue) 250 kg/ha and poultry manure (droppings) 250 kg/ha.

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1. INTRODUCTION

Fluted pumpkin (*Telfairia occidentalis*) is a warm-season vinous vegetable crop belonging to the family of Curcurbitacea. It is a native of tropical Africa, particularly West Africa. Fluted pumpkin is one of the most important vegetables grown in South-Eastern Nigeria. It is a member of the family with separate male and female plants always evident in the field. It is tolerant to drought and wider ranges of soil fertility condition. The soil amendment practices such as mulching materials, lime ($CaCO_3$), inorganic fertilizer and poultry droppings help in seed yield and it is higher as it can yield up to 2.8 tons of sees per hectare. It is a leafy vegetable that has been widely accepted as a dietary constituent among peasants in Nigeria (Akwakwo et al., 2000). The leaves and young shoot are edible and are used as potherbs. The leaf has a high nutritional, medicinal and industrial value being rich in protein (29%), fat (18%), mineral and vitamin (20%). Apart from the leaves, the seed which can be cooked, roasted, eaten or ground and added in soup contains 20.5 g protein, 45 g fat, 23 g carbohydrates, 2.2 g fibre and 4.8 g total ash, respectively. The oil in the seeds is non-drying and is useful in soup and for cooking. It has been discovered to be blood purifiers and could, therefore, be useful in the maintenance of good health, most especially among poor resource rural areas in the developing countries.

Despite all these economic potentials of the crop, it is among the neglected vegetable of the tropics, commonly grown under subsistence farming system and usually mixed with other food crop or grown in the background along fences. Soil amendment is any material added to the soil to improve its physical properties such as water retention, permeability, water infiltration, drainage, aeration and structure. The goal is to provide a better environment for roots to absorb nutrients easily. Organic matter also is an important energy source for bacteria like earthworm and fungi that live in the soil, these soil conditioners added, depending on the current soils composition, climate and type of plant growth, some soils lack nutrients necessary for proper plant growth and others hold too much or little.

In soil amendments, we have mulching materials, poultry droppings; lime ($CaCO_3$) and inorganic fertilizer (NPK 15-15-15) which help in the restoration of the soil from both physical and chemical degradation. Inorganic fertilizer and organic manure are a very good way of nourishing the soils and amendment materials for the soil are organic and inorganic compounds or materials which when added to the soil enhances the availability of nutrients and soil structural stability.

1.1 Objective of the Study

The objective of this study it was to evaluate the effect of lime ($CaCO_3$), inorganic fertilizer (NPK 15-15-15), mulching materials (plant residues), poultry manure on soil physicochemical properties, growth and edible leafield of fluted pumpkin (*Telfairia occidentalis*), in Enugu South Eastern Nigerian.

2. MATERIALS AND METHODS

2.1 Experimental Site

The research was carried out at the Teaching and Research Farm of Faculty of Agriculture and Natural Resources Management, Enugu State University of Science and Technology, during the 2019 planting season. The area is characterized by an annual rainfall between 1,700 mm to 1,800 mm and a humid tropical climate with wet season between April-October and dry season between November-March. The experimental site is located between latitude $06°17^1$ $58°6^1$ and longitude 7°32, 58.6°East in the derived zone of the South East Agro-ecological Zone of Nigeria. The soil is typical paleustult.

2.2 Materials and Sources

The pods of the fluted pumpkin (*Telfairia occidentalis*) were bought from seed section of the market from where the seeds were got and other treatments were added using the following rates: inorganic fertilizer (NPK 15-15-15) 250 kg/ha, mulching materials (plant residue) 250 kg/ha, lime ($CaCO_3$) 250 kg/ha and poultry manure (poultry droppings) 250 kg/ha.

2.3 Soil Analysis

Soil sampling and analysis were carried out. Soil samples were collected at 15 cm depth with the

aid of soil auger at random from different parts of the experimental site to determine the physicochemical properties of the soil. The physicochemical properties were determined before and after planting and these were particles size using Bouyoucos hydrometer method [1], pH was determined by using both distilled water and O.INKCl solution [2] and organic carbon were determined using Walkley and Black method [3], the cation exchange capacity of the soil was obtained using ammonium acetate method [4]. Exchangeable bases were determined using a complexometric titration method described by Chapman [5], available phosphorus was determined using Bray II solution [6]. Total nitrogen was determined using micro Kjeldahl distillation method [7].

2.4 Field Method Design

Randomized complete block design (RCBD) was used in carrying out this experiment. A total land area of 180 m^2 (15 m x 12 m) was used. The land was divided into four (4) blocks with each having five (5) experimental units, making a total of twenty (20) experimental units, each having an alley of 1 m x 1 m between rows and 0.5 m x 0.5 m between columns. Two seeds were planted per hole. To increase the chance of survival and later thinned to one (1) stand with a spacing distance of 0.5 m x 0.5 m and there were eight (8) stands on each experimental unit. The entire land consists of 160 plants of fluted pumpkin (*Telfairia occidentalis*). Fluted pumpkin seeds were planted in July and harvested in December 2019.

2.5 Cultural Practices

Weeding of the farm was carried out at interval after planting with hoes, to enhance growth and good performance of the plant. Applying pesticide helped in checking disease incidence, harvesting of the crop was carried out using a knife to cut the vine and the leaves.

2.6 Data Collection

Some agronomic measurements were taken on the vine length, number of branches, leaf area index (LAI), fresh weight yield of vegetables were used to assess the crop productivity using sensitive weighing balance while some physicochemical properties of the soil before and after planting like cation exchange capacity, exchangeable bases, exchangeable acidity, soil porosity, soil colour, soil particles size, bulk density, total phosphorus available and total nitrogen were determined.

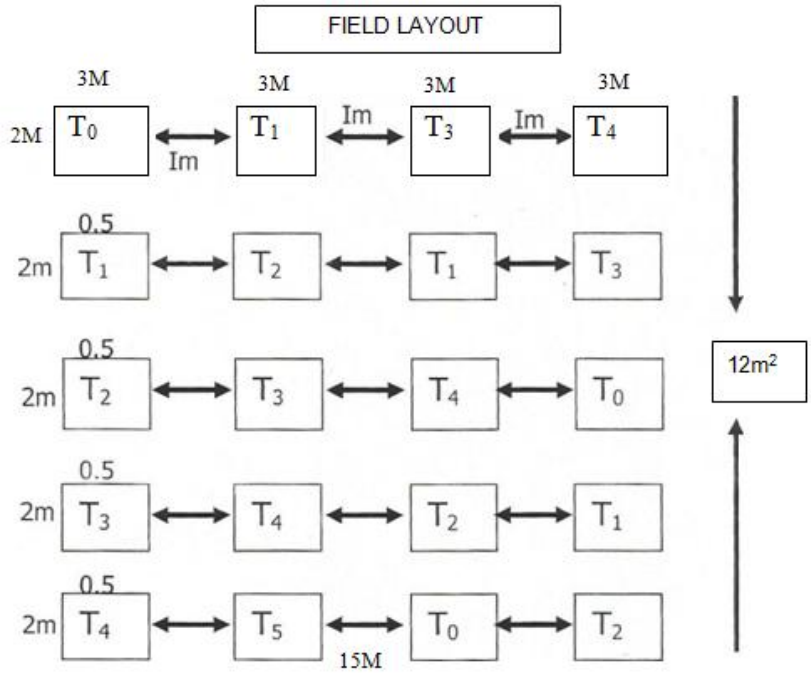

Fig. 1. The total land area covers 15 m x 12 m 180 m^2

T_0: Treatments, T_1: Control, T_2: Lime ($CaCO_3$) 250 kg/ha, T_3: Inorganic fertilizer (NPK 15-15-15) 250 kg/ha, T_4: Mulching materials (plant residues) 250 kg/ha, T_5: Poultry manure (poultry droppings) 250 kg/ha

Table 1. Analysis of variance (ANOVA) used for the study

Source variation of	General degree of freedom	Specific degree of freedom
Block	(r-1)	(4-1) = 3
Treatment	(t-l)	(5 -1) = 4
Error	(r-1) (t-1)	(4-1) (5-l) = 12
Total	(rt-l)	(5 x 4 - 1) =19

2.7 Data Analysis

Data collected from the experiment were analyzed using analysis of variance for an RCBD at P = (0.5) according to Obi [8].

3. RESULTS AND DISCUSSION

The result presented in Table 2a and Table 2b shows the physicochemical properties of the soil before and after planting. The results of the Pre-planting and Post-planting soil analysis conducted as shown in Table 2 showed that soil textural class is sandy loam. In the pre-planting analysis, percentage clay was 10.6%, Silt, 13.4% and sand 76.0% but in the post-planting analysis the plot treated with poultry manure had clay 15.3%, Silt 20.7% sand 64.02%; NPK, clay 13.7% silt 24.4%, sand 62.0%,; mulching materials, clay 12.8%, Silt 30.2%, sand 57.0% and for lime, clay 12.8%, silt 30.3% and sand 56.9%.

The soil samples were collected at a depth of 15 cm. From the analysis, the pH (1-12) was 6.07 before planting and where the plot was treated with poultry manure the pH was 6.00, with NPK treatments, pH was 6.10, in mulching materials, pH was 6.03 while in lime pH was 6.23. The pH (KCl) was 5.92, 5.84, 6.00 and 5.89 for plots treated with poultry manure, NPK, mulching and lime in post-planting analysis, respectively. % organic carbon (%OC) was 0.06 before planting and 0.3, 0.28, 0.03 and 0.4 for poultry, NPR, mulching and lime after planting, respectively. The percentage of organic matter before planting was 0.09 and 0.31, 0.20, 0.29, and 0.18 for poultry, NPK, mulching and lime after planting, respectively. The pre-analysis% of nitrogen was 0.003 and post-analysis was 0.09, 0.90, 0.054 and 0.06 for plots treated with poultry manure, NPK, mulching and lime respectively.

Total phosphorus showed the level of phosphorus before the experiment was 27.8 and after planting, poultry 30.92, NPK 26.78, mulching 23.00 and lime 24.02 calcium (Ca) was 2.08 $Cmol^{+}kg$-l before planting and after was 2.24, 2,00, 1.68 and 2.00 Cmol+kg-l for plots treated with poultry droppings, NPK, mulching and lime respectively. Also, the value of magnesium before planting was 0.18 Cmol kg-l and after planting, plots treated with poultry manure had 0.56 (Cmol+kg-l) NPK 0.48. mulching 0.36 and lime 0.49 Cmol $+kg^{1}$. Sodium value was 0.55 Cmol kg-l before planting and with poultry manure, 0.84, NPK 0.80, mulching 0.74 and lime 0.78 Cmol $+kg^{l}$ while potassium (K) was 0.57 before the planting and plot treated with poultry manure had 0.80, NPK 0.69, mulching 0.54 and lime 0.65 after the experiment.

3.1 Vine Length and Number of Branches

Table 3 shows the effect of lime ($CaCO_3$), NPK 15-15-15 fertilizer, mulching materials (plant residue) and poultry manure on vine length and the average number of branches of *Telfairia occidentalis*.

Results in Table 3 showed that these soil amendment practices significantly affected the vine length of the fluted pumpkin. The result further showed that inorganic fertilizer (NPK 15-15-15) significantly produced the longest vine length (328 cm), followed by poultry manure the vine length of 286 cm and lime with a vine length 252 cm followed by control with a vine length of 209 cm and the least vine was mulching material (plant residues) with a vine length (167 cm). The great variations of vine length among soil amendment practices showed that vine length is significantly affected by different soil amendment practices.

3.2 Number of Branches

In Table 3, result that different amendment practices significantly affected the number of branches of fluted pumpkin. Control, lime (CaCO3), mulching materials (plant residue) and poultry manure are statistically the same in terms of the number of branches of fluted pumpkin but significantly differ from inorganic fertilizer (NPK 15-15-15) which gave the highest number of branches six (6).

Table 2a. Soil analysis before planting (Pre-analysis)

Parameter	Clay%	Silt%	Sand %	pH H_2O	pH KCl	0C%	OM%	N%	P (mg/kg)	Ca	Mg	K	Na	Ea	ECEC	Bulk density
Before (Pre-analysis)	10.6	13.4	76.0	6.07	5.92	0.06	0.09	0.03	27.8	2.08	0.18	0.57	0.55	0.40	3.45	1.36

Table 2b. Soil analysis after planting (Post-analysis)

Parameter	Clay%	Silt%	Sand %	pH H_2O	pH KCl	0C%	OM%	N%	P (mg/kg)	Ca	Mg	K	Na	Ea	ECEC	Bulk density
Poultry manure	15.3	20.7	64.0	6.00	5.43	0.30	0.31	0.09	30.92	0.56	0.80	0.84	0.40	4.40	4.26	1.36
Fertilizer NPK (15-15-15)	13.7	24.3	62.0	6.1	5.84	0.28	0.2	0.19	26.78	2.0	0.48	0.69	0.80	0.39	4.03	1.32
Mulching material	12.28	30.2	57.7	6.03	6.0	0.3	0.29	0.054	23.0	1.68	0.36	0.54	0.74	0.37	4.0	1.30
Lime ($CACO_3$)	13.8	29.3	56.9	6.23	5.89	0.14	0.18	0.06	24.02	2.0	0.49	0.65	0.78	0.34	4.01	1.31

Table 3. List of different treatments used for vine length and number of branches measurement

Treatments	Vine length (CM)	Average number of branches
Control	209	3
Lime [CaCO3]	252	3
Inorganic fertilizer (NPK 15-15-15)	328	6
Mulching materials (plant residue)	167	3
Poultry manure (poultry dropping)	286	4
FSLD (0.05)	11.87	1.32

Table 4. List of different treatments for Leaf Area Indexing (LAI)

Treatment	Leaf Area Index (LAI)
Control	0.5267
Lime [$CaCO_3$]	0.8153
NPK(15-15-15)	7.7118
Mulching materials (plant residue)	0.5087
Poultry manure (poultry dropping)	4.5458
FSLD (0.05)	1.07

This is in agreement with the report made by Russel (1993) that the level of vegetable responses to the soil is related to the sufficiency of fertilizer to the soil. Enyi [9] also reported the proliferation of branches *Telfairia occidentalis*, with NPK 15-15-15 at the rate of 625 kg/ha.

3.3 Leaf Area Index

Table 4 showed the effect of lime ($CaCO_{3)}$ (plant residue) and poultry manure on leaf area index (LAI).

From Table 4, the result indicated that different soil amendment practices on the fluted pumpkin (*Telfairia occidentalis*) are significantly at (P=0.05) on leaf area index of fluted pumpkin.

Inorganic fertilizer significantly produces the highest leaf area index of (7.7118) followed by poultry droppings that produce (4.54580), lime ($CaCO_3$), mulching materials and control are statistically the same in leaf area index of fluted pumpkin and this showed that there was no much difference between control, lime and mulching material. The highest leaf area index which occurred in inorganic fertilizer is following the result of Spoto [10] which that available high nitrogen and phosphorus in the soil produces a vegetable crop with large leaf area index and increases the net assimilation rate (NAR) of the vegetable crop. This is also in line with the assertion that nitrogen fertilization affects yields, predominantly through its effect on leaf area index (LAI) [11].

3.4 Fresh Weight Yield of Edible Leaf of Fluted Pumpkin

Table 5 showed the effect of lime [$CaCO_3$), inorganic fertilizer (NPK 15-15-15), mulching materials (plant residue) and poultry manure (poultry droppings) on fresh weight edible leaf yield of fluted pumpkin (*Telfairia occidentalis*).

The result in Table 5 shows that different soil amendment practices significantly affected the fresh weight yield of edible leaf of fluted pumpkin (*Telfairia occidentalis*). Inorganic fertilizer (NPK 15-15-15) significantly produced the highest fresh weight yield of edible leaf of (11.75 kg), poultry droppings also produced significantly fresh weight yield of edible leaf of

Table 5. List of different treatments for fresh weight yield of the edible leaf

Treatment	Fresh weight of edible leaf (kg) yield
Control	4.51
Lime(CaCO3)	9.15
Inorganic fertilizer (NPK 15-15-15)	11.75
Mulching materials plant residue)	4.95
Poultry manure (poultry droppings)	10.68
FSLD (0.05)	0.56

(10.68 kg) followed by lime ($CaCO_3$) that produced (9.15 kg) and mulching materials that produced (4.95 kg) while control or zero application produced the least fresh weight yield of edible leaf of (4.51 kg). Mulching materials (plant residue) and control are statistically the same, even though that mulching produced highest fresh weight yield of edible leaf yield than the control but poultry manure, inorganic fertilizer and lime are different on fresh weight yield of the edible leaf of fluted pumpkin. The significant highest fresh yield by inorganic fertilizer is by the result of Adetunji et al. [12] that NPK fertilizer at the rate of 500 kg/ha promotes cell division and carbohydrate utilization which encourages vegetative yield of fluted pumpkin (*Telfairia occidentalis*).

4. CONCLUSIONS

The result of this research showed significant difference at (P=0.05) of different soil amendment practices on vine length, the average number of branches per plot, leaf area index and fresh weight yield of the edible leaf. Cultivated fluted pumpkin with inorganic fertilizer (NPK 1515-15) for edible leaf gave longer vine length, higher fresh weight yield, increased number of branches and higher leaf area index (LAI) than using lime (CaCO3) poultry dropping and mulching materials (plant residue) in the production of fluted pumpkin for marketable vegetable yield.

Production of the fluted pumpkin using inorganic fertilizer (NPK 15-15-15) as a soil amendment practice was preferable and also recommendable for leafy production as it gave optimum fresh weight yield of the edible leaf (marketable vegetable yield) of fluted pumpkin (*Telfairia occidentalis*).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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