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Enhancing Soil Fertility Status, Sweet Potato Yield and Tuber Nutrient Composition through Different Manure Sources in Southeastern Nigeria

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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ABSTRACT

The experiment was carried out to investigate the effects of different manure sources on selected soil chemical properties, sweet potato tuber yield and tuber nutrient compositions. The high yielding sweet potato varieties are fertilizer responsive. Research evidences indicated that the application of inorganic fertilizers increases root yield, but hampers the quality of sweet potato. Inorganic fertilizers are believed to contribute substantially to human and animal food intoxication and environmental and soil instability/degradation. Better sweet potato root quality was observed at optimum amount of nitrogen supply especially through organic sources. Furthermore, the more toxic nitrite is often associated with inorganic fertilizer application in the soil which usually associates in the human bodies with gastric cancer, to which infants are at a greater risk than adults, for several reasons. In this end, many researches have not being done in this case as to cube or reduce the health challenges associated with the consumption of agricultural toxic foods. The treatments were built into a randomized complete block design (RCBD), with 7 seven treatments replicated three times. The following treatments were used; poultry dropping, Neem leaf, Moringa leaf, Rice husk Dust, Rice Husk Ash, NKP fertilizer, and no soil amendment (control).

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The soil parameters studied include; soil pH, organic carbon, total nitrogen and cation exchange capacity, while the tuber nutrients analyzed for include; the ash, crude fat, vitamin C, moisture content, crude fibre, carbohydrate and crude protein. Results obtained showed significant differences among the treatments in all the parameters studied, except in tuber yield where all the treated plots yield same, but significantly increased the yield weight relative to the control. It was discovered that poultry dropping gave the greatest difference among other treatments in tuber yield. Generally, this study indicates that sweet potato production could be enhanced by the use of appropriate organic manure at suitable rate and at an appropriate time in the study area. It was also obtained that the soil pH and cation exchange capacity of the studied soils were highly improved mostly by the application of organic sources of the plant nutrients. The application of organic amendments significantly lowered the sweet potato tuber crude protein content, and increased the Vitamin C levels, thereby giving the organic sources of plant nutrients a credit as a safer way of producing food items that will give better human health safety.

Keywords: Sweet potato; organic amendments; Moringa oleifera; Azadirachta indica; soil amendments; nutrient composition.

1. INTRODUCTION

Sweet potato (*Ipomea batatas* L.) is the fifth most important food crops after rice, wheat, maize and cassava [1]. Sweet potato is a crop, which reliably provides food on marginal and degraded soils with little labour and few or no inputs from outside the farm. The crop is efficient in the production of carbohydrates, proteins, vitamins and cash income per unit of land and time [2]. In-spite that sweet potatoes are not usually regarded as protein source because of its low protein content, it provides 5.30% of daily energy requirement and contributes 3.40% of total protein intake compared with 4.6%, 4.8% and 5.8% contributed by eggs, fish and cheese, respectively [3].

Its nutritional content provides an enormous potential for preventing malnutrition and enhancing food security in the developing world. Sweet potato is regarded as an important crop because of it nutritional and industrial utilization. It has been receiving increasing attention because it grows on soils with limited fertility; it is drought tolerant and often cultivated without fertilizer or pesticides [4].

The maintenance of the nutritional status of tropical soil has not been adequate due to soil degradation cause by physical degradation, erosion, compaction and crusting associated with nutrient mining, acidification, loss of organic matter and deterioration of drainage conditions causing waterlodging and salinization [5]. Because of the fragile nature of tropical soils, especially soils of the study area, appropriate soil management is necessary for sustaining high soil and crop productivity. According to Zingore et al. [6], the soils are poor in organic matter and available nutrients; and hence productivity and sustainability decline over time. In addition, Owolabi et al. [7] submitted that most soils in Southern Nigeria are acidic due to the nature of parent material, heavy leaching and weathering. In addition to acidity, the soils suffer from nutrient deficiency.

Therefore, continuous cultivation of crop like sweet potato (*Ipomoea batatas* Lin) on the same land in the area will lead to soil nutrient exhaustion and low yield. Moreso, sweet potato like any other root tuber crops is a heavy feeder exploiting greater volume of soil for nutrient and water [8].

Thus, continuous cropping on these soils reduces organic matter during the first few years following land clearing [9,10]. Therefore external nutrient inputs are essential to improve and sustain crop production on these soils. Nutrient inputs may either be from organic source or Inorganic fertilizers [11].

Nyakatawa et al. [12] suggested that it is possible to increase yields of crops on physically degraded soils by using organic resources such as manure for soil fertility improvement after adopting appropriate tillage systems. It is well known that, potato plant has high nutrients requirement, especially N-fertilizers, largely due to its shallow root system and short growth duration.

Research evidences indicate that the application of inorganic fertilizers increases root yield [13] but hampers the quality of sweet potato [14]. Better sweet potato root quality was observed at optimum amount of nitrogen supply especially through organic sources [14]. Continuous cultivation of sweet potato (*Ipomoea batatas* Lin) on the same land will lead to soil nutrient exhaustion and low yield. Moreover, sweet potato like any other root tuber crops is a heavy feeder exploiting greater volume of soil for nutrient and water. Organic manuring of sweet potato improves soil health better than inorganic source [15].

Therefore, it is important to investigate root tuber quality and tuber yield performance as affected by nutrient sources from inorganic and organic fertilizer, hence the study aimed at determining the effect of different manure sources as soil amendments on selected soil chemical properties, tuber yield and nutrient composition of sweet potato tubers in Ishiagu.

2. MATERIALS AND METHODS

2.1 Site Description

The field study was conducted at research and teaching farm of Federal College of Agriculture, Ishiagu, Ebonyi State. The area lies between latitude 5° 55´ N and 6° 00´ N and longitudes 7° 30´ E and 7° 35´ E in the derived savanna zone of Southeastern Nigeria. The site was planted with a sweet potato variety (TIS 87/0087 (pink fleshed) that is resistant to sweet potato virus disease in 2014 cropping season. This variety was sourced from the National root crop research Institute (NRCRI) Umudike, Abia State, Nigeria.

The soil is a hydromorphic Ultisol and has been classified as Typic-Haplustult [16].The underlying geological material is shale with sand intrusions, locally classified as the Asu River group.

2.2 Field Study

The field was cleared and tilled manually with native hoe into seedbeds of 2 m x 3 m plot size and the sweet potato (TIS 87/0087 (pink fleshed) variety) was planted at a spacing of 30 cm x 100 cm. The experiment was laid out in a randomized complete block design (RCBD) with seven (7) treatments replicated three (3) times. The treatments were; poultry manure at 10 t/ha, NKP fertilizer at 300 kg/ha, Neem leaf (*Azadirachta indica*) at 10 t/ha, Moringa leaf (*Moringa oleifera*) at 5 t/ha, Rice husk dust at 10 t/ha, Rice husk ash at 5 t/ha and control (zero application) which were sourced within the College of Agriculture, Ishiagu, premises/Livestock unit and at the rice-mill centre. The fresh Neem and Moringa leaves were air-dried to a moisture content of about 30%, weighed and later crushed to powder before the application.

The poultry dropping was applied to the soil two weeks before planting, while the neem and moringa leaf materials were incorporated into the soil one week before planting because their fine textured particle sizes which will enhance early mineralization process. The NPK fertilizer was applied two weeks after the crop sprouting, while the ash was applied three days before planting as it mineralizes faster than those other amendments used.

2.3 Soil Sampling and Laboratory Techniques

At the beginning of the field trial, a composite auger sample from random points was collected at 0 – 20 cm depth. Another set of soil samples were collected at harvest from individual plots to determine changes that occurred due to treatments application. The soil samples were air-dried and sieved with 2 mm sieve. Soil fractions less than 2 mm from individual samples were then analyzed using the following methods; Particle size distribution of less than 2 mm fine earth fractions was measured by the hydrometer method as described by Gee and Bauder [17]. Soil pH was measured in a 1:2.5 (soil:0.1 M KCl) suspensions [18]. The soil OC was determined by the Walkley and Black method as described by Nelson and Sommers [19]. Total nitrogen was determined by semi-micro kjeldahl digestion method using sulphuric acid and $CuSO_4$ and Na_2SO_4 catalyst mixture [20]. The CEC was determined by the method described by Rhoades [21].

2.4 Sweet Potato Tuber Nutrients Determination

Three sweet potato tubers were randomly selected from each of the seven treatments in the three replicates. These gave rise to 63 tubers in all that were selected and taken to laboratory for the laboratory analysis.

2.4.1 Laboratory techniques

The determination of the tuber nutrients analysis were measured using the methods according to AOAC, 1995 and 2004.

2.4.1.1 Determination of Moisture content (MC)

The samples (Tubers) were weighed and cut into pieces and dried in an oven at 105℃ for 4hours. Cooled in a desiccator and reweighed until a constant weight was obtained [22].

$$\% \text{ MC} = \frac{\text{weight loss during drying}}{\text{Weight of sample}} \times \frac{100}{1}$$

2.4.1.2 Percentage Ash content

The dried sample from (MC%) above was returned to a muffle furnace and incinerates at 600℃ for 2 hours and then cooled in a desiccator [22].

$$\%\text{Ash} = \frac{\text{Weight of Ash}}{\text{Weight of sample}} \times \frac{100}{1}$$

2.4.1.3 Crude protein (CP) determination

2 g (grams) of the sample was mixed with 5 g of anhydrous sodium sulphate, copper sulphate selenium and 25 ml conc. H_2S0_4 all in a 500 ml Kjeldall flask on an electric coil heater in a fume chamber. Distillation was done with Markham distillation apparatus [22].

% crude protein =

$$0.00014 \times \text{Vol. of acid} \times \frac{250 \times 100 \times 6.25}{5 \times w}$$

Where W = weight (grams) of the sample digested.

2.4.1.4 Crude fibre determination

2.5 g of the sample was add to 200 ml of boiling H_2S0_4 and connected with digestion apparatus. The mixture was boiled for 30 minutes, filtered and washed with hot water, until free from acid. The residue was transferred into a flask with 200 ml boiling NaOH solution. The flask was connected to a digestion apparatus and boil for 30 minutes again, the content of the flask was filter through Gooch crucible, washed with hot water until free from alkali and then with 10 ml alcohol. It was then dried at 105℃ for 2 hrs, cooled in a dessicator and weighed. It was further incinerated in a furnace at 600℃ for 30 minutes, cooled in a dessicator and weighed [23].

$$\% \text{ crude fibre} = 100 \left(\frac{w_1 - w_2}{w}\right)$$

Where

w = weight of sample

W_1 = weight of crucible and content after drying (g)

W_2 = weight of crucible and Ash after incineration

2.4.1.5 Determination of fat (ether extract)

2 g of the sample was oven dried and put into a folded filter paper; and introduced into the thimble of the soxhlet extractor. Petroleum ether was used for fat extraction for a period of 4 hours at the condensation rate of 5 – 6 drops per seconds. The solvent was recovered leaving only the soil in the flask. The oil was then dried to constant weight [22].

$$\% \text{ crude fat} = \frac{\text{Weight of fat}}{\text{Weight of sample}} \times \frac{100}{1}$$

2.4.1.6 Determination of vitamin C

Vitamin C content was determined using 2, 6 - dichloroindophenoltitrimetric method [23].

2.4.1.7 Determination of CHO

This was done by spectrophotometric method.

The juice (0.5 ml) extracted from the samples were put into 100 ml volumetric flask and made up to the mark with pure distilled water, mixed thoroughly. 1 ml aliquot of the homogenate was put into 50 ml test tube and added to it was 1 ml of 5% phenol and 5 ml of conc. H_2SO_4. The solution was allowed to stand at room temperature until colour developed. A working standard of CHO were prepared in order of 0, 5, 10, 15, and 20 ppm and treated as the sample absorbance was measured at 490mm using spectrophotometer [23]. The reading of the standard were used to prepare a calibration graph.

% total CHO =

$$\frac{\text{Absorbance x slope reciprocate47.0 x 100}}{\text{sample w x 106.} \qquad 1}$$

2.5 Statistical Analysis

Data analysis was performed using **GENSTAT** 3 7.2 Edition. Significant treatment means was separated and compared using Least Significant

Difference (LSD) and all inferences were made at 5% Levels of probability.

3. RESULTS AND DISCUSSION

3.1 Initial Soil Properties of the Studied Site

The soil initial physical and chemical properties are presented in Table 1. It was obtained that the soils of the study site are sandy loam with 8% clay, 17% silt and 75% total sand contents. The pH value of the studied soil is 4.6, while the organic carbon and total nitrogen were; 5.7 g/kg, 0.60 g/kg, respectively. The cation exchange capacity was very low with a value of 6.8 cmol kg^{-1}.The low soil pH of the studied site could be related to high percentage of total sand in the area which might have increased the level of leaching of the basic elements from the soil, thereby increasing the exchangeable acidity.

Table 1. Some physical-chemical properties of the soil (0-20 cm) soil depth

Soil properties	Values
Clay %	8
Silt %	17
Fine sand %	45
Coarse sand %	30
Textural class	Sandy loam
pH (H_2O)	4.6
Organic carbon (g/kg)	5.7
Total nitrogen (g/kg)	0.6
Cation exchange capacity ($cmolkg^{-1}$)	6.8

3.2 Effect of Different Soil Amendments on the Selected Soil Chemical Properties

The results (Table 2) showed that the application of the amendments significant ($p < 0.05$) increased the soil pH (H_2O) higher than the unamended plots. The highest significant ($p < 0.05$) improvement on the soil pH (6.2) was recorded in plots treated with rice husk ash at 5 t/ha, followed by plots amended with poultry dropping, while the control plots gave the least pH values within the period.

The effect of soil amendments on the soil organic carbon was presented in Table 2. Soil organic carbon was significantly ($p < 0.05$) improved resulting from the application of the amendments, with plots treated with rice husk dust and neem leaf (7.57 g/kg and 7.57 g/kg), respectively, giving the highest significant values. The soil organic carbon values in this study varied from 3.10 g/kg to 7.57 g/kg with the least value obtained from the control plots. It was obtained that the plant residues used in the study improved the soil organic carbon pool significantly ($p < 0.05$) higher than the mineral fertilizer (NPK 12:12:12).

Table 2 revealed that there was significant ($p < 0.05$) difference among the treatments on the soil total nitrogen. Plots amended with neem leaf and poultry droppings (0.84 g/kg and 8.1 g/kg), respectively, significantly ($p < 0.05$) increased the soil total nitrogen higher when compared to other treated plots. The results also revealed that all the amended plots significantly ($p < 0.05$) increased the total nitrogen relative to the control.

The results (Table 2) indicated that the application of amendments significantly ($p < 0.05$) improved the cation exchange capacity except in plots treated with NPK fertilizer and rice husk ash, within the period of study. It was observed that rice husk dust amended plots increased the CEC significantly ($p < 0.05$) higher than other amended plots. This was followed by plots treated with poultry dropping, while the control recorded the least CEC value. The result is in line with the submissions that organic manuring of sweet potato improves soil health better than inorganic source [15]. The values ranged from 6.33 $cmolkg^{-1}$ to 11.63 $cmolkg^{-1}$. Generally, plots amended with rice husk ash and NPK mineral fertilizer, did not significantly ($p < 0.05$) increase the cation exchange capacity over the control, even though their values were higher than the values obtained from the control.

The sweet potato yield tuber was significantly ($p < 0.05$) improved by the application of the treatments within the period. Table 2 showed that the highest significant ($p < 0.05$) increased tuber yield weight (7.50 t/ha) was recorded from plots treated with poultry dropping. This agrees with the submissions of Nyakatawa et al. [12] who suggested that it is possible to increase yields of crops on physically degraded soils by using organic resources such as manure for soil fertility improvement after adopting appropriate tillage systems. It was obtained that among the amended plots, except the poultry dropping (7.50 t/ha) and neem leaf (5.63 t/ha), all other treated plots significantly ($p < 0.05$) increased the yield tuber weight in the same way (Table 2).

3.3 Effect of Different Soil Amendments on the Nutrient Composition (Ash, Crude Fat and Vitamin C) of Sweet Potato Tuber

The effect of the soil amendments on the sweet potato tuber ash, crude fat and Vitamin C were presented in Table 3. Plots treated with moringa leaf produced tubers that showed the highest significant improvement on the ash percent (1.5133%) within the period of study. This was followed by plots amended with rice husk ash (1.800%). The values ranged from 1.4333 - 1.5133, with the least ash percent recorded from tubers in the control plots. This implies that all the amended plots significantly ($p < 0.05$) improved the ash content of the sweet potato ash higher compared to the ash content of tubers from the control plots. This result is in agreement with the submissions of Bohm et al. [24], which reported that percentage of ash, potassium, crude protein in tubers increased with fertilizer application. On the other hand, the results indicated that plots treated with organic materials produced tubers that contain higher ash content when compared to tubers produced with the application of NPK mineral fertilizer.

Table 3 showed that the highest significant ($p <0.05$) improvement on the sweet potato fat percent (0.53667%) within period of study was produced from plots with rice husk dust. The low fats values obtained from the moringa, neem leaves and rice husk ash treated plots (0.51000, 0.51000, and 0.51667%) could be a good attribute of these amendments as excess fats in human diet is not nutritional safe/healthy to human. The result agrees with the submissions of Lichtenstein et al. [25] that eating too much saturated fat is one of the major risk factors for heart disease. A diet high in saturated fat causes a soft, waxy substance called cholesterol to build up in the arteries. Too much fat also increases the risk of heart disease because of its high calorie content, which increases the chance of becoming obese (another risk factor for heart disease and some types of cancer). In his submission, Kareem [26] stated that ether extract highest percentage in sweet potato was had from inorganic fertilizer treated plots, followed by the control plots while the least percentage was from organic and organo-mineral fertilizer treated plots.

It was obtained that Vitamin C was influenced differently in tubers produced from different manure applications within period of study. The results indicated that plots treated with plant leaves materials (neem and moringa leaves) produced sweet potato tubers that significantly ($p < 0.05$) increased the Vitamin C (16.6.867% and 16.900%) accumulation in the sweet potato tubers. Generally, the results revealed that organically amended plots produced sweet potato tuber have higher Vitamin C accumulation than NPK mineral fertilizer amended plots. Kareem [26], in a similar work reported that Vitamin A production was highest in the organo-mineral fertilizer plots while the least was from inorganic fertilizer treated plots. In line with this, it has become a widespread belief that organic farming improves the state of the environment, the health of people and increases the quality of food products [27,28]. The assertion that organic agriculture produces healthy food is based on higher concentrations of beneficial secondary plant substances in organically grown crops compared to non- organically grown ones [29].

Table 2. Effect of different soil amendments on soil pH, organic carbon, total nitrogen, cation exchange capacity and tuber weight yield in the studied site

Soil amendments	Soil pH	Organic carbon (g/kg)	Total nitrogen (g/kg)	CEC (cmol/kg)	Tuber weight yield (t/ha)
NPK @ 300 kg/ha	5.5	3.77	0.68	7.13	6.97
Poultry dropping @ 10 t/ha	5.6	5.17	0.81	10.67	7.50
Rice husk dust @ 10 t/ha	5.2	7.57	0.71	11.63	6.77
Rice husk ash @ 5 t/ha	6.2	3.53	0.65	7.13	6.97
Moringa leaf @ 5 t/ha	5.5	5.47	0.63	8.97	6.90
Neem leaf @ 10 t/ha	5.6	7.57	0.84	8.87	5.63
Control (Zero application)	4.7	3.10	0.44	6.33	3.10
Mean	**5.5**	**5.17**	**0.68**	**8.68**	**6.26**
LSD 0.05	**0.4297**	**1.206**	**0.1745**	**1.937**	**2.414**
F- probability	<.001	<.001	0.006	<.001	0.026

Table 3. Effect of different soil amendments on nutrients composition (Ash, crude fats and Vitamin C)

Soil amendments	Ash (%)	Fats (%)	Vitamin C
NPK @ 300 kg/ha	1.4533	0.52667	16.300
Poultry dropping @ 10 t/ha	1.4733	0.52667	16.700
Rice husk dust @ 10 t/ha	1.4667	0.53667	16.667
Rice husk ash @ 5 t/ha	1.4800	0.51667	16.400
Moringa leaf @ 5 t/ha	1.5133	0.51000	16.900
Neem leaf @ 10 t/ha	1.4700	0.51000	16.867
Control (Zero application)	1.4333	0.52333	15.780
Mean	**1.4700**	**0.52143**	**16.516**
LSD 0.05	**0.01729**	**0.005930**	**0.2444**
F- probability	<.001	<.001	<.001

3.4 Effect of Different Soil Amendment on Sweet Potato Tuber Moisture Content, Crude Fibre, Carbohydrate and Crude Protein

Results (Table 4) showed that the carbohydrate accumulation was high significantly ($p < 0.05$) improved in tubers produced from moringa leaf amended plots, followed by plots treated with neem leaf within the period. The results indicated that except the moringa leaf treated plots; other amended plots did not significant improved carbohydrate accumulation on sweet potato tubers higher than the control. The values ranged from 68.10%-69.78%. These range values agreed with the report of Woolfe, [3] that sweet potato tuber provides significant amount of protein, vitamin, carbohydrate and iron.

The results (Table 4) indicated that inorganically amended plots significantly increased protein levels in the sweet potato tuber compared organic to treated soils. This result could be attributed to the higher soil total nitrogen released into the soil by NPK fertilizer as reported in Table 2, as nitrogen is a major component of protein in plant materials. It was also observed that the highest significant improvement on the protein percent of the tubers was obtained from plots treat with NPK 12:12:12, followed by plots treated with poultry dropping, while the least value was obtained from plots with no amendments. Nevertheless, there are reasonably consistent findings that show lower nitrate concentration in organic amended vegetable crops [30,31]. Low nitrate content in the edible part of the plants is very important for human health, due to its potential transformation to nitrates, which have the highest possibility to interact with hemoglobin and affect blood oxygen transportation [32].

The results indicated that all the treated plots significantly increased protein contents of the sweet potato tubers relative to the control. The low values of protein obtained in this experiment as against protein values in some other crops is in line with Woolfe, [3] submission that sweet potatoes are not regarded as protein source because of low protein it contains, but it contributes 3.4% of total protein intake compared with 5.5% and 5.8% contributed, respectively, by eggs, fish and cheese. Protein is an essential compound in food, where its concentration in plants is highly dependent on N availability in soil at sowing time, N released during the growing seasons through mineralization of soil organic matter and N applied as organic or inorganic fertilizer [33].

The promoting effect of organic compost in increasing protein content could be interpreted in a way, that the use of chemical fertilizers alone to sustain high crop yield has not been successful due to enhancement of soil acidity, nutrient leaching and degradation of soil physical and organic matter status [34,35], which in turn decreased N uptake and led to finally to reduce total protein.

The crude fribre showed that neem leaf had the highest significant ($p < 0.05$) improvement on the crude fibre content of the tubers, followed by moringa leaf, while the lowest value was obtained from control plots (Table 4). The results (Table 4) showed that all the amended plots significantly increased the crude fibre higher than the control. The values varied from 0.637% - 0.693% (control plots to neem leaf treated plots), respectively.

In the moisture content (MC) of the sweet potato tubers, the results (Table 4) observed that moringa leaf amended plots produced sweet potato tubers with the highest significant improvement on the parameter, followed by rice husk ash, while the lowest value was obtained from the control plot with a value of 34.143%. The values varied from 34.143-36.113%. All the organically amended plots produced tubers with high significant accumulation of moisture content compared to the moisture content of the sweet potato tubers harvested from the NPK fertilizer treated plots.

3.5 The Relationship between Soil Properties and the Tuber Nutrient Composition

Figs. 1a to 1b showed the relationship between soil total nitrogen and sweet potato tuber crude protein and vitamin C contents at harvest. It was obtained that soil total nitrogen correlated positively with the tuber protein content and vitamin C level. It was revealed that a stronger correlation was observed in the relationship between the soil total nitrogen and vitamin C than its relationship with crude protein (Fig. 1b) as the R^2 was 0.4401 as against 0.1859 obtained in Fig. 1a. The correlation between soil total nitrogen and crude protein conforms to the submission of Wang et al. [33], that protein concentration in plants is highly dependent on N availability in soil at sowing time, N released during the growing seasons through mineralization of soil organic matter and N applied as organic or inorganic fertilizer.

Figs. 2a to 2b showed the relationship between the carbohydrate and crude fibre content of the sweet potato tuber with the soil organic carbon. The results showed that even though the correlations of the tuber crude fibre and carbohydrate with the soil organic carbon is positive, the relationship is poor and weak. This implied the soil organic carbon does not have much positive effect on the sweet potato tuber carbohydrate content and that of crude fibre.

Table 4. Effect of different soil amendments on nutrients composition (moisture content, crude fibre, carbohydrate and crude protein)

Soil amendments	Moisture content (%)	Crude fibre (%)	Carbohydrate (%)	Protein (%)
NPK @ 300 kg/ha	34.220	0.667	68.480	1.4767
Poultry dropping @ 10 t/ha	35.283	0.670	68.480	1.4667
Rice husk dust @ 10 t/ha	35.197	0.667	68.470	1.4267
Rice husk ash @ 5 t/ha	35.777	0.650	68.443	1.4567
Moringa leaf @ 5 t/ha	36.113	0.693	68.537	1.4367
Neem leaf @ 10 t/ha	34.707	0.677	69.780	1.4467
Control (Zero application)	34.143	0.637	68.103	1.3800
Mean	**35.063**	**0.666**	**68.613**	**1.4414**
LSD 0.05	**0.1952**	**0.01915**	**0.5026**	**0.01553**
F- probability	<.001	<.001	<.001	<.001

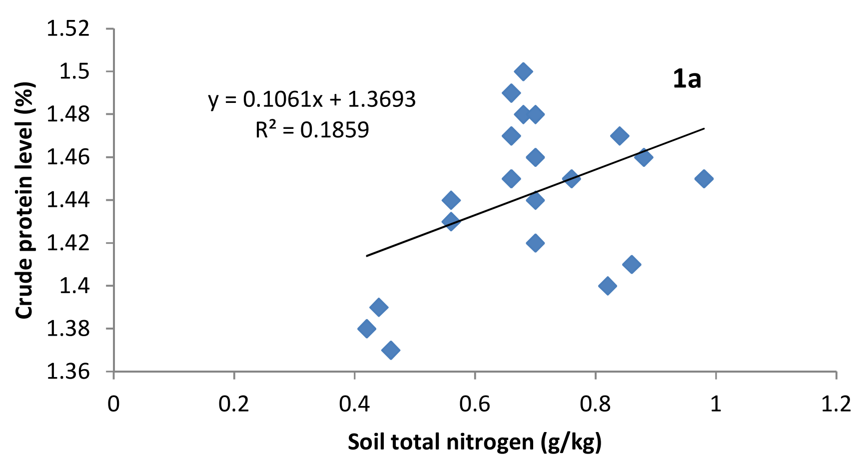

Fig. 1a. Relationship between soil total nitrogen and crude protein content of the sweet potato tuber

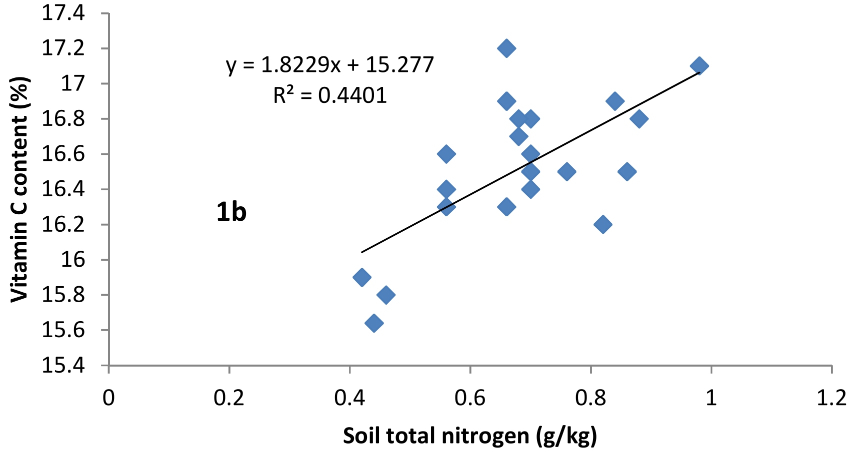

Fig. 1b. Relationship between soil total nitrogen and Vitamin C level of the sweet potato tuber

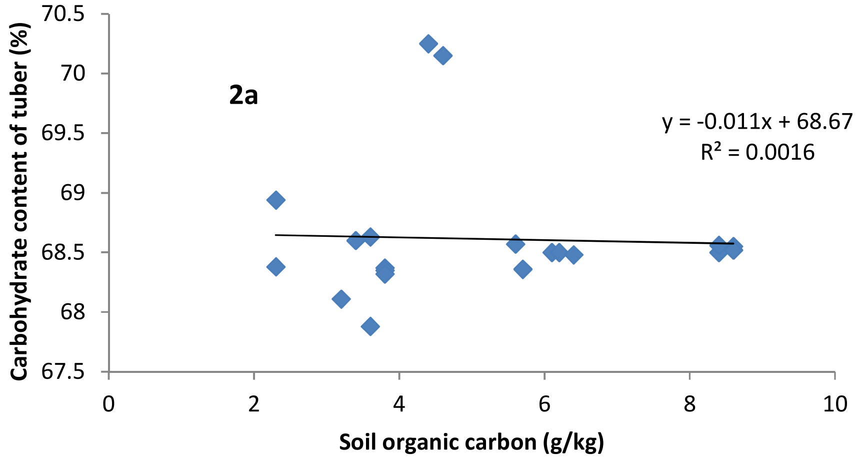

Fig. 2a. Relationship between soil organic carbon and carbohydrate content of the sweet potato tuber

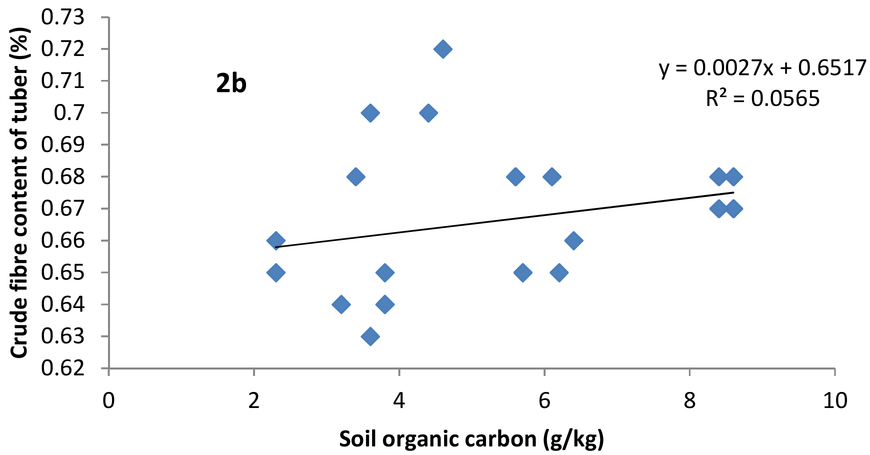

Fig. 2b. Relationship between soil organic carbon and crude fibre content of the sweet potato tuber

4. CONCLUSION

The results of the field trial showed that application of organic amendments significantly improved the soil chemical properties studied, especially the soil pH and cation exchange capacity, higher than the mineral fertilizer (NPK 12:12:12). It was also revealed that poultry dropping gave overall best tuber yield increase among the amendments studied. The results generally showed that amendments of the soil did significantly improve the studied soils chemical properties higher than unamended soils.

It was obtained that organically amended soils significantly produced quality sweet potato tubers that will be safer for human consumption, especially the adults. The results equally revealed that soil total nitrogen has positive relationship with the sweet potato tuber crude protein and Vitamin C content.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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