



RESIDUAL EFFECTS OF POULTRY MANURE ON YIELD, QUALITY PARAMETERS OF CARROT AND SELECTED SOIL CHEMICAL PROPERTIES ON ALFISOL IN SOUTHWEST, NIGERIA

Adeleye, A. A., Ayeni, L. S. and Adeleye, E. O.

Department of Agricultural Science Education, Adeyemi Federal University of Education, Ondo

Corresponding Author's Email: biodunadeleye134@gmail.com

ABSTRACT

Maintenance and management of soil fertility are central to the development of a sustainable food production system. Field experiments were conducted to evaluate the potential of poultry manure (PM) in enhancing growth, root yield, nutritional quality of carrot, and soil nutrients in the rainforest agroecology of southwest Nigeria. Poultry manure at three rates (0, 5, and 10 t ha⁻¹) were investigated in a randomized complete block design, each rate of PM was replicated three times. Data collected were subjected to analysis of variance using Statistical Analysis System Institute Package. The results showed that the experimental soil was acidic (pH 5.5), and low in nitrogen (0.1 g kg⁻¹). Relative to the control, PM significantly ($P < 0.05$) influenced growth, root yield, nutritional quality of carrot, and soil major nutrients. There were no significant differences ($P > 0.05$) in the effect of 5 t ha⁻¹ and 10 t ha⁻¹ PM on gross root yield and marketable root yield of carrots. Poultry manure at 10 t ha⁻¹ produced the highest root yield parameters, and also, had the highest residual effects on soil nitrogen, available P and organic carbon. The use of 10 t ha⁻¹ PM is recommended for carrot production in the rainforest agroecology of southwest Nigeria. This rate of PM enhanced the best carrot performance and soil quality in the present study.

Keywords: Poultry, Manure, Yield, Soil, Nutrients, Residual

INTRODUCTION

Carrot is one of the most essential root vegetable cultivated worldwide. Carrot ranks among the 10 top vegetable crops that play a major role in human nutrition because of its high dietary fibre (Dawid *et al.*, 2015). Carrot contains abundant nutrients such as protein, carbohydrates and minerals. It is recognized as an important source of natural antioxidants and carotene (Surbi *et al.*, 2018; Tanveer *et al.*, 2019). Carrot grows well in high nutrients status and less acidic soil, a pH of 6.5-7.0 is reported to be ideal for high carrot production (Alice *et al.*, 2014). Nitrogen, phosphorus and potassium are the major limiting nutrients relating to the growth, development and yield of carrot (Appiah *et al.*, 2017). In Nigeria, carrot root yield is reported to be low due to low soil nutrients status and scarcity of high yielding varieties (Ahmed *et al.*, 2014). Carrots respond well to both organic and inorganic fertilizer; but the rate depends on the nutrients status of the soil (Ahmed *et al.*, 2014). Maintenance and management of soil fertility are central to the development of a sustainable food production system. Achieving food security in Nigeria is an on going goal for farmers. In pursuit of this goal, farmers are encouraged to adopt cultivation methods that are sustainable while also meeting the demand for food. In Nigeria, it has been established that sustainable crop production is not feasible with dependence on chemical fertilizer alone. High input of nutrients from inorganic fertilizer in a continuous cropping situation has been reported to pose an environmental burden and enhance the toxic bio availability of nutrients to living beings (Rahman *et al.*, 2018). There is an increasing interest in the organic cultivation of root vegetables like carrot. Vegetables produced in soils where organic substrates are incorporated are gaining importance because of less chemical residues and better taste of organically grown vegetables (Ditleversen, *et al.*, 2019). The management of soil through organic sources of nutrients to promote soil health, better crop yield and nutritional quality has achieved a great deal of interest on a global level.

Research information abounds in the literature about the use of poultry manure as a source of nutrients in some other arable crops production in Nigeria, however, research information on the use of poultry manure in carrot production in southwest, Nigeria is scanty. Research trials have indicated increased yield of carrot in other part of the world (Gatsinzi *et al.*, 2016). Poultry manure provides appreciable quantities of all essential nutrients to the soil which enhanced high crop yield (Bai *et al.*,



2018; Scharma *et al.*, 2018). Carrot is becoming more popular due to their abundant nutrients and benefits for human health (Gatsinzi, *et al.*, 2016). Considering the advantages of carrot production, its increasing appeal for human consumption in Nigeria since the advent of Covid-19 pandemic, and its less availability in southwest Nigeria, it has become apparent that research interest is focused on carrot production in southwest Nigeria. This study aimed at evaluating the potential of poultry manure in the enhancement of growth, root yield, nutritional quality parameters of carrot and some selected soil chemical properties in the rainforest agroecology of southwest Nigeria.

MATERIALS AND METHODS

Description of the Experimental Site

The study was carried out at the Teaching and Research Farm of Adekunle Federal University of Education, Ondo (Latitude 07° 04'N, Longitude 04° 49' E) in the rainforest zone of southwest Nigeria during 2019 and 2020 cropping seasons. The soil at the site is sandy in texture and moderately acidic pH 5.7, classified as oxic Tropudalf (Alfisol) derived from quart, gneiss and schist. The geology of the site is dominated by crystalline rocks, which forms part of the basement complex rock of southwest Nigeria (Hapstead, 1974). The terrain of the site is gently slopy. The site has been previously cultivated to maize and cassava and the site has been left fallow for two years prior to the field experiment and the fallow vegetation comprises sian weed, sunflower and goat weed.

Treatment and Experimental Design

The treatment is made of poultry manure at three levels, 0, 5, and 10 t ha⁻¹ arranged in Randomized Complete Block Design (RCBD). A total land area of 10 m x 10 m was marked out for the experiment and divided into three (3) blocks. Each block was further divided into three (3) plots of 3 m x 3 m. Each plot was demarcated by 0.5 m pathways. Each poultry manure level was replicated three (3) times. A total of nine (9) plots were maintained at each planting season. The plots were made into nine (9) raised beds of 3 m x 3 m with traditional hoe. Dried and well cured poultry manure was uniformly spread on the plots at the assigned rates and incorporated into the soil with a local hand-hoe a week after land preparation. Carrot seeds (Thema variety) were sown directly to the prepared bed a week after poultry manure application by drilling in rows spaced at 20 cm apart and later thinned three (3) weeks after the emergence of carrot seedlings to attain spacing of 20 cm apart. Weeding was carried out at 3 weeks interval by hand pulling of the weeds. At the second cropping season, the same plots were used, no poultry manure treatment was applied in order to estimate the residual affects of the poultry manure on carrot performance and soil major nutrients.

Growth Parameters

Fifteen (15) carrot stands were tagged per plot for the measurement of growth parameters. Leaf length, number of leaves, and plant height were measured at 40, 60 and 80 days after sowing of carrot seeds. Plant height was measured using a meter rule from the ground level to the top of the shoot. Leaf length was measured using a meter rule, while the leaves were counted.

Yield Parameters

Root yield parameters such as fresh root weight, root diameter, root length and malformed roots were taken at harvest on treatment basis using 10 stands of carrot per replicate. Malformed roots (rotten, cracked, and forked roots) were counted separately on treatment basis and the percentage was calculated from the number of total harvested roots. Root dry weight was determined by oven drying roots to a constant weight at 65°C. Percent dry matter was calculated as:

$$\% \text{ Dry Matter} = \frac{\text{Dry Weight of Root}}{\text{Fresh weight of root}} \times 100$$

Marketable root yield was determined by counting roots with no deformities in relation to the total number of roots harvested per treatment.

Proximate Analysis of Carrot Root

At harvest, samples of fresh carrot roots on a treatment basis were selected and washed in tap water for proximate analysis. Crude fibre, crude protein, crude fat, ash and moisture content were evaluated in accordance with the procedures of the Association of Official Analytical Chemists (AOAC, 2000).



Soil Analysis

Five core surface samples (0-15 cm) were collected randomly from the experimental field using a soil auger before the application of the treatments, bulked, air-dried, and passed through a 2 mm-sieve for routine chemical analysis of the initial soil particle distribution and some soil chemical properties. Also, another set of surface (0-15 cm) soil samples were collected on a treatment and replicate basis at harvest and processed for chemical analysis of the post-harvest selected soil chemical properties. Soil pH was determined at a 1:2.5 soil-water ratio using a glass electrode pH meter, and total nitrogen by the Kjeldahl digestion method (Bremner, 1996). The particle size distribution was done using the hydrometer method (Gee and Or, 2002). Organic carbon was determined following the procedure of Walkley and Black using the dichromate wet oxidation method (Nelson and Sommers, 1999). Available P was extracted by Bray-1-method and P in the extract was determined colourimetrically (Frank *et al.*, 1998). Exchangeable Ca, K, Mg and Na were extracted with 1.0 N NH_4OAc (Ammonium acetate). The K and Na in the extract were read using a flame photometer. While Ca and Mg were read using an Atomic Absorption Spectrophotometer (AAS) (Hendershot *et al.*, 2008). Exchangeable acidity was determined from 1.0N KCl extract and titrated with 0.1 N HCl (Maclean, 1982). ECEC was by Summation of 1.0N NH_4OAc extractable bases plus 1.0 N KCl extractable acidity. Percent base saturation was obtained by dividing the total exchangeable base (TEB) by the cation exchange capacity (CEC) and multiply by 100.

Data Analysis

Data on the measured growth, yield, nutritional quality variables, and soil major nutrients were subjected to analysis of variance using the Statistical Analysis System Institute Package- General Linear Model (SAS, 2002). Means were compared using Duncan's Multiple Range Test at a 5% level of significance.

RESULTS

Table 1 shows some physical and chemical properties of the experimental soil before the treatments application. The soil was acidic (pH 5.5), low in nitrogen (0.1 g kg^{-1}), low in available P (8.0 mg kg^{-1}), organic carbon (9.2 g kg^{-1}), and sandy in texture. The micro nutrients (Mn, Fe, Cu and Zn) were high and exchangeable bases (K, Mg, Ca and Na) were low. The effect of poultry manure (PM) on growth parameters of carrot is presented in Table 42. Poultry manure significantly ($P < 0.05$) influenced plant height, leaf length, and shoot dry matter. Effect of PM on the number of leaves was not significantly different ($P > 0.05$). The best growth parameters in terms of plant height, leaf length, and shoot dry matter were obtained with 10 t ha^{-1} PM, while the poorest growth parameters in terms of plant height, leaf length, and shoot dry matter were obtained in the control plots. The effect of 5 t ha^{-1} and 10 t ha^{-1} PM on plant height leaf, length and shoot dry matter were not significantly different ($P > 0.05$) at both cropping seasons. In the second cropping season, there were slight improvements in the plant height, leaf length, and shoot dry matter in poultry manured plots, while reductions in growth parameters were obtained in the control plots.

Table 1: Initial Soil Physical and Chemical Properties of the Experimental Site

	Value
Sand (g kg ⁻¹)	943
Silt (g kg ⁻¹)	15
Clay (g kg ⁻¹)	42
Textural Class	Sandy Soil
Organic carbon (g kg ⁻¹)	9.2
pH (H ₂ O) (1:2.5)	5.5
Total nitrogen (g kg ⁻¹)	0.1
Available P (mg kg ⁻¹)	8.0
Ca (cmol kg ⁻¹)	1.7
Mg (cmol kg ⁻¹)	0.3
Na (cmol kg ⁻¹)	0.4
K (cmol kg ⁻¹)	0.2
Exch. Ac. (cmol kg ⁻¹)	0.1
ECEC (cmol kg ⁻¹)	2.8
B. Sat (%)	96
Mn (mg kg ⁻¹)	18
Fe (mg kg ⁻¹)	27
Cu (mg kg ⁻¹)	3.0
Zn (mg kg ⁻¹)	4.0

Exch. Ac = Exchangeable acidity, ECEC – Effective cation exchange capacity, B.Sat = Base saturation.

Table 2: Effect of Poultry Manure on Growth Characteristics of Carrot

Treatment (t ha ⁻¹)	Plant height (cm)		Leaf length (cm)		Number of leaf		Shoot dry Matter (%)	
	2019	2020	2019	2020	2019	2020	2019	2020
P ₀	44.3b	38.4b	28.9b	25.4b	7.2a	7.4a	7.1b	8.1b
P ₅	45.5b	46.4a	36.1a	36.7a	7.5a	7.7a	9.1a	8.8a
P ₁₀	52.6a	53.1a	36.8a	37.2a	7.8a	7.8a	10.2a	9.3a
SE _±	0.92	0.88	0.47	0.49	0.17	0.17	0.38	0.42

Means with same letter in a column are not significantly different ($P > 0.05$).

P₀ = 0 t ha⁻¹PM, P₅ = 5 t ha⁻¹ PM, P₁₀ = 10 t ha⁻¹ PM, Trt= Treatment.

Table 3 shows the influence of poultry manure on root yield characteristics of carrot. Relative to control, PM significantly ($P < 0.05$) influenced root length, root diameter, gross root yield, root dry matter, and per cent deformed roots. Poultry manure at 10 t ha⁻¹ had the highest root length, marketable root yield, and per cent deformed roots, in contrast, which was significantly higher than that of the control plots with the lowest root yield parameters. There were no significant ($P > 0.05$) differences in gross root yield and marketable root yield in plots amended with 5 t ha⁻¹ PM and plots amended with 10 t ha⁻¹ PM. The mean gross root yield for the two cropping seasons for 0, 5, and 10 t ha⁻¹ PM were 16.9, 19.85, and 22.62 t ha⁻¹ respectively.



Table 3: Effect of Poultry Manure on Root Yield Characteristics of Carrot

Trt (t ha ⁻¹)	Root Length (cm)		Root Diameter (cm)		Root Dry Matter (%)		Gross Root Yield (t ha ⁻¹)		Deformed Roots (%)		Marketable Yield (t ha ⁻¹)	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
P ₀	9.91c	9.12b	1.60b	1.48b	8.92b	8.21b	18.4b	15.46b	2.50b	1.55b	17.94b	15.22a
P ₅	10.97a	11.18a	1.74a	1.78a	10.31a	10.61a	19.21a	20.50a	3.48a	2.19a	18.32b	18.78b
P ₁₀	12.60a	12.98a	1.84a	1.90a	10.59a	10.62a	22.42a	22.85a	2.74a	1.72b	21.79a	22.1a
SE _±	0.35	0.36	0.04	0.06	0.36	0.37	1.46	1.48	0.19	0.22	1.42	1.38

Means with the same letter in a column are not significantly different ($P > 0.05$).

P₀ = 0 t ha⁻¹PM, P₅ = 5 t ha⁻¹ PM, P₁₀ = 10 t ha⁻¹ PM, Trt = Treatment.

Table 4: Effect of Poultry Manure on Proximate Composition of Carrot Root

Trt (t ha ⁻¹)	Protein		Fat		Fibre		Ash		Moisture		Dry Matter		NFE	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
P ₀	0.51c	0.47c	0.31b	0.28	1.65b	1.47a	0.65c	0.58b	87.00a	89.91a	10.57b	10.05b	9.92a	8.28a
P ₅	0.68b	0.54b	0.43a	0.34	1.72a	1.42a	0.78b	0.64a	87.84a	89.21a	12.10a	10.52a	9.07b	7.84b
P ₁₀	0.71a	0.59a	0.42a	0.35	1.41c	1.35b	0.82a	0.67a	87.78a	89.03a	12.31a	10.55a	8.72b	8.02b
SE _±	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.14	0.12	0.09	0.09	0.16	0.12

Mean with the same letter in column are not significantly different ($P > 0.05$).

P₀ = 0 t ha⁻¹PM, P₅ = 5 t ha⁻¹ PM, P₁₀ = 10 t ha⁻¹ PM, Trt = Treatment, NFE = Nitrogen Free Extract.



The effect of poultry manure on the proximate composition of carrot roots is presented in Table 4. The poultry manure significantly ($P < 0.05$) influenced the proximate composition of carrot roots in terms of protein, fat, fibre, ash, dry matter, and nitrogen free extract (NFE). Protein, fat, ash, and dry matter content of carrot roots increased with increasing rates of PM, while fibre, and NFE content decreased with increasing rate of PM. The influence of 5 t ha^{-1} PM on the protein, fat, fibre, ash, and dry matter contents of carrot were not significantly ($P > 0.05$) different from that of 10 t ha^{-1} PM. Carrot roots in the control plots had the least protein, fat, ash, and dry matter but had the highest fibre and NFE, while 10 t ha^{-1} PM plots had carrot roots with the highest protein, fat, ash, and dry matter. In the second cropping season, there were reductions in the content of protein, fat, fibre, ash, and NFE of carrot roots.

Table 5 shows the effect of poultry manure on selected soil chemical properties at the end of the first cropping season. Relative to the control plots, PM significantly ($P < 0.05$) influenced soil pH, total organic carbon, total N, available P. There were no significant differences ($P > 0.05$) in the effect of 5 t ha^{-1} PM and 10 t ha^{-1} PM on soil exchangeable cations (Mg, Ca, and K), exchangeable acidity, and total N. Poultry manure at 10 t ha^{-1} had the highest soil pH, exchangeable cations, ECEC, total N, organic carbon, and available P. Control plots had the least soil pH, organic carbon, total N, and available P. The residual effects of poultry manure on some selected soil chemical properties is presented in Table 6. There were increases in soil pH, total organic carbon, available P, exchangeable cations (Ca, Mg and K) when compared with their corresponding values in the first cropping season. Highest rate of PM (10 t ha^{-1}) consistently had the highest soil pH, exchangeable cations, ECEC, organic carbon, total N, and available P.

Table 5: Effect of Poultry Manure on the selected Soil Chemical Properties in 2019 Cropping Season

Trt (t ha^{-1})	pH	Ca	Mg	K	Na	Ex. Ac	ECEC	Total N	Total Org C. (%)	Avail P.
		Cmol kg^{-1}								
P ₀	5.57c	3.04b	1.69b	0.47b	0.41a	0.11a	5.72c	0.13b	1.68c	16.91c
P ₅	5.90b	3.65a	1.77a	0.56a	0.38b	0.09b	6.45b	0.15a	1.89b	23.32b
P ₁₀	6.27a	3.93a	1.80a	0.62a	0.39b	0.08b	6.82a	0.15a	2.09a	27.71a
SE \pm	0.07	0.11	0.03	0.03	0.06	0.002	0.11	0.04	0.05	0.06

Mean with the same letter in column are not significantly different ($P > 0.05$).

P₀ = 0 t ha^{-1} PM, P₅ = 5 t ha^{-1} PM, P₁₀ = 10 t ha^{-1} PM.

Trt = Treatment, Ex.Ac = Exchangeable acidity, ECEC = Effective cation exchange capacity, Total org C – Total organic carbon, Avail P = Available P, Total N = Total nitrogen.

Table 6: Effect of Poultry Manure on the selected Soil Chemical Properties in 2020 Cropping Season

Trt (t ha^{-1})	pH	Ca	Mg	K	Na	Ex. Ac	ECEC	Total N	Total Org C. (%)	Avail P.
		Cmol kg^{-1}								
P ₀	5.69b	3.29b	1.72b	0.48b	0.41a	0.10a	6.00b	0.10b	1.62b	15.12c
P ₅	5.97b	3.61a	1.82a	0.58a	0.41a	0.10a	6.52a	0.12a	1.92a	24.65b
P ₁₀	6.44a	3.97a	1.87a	0.63a	0.40a	0.08b	6.95a	0.13a	2.13a	28.51a
SE \pm	0.16	0.15	0.05	0.03	0.01	0.03	0.20	0.03	0.08	1.22

Mean with the same letter in column are not significantly different ($P > 0.05$).

P₀ = 0 t ha^{-1} PM, P₅ = 5 t ha^{-1} PM, P₁₀ = 10 t ha^{-1} PM.

Trt = Treatment, Ex.Ac = Exchangeable acidity, ECEC = Effective cation exchange capacity, Total org C – Total organic carbon, Avail P = Available P, Total N = Total nitrogen.

DISCUSSION

The soil at the site of the field experiment has a sandy texture with high proportion of sand particles. Soils of this nature are characterized by low water and nutrients holding capacities. The acidic nature of the soil at the site of the experiment might be attributed to the coarse nature of the soil, which



should have encouraged the leaching of the exchangeable bases. The soil is deficient in N, P, K, Ca, Mg and organic carbon on the basis of the established critical level of nutrients for arable crops by Aduayi *et al* (2002). Therefore, a supplementary supply of nutrients from external sources is needed for optimum carrot performance on the experimental soil.

Carrot growth parameters responded positively to PM application. The positive response of carrot growth to PM could be attributed to high nutrients supplies to the soil on partial or complete mineralization of the poultry manure. The result obtained conforms with the result obtained by Alice *et al.* (2014) that organic manure had a significant influence on the growth parameters of carrot. Reductions in growth parameters of carrot in the control plots and the increases obtained in plots amended with PM in the second cropping season could be attributed to the residual effect of the poultry manure. This view is inline with the views of Amusan *et al.* (2011), and Chandha (2013) that organic manures have the capacity that can elicit crop growth responses over time. In addition, organic manures have been shown to release nutrient elements to the soil and improve other soil chemical and physical properties which could enhance crop growth and development (Akanbi *et al.*, 2014; Iradhatullah *et al.*, 2018).

The increased root yield of carrot obtained in poultry manured plots might probably due to the nutrients released to the soil by the manure and the low initial nutrients status of the experimental soils. In support of this view, Khairul *et al.* (2015) noted that crops response more to fertilizer application in soils with very low nutrients content than soils of high nutrients reserve. The improved root yield obtained in the second cropping season in plots previously amended with PM in the first cropping season implies that PM is not effective in enhancing high carrot root yield on immediate basis but rather effective in improving carrot root yield and soil productivity on a long term basis or that it has a high residual effect. These observations aligned with the slow nutrients release from the PM to the soil for crop uptake. These findings conform with the results reported by Zhang *et al.* (2016), and Rahman *et al.* (2018) that fertilizer efficiency of organic manures extend beyond the year of application. The higher malformed roots in plots amended with poultry manure in relation to the control plots might be due to the improved soil moisture content of the PM amended plots. The improved moisture content might be responsible for the enhanced biological activities in the soil that might partly be responsible for the rotting of the carrot roots.

Improvements in proximate composition of carrot roots in terms of crude protein, fat, ash, dry matter, and the reduction in crude fibre with increased level of PM might be attributed to the improved nutrients supplied to the soil for the utilization by carrot seedlings. The improvements in crude protein, fat, ash, dry matter, and the reduction in crude fibre of carrot roots from poultry manured plots in relation to carrot roots from the control plots indicate that carrot roots from poultry manured plots are of better quality than the carrot roots from plots where no treatment was applied (control plots). This therefore, suggest that carrot roots from poultry manured plots would be more beneficial to human health. The finding that carrot roots from the plots amended with poultry manure contained higher content of protein, fat, ash, and dry matter than carrot roots from control plots are in agreement with the results obtained by Gatsinzs *et al.* (2016), and Rahman *et al.* (2018). Improvements in soil pH, total organic carbon, total N, available P, exchangeable bases, and ECEC in plots amended with PM could be related to the nutrient composition of poultry manure. These improvements in nutrients status imply that PM can be used for soil fertility management for sustainable production of carrot. In support of this view, Henneron *et al.* (2018) and Scharma *et al.* (2018) found that poultry manure significantly increased soil pH, N, P, Mg, Ca, and organic matter which enhanced availability of nutrients for the plant uptake. Improvements in nutrients status in the second cropping season in plots previously amended with PM during the first cropping season could be attributed to the slow release of nutrients from PM which must have prevented the rapid loss of nutrients from the soil through leaching process, hence, PM has significance residual effect on the soil nutrients status. In support of this view, Adeoye *et al* (2008) observed that organic manures provide nutrients slowly but maintain uniformity of supplying available nutrients throughout the growing season and at the same time having residual effect on the soil nutrients status.



CONCLUSION AND RECOMMENDATION

The findings in this study indicate that poultry manure is a valuable organic manure for maintaining soil quality and optimum productivity and sustainability of carrot production, and also improves the nutritional quality parameters of carrot roots. The use of 10 t ha⁻¹ PM should be encouraged among carrot farmers in the rainforest agroecology of southwest Nigerian as this rate of PM enhanced optimum growth, root yield, nutritional quality and soil nutrients status in the present study.

REFERENCES

- Adeoye, G. O., Adeoluwa, O. O., Ojelade, M., Sridhar, M. K., Mahinde, E. A. and Olowoake, A. A. (2008). Comparative evaluation of organo-mineral fertilizer and mineral fertilizer (NPK) on yield and quality of maize (*Zea mays*). *Nigerian Journal of Soil Science*, **18**: 132-137.
- Aduayi, E. A., Chude, V. O., Adebuseyi, B. A. and Olayiwola, S. O. (2002). Fertilizer use and management practices for Crops in Nigeria, 3rd Ed. Federal Fertilizer Department, Federal Ministry of Agriculture and Rural Development, Abuja, Nigeria, 25pp.
- Ahmed, A., Sambo, B. E., Arunah, U. L. and Odion, E. C. (2014). Response of farmyard manure and inorganic fertilizer for sustainable growth of carrot (*Daucus carota* L.) in Northern Nigeria. *Journal of Agriculture and Veterinary Science*. **7**(2): 26-35.
- Akanbi, O. S., Famaye, A. O., Olaniyi, O. O., Ipinmoroti, R. R. and Iloyanomo, C. L. (2014). Comparative effects of cocoa pod husk and oil palm bunch ash on nutrient uptake, growth and dry matter yield of cocoa (*Theobroma cacao*) in Ibadan, south west Nigeria. *Agricultural Sciences* **5**:1046-1052.
- Alice, N. M., Gert, M. C. and Gesine, M. C. (2014). Response of Carrot (*Daucus carota* L.) yield and quality to organic fertilizer. *South African Journal of Plant and Soil* **31**(1): 1-6.
- Amusan, A. O., Adetunji, M., Azeez, J. O., and Bodunde, J. G. (2011). Effect of the integrated use of legume residue, poultry manure and inorganic fertilizers on maize yield, nutrient uptake and soil properties. *Nutrient Cycling in Agroecosystems*. **90**: 321-330.
- A. O. A. C. (2000). Official Method of Analysis 17th eds. Vol (1 & 2). Horowitz Edition interm. Maryland, USA, Washington DC. Pp. 452-456.
- Appiah, F. K., Sarkodie-Addo, J. and Opoku, A. (2017). Growth and yield response of carrot (*Daucus carota* L.) to different green manures and plant spacing. *Journal of Biology Agriculture and Health Care*. **7**(20): 16-23.
- Bai, Z., Caspari, T., Gonzalez, M. R., Batjes, N. H., Mader, P., Bunemann, E. K., de Goede, R., Brüssard, L., Minggong, X., Ferreira, C. S. S. (2018). Effects of agricultural management practices on soil quality. A review of long-term experiments for Europe and China. *Agric. Ecosyst. Environ.* **265**: 1-7.
- Bremner, J. M. (1996). Nitrogen-total. In Sparks, D. I. (Ed.), *Method of Soil Analysis*. Part 3.
- Chanda, K. L. (2013). Handbook of Horticulture, Indian Council of Agricultural Research (ICAR), New Delhi, India, 148pp.
- Dawid, C., Dunemann, F., Schwab, W., Nothnagel, T. and Hofmanns, T. (2015). Bioactive C17-Polyacetylenes in Carrots (*Daucus carota* L.): Current knowledge and future perspective. *Journal of Agriculture and Food Chemistry*. **63**: 9211-9222.
- Ditlevesen, K., Sandoe, P. and Lassen, J. (2019). Healthy food is nutritious, but organic food is healthy because it is pure: The negotiation of healthy food choices by Danish consumers of organic food. *Food Quality and Preference*. **71**: 46-53.
- Frank, K., Beegbe, D. and Denning, J. (1998). Phosphorus, In: Brown, J. R. (Ed.). Recommended chemical soil test procedures for the north-central region, North-Central regional research publication No. 22 (revised) Missouri Agric. Exp. Stn., Columbia, MO. Pp. 21-26.



- Gatsinzi, K., Habyarimana, J. and Gatsinzi, A. (2016). Nutritional quality of carrot (*Daucus carota* L.) as influenced by farm yard manure. *African Journal of Agricultural Economics and Rural Development*, **4**(3): 322-327.
- Gee, G. W. and G. D. (2002). Particle size analysis. In: Dope, J. H. and Topp, G. O. (Eds), methods of soil analysis, Part 4. *Physical methods. Soil Science Society of America*, No 5, Madison, Wisconsin, pp. 255-293.
- Hapstead, M. I. (1974). Classification of Nigeria Soils. *Soil Science* **16**: 437-443.
- Hendershot, W. H., Lalonde, H. and Duquette, M. (2008). Ion Exchange and Exchangeable Cations. In: Carter, M. R. and Gregorich, E. O. (Eds). *Soil Sampling and Methods of Analysis, 2nd Edition. Canadian Society of Soil Science, CRC Press and Taylor and Francis Group*, Oxford, U.K.
- Henneron, L., Bernard, L., Hedde, M., Pelosi, C., Villenave, C., Bertrand, M., Girardin, C. and Blanchert, E. (2015). Fourteen years of evidence for positive effect of conservation agriculture and organic farming on soil life. *Agronomy for sustainable development* **35**: 169-181.
- Iradhatullah, R., Nasruddin, A., Kuswinanti, I., Asrul I. and Rasyid, B. (2018). Utilization of Cocoa pod husk waste composting by (*Iromella* sp) and (*Pleurotus* Sp) as a medium to growth of cocoa seedling. I. O. P. Conf. series. *Earth and Environment Science*, **15**(6): 2018 - 2026. Doi: 10-1088/1755-1315/156/1/012012.
- Khairul, M. A., Pulok, M. A. I., Chowdhury, M. S. N., Moonmoon, J. P, and Munnahar (2015). Effect of different types of organic manure and mulching on the growth and yield of carrot. *International Journal of Science and Research Publications*, **5**(2): 1-6.
- Melean, E. O. (1982). Soil pH and lime requirement. In method of Soil Analysis, Part II Page, A. L. (Ed.) Chemical and Microbiology properties. *America Society of Agronomy*, Madison, Wisconsin, pp. 199-234.
- Nelson, D.W. and Sommers, L. E. (1996). Total carbon, organic carbon and organic matter. "In Spark, D. L. (Ed). *Methods of Soil Analysis* Part 3.2 Edition SSSA Book Series No 5 ASA and SSSA. Madison, W. I. USA. Pp 961-1010.
- Rahman, M. A., Islam, M. T., Mantun, M. A., Rahman, M. S., and Ashrat (2018). Yield and quality performance of carrot under different organic and inorganic nutrient sources with mulching options. *Asian Journal of Agricultural and Horticultural Research* **1**(4):1-8.
- SAS (2002). Statistical Analysis System Institute Inc. ASA/STAT Guide for Personal Computer. Version 6 Edition, NC., SAS Institute Inc. 1087pp.
- Scharma, M., De Han, J. J., Kroonen, M., Verstege, H. and Vander Putten, W. H. (2018). Crop yield cap and stability in organic and conventional farming system. *Agricultural, Ecosystem and Environment*. **256**: 123-130.
- Surbi, R. L., Weng, N., Simon, P. W. and Tanumihardj, S. A. (2018). A review food, chemical composition and utilization of carrot (*Deucus carota* L) Pomace. *International Journal of Chemical Studies* **6**(3): 2921-2926.
- Tanveer, A., Maria, G., Qumer, I., Augustin, A., Asmat, B., Rana, B., Muhammed, A. .and Sajjad, A. (2019). Phytochemicals in *Daucus carota* and their health benefits. *Review article foods*, **8**: 424 – 431. doi: 10.3390/foods8090424.
- Zhang, P., Chen, X., Wei, T., Yang, Z., Jia, Z., and Yang, B. (2016). Effects of straw incorporation on the soil nutrient content, enzyme activities, and crop yield in a semiarid region of China. *Soil Tillage Research*. **160**: 65-72.