East African Scholars Journal of Agriculture and Life Sciences
Abbreviated Key Title: East African Scholars J Agri Life Sci
ISSN 2617-4472 (Print) | ISSN 2617-7277 (Online) |
Published By East African Scholars Publisher, Kenya

OPEN ACCESS

Volume-2 | Issue-6 | Jun-2019 |

Research Article

Improvement of Soil Properties and Jatropha Growth by Organic Manure (Enpost®) In Otukpo, Benue State, Nigeria

Clement Alex Onwu[1], Patricia James Aliyu[1], and Waizah Yakub[1]
[1]Department of Soil Science and Land Resources Management, Federal University Wukari, Wukari, Taraba State Nigeria

*Corresponding Author
Clement Alex Onwu

Abstract: An experiment was conducted to investigate the improvement of soil properties, jatropha growth, nutrient uptake and yield by application of organic manure (enpost) in Agricultural Vocational Training Centre, Otobi, Otukpo, Benue State, Nigeria. The treatments consisted of four rates of organic manure (0.00, 4.00, 6.00 and 8.00 t ha^{-1}) were replicated three times in a randomized complete block design. Soil properties, growth parameters, nutrient uptake and yield were measured to compare the treatments. The soil at the experimental site was slightly acidic, low in organic matter, N, P, and Ca. The application of the organic manures raised the soil pH, organic matter, total N, available P and exchangeable K, Ca and Mg status of the soil and reduced exchange acidity. The 8.00 t ha^{-1} rate produced significantly the highest growth parameters and uptake of N, P and K. The yield (1.13 and 1.83 t ha^{-1} for the two years respectively) were obtained from 8.00 t ha^{-1} which was significantly higher than other treatments. It is recommended at application rate of 8.00 t ha^{-1} for optimum performance of jatropha.
Keywords: Jatropha; enpost; organic manures; nutrient uptake; primary branches; yield.

INTRODUCTION

Jatropha curcas L. is a large shrub or a small tree belonging to the *Euphorbiaceae* family. Under normal conditions it reaches a height of three to five meters, but under favorable conditions a height of eight to ten meters can be reached. The Jatropha is a diploid species with 2*n*, or 22 chromosomes and is not sensitive to day length (Heller, 1996). The bark is smooth and brownish to grayish, and when the plant is cut milky, white sap appears. The branches contain latex, and the seeds are toxic. The leaves are alternately arranged on the stem; they are bright to dark green with a length and width of about 6 to 15 cm and have five to seven shallow lobes (Heller, 1996). Jatropha is monoecious, meaning there are both male and female flowers on the same plant, and the flowers unisexual, but also hermaphrodite flowers occur. The Jatropha plant dislikes permanent wetness, and waterlogged soils should be avoided (Ouwens *et al*., 2007). Very light soils like sand, sandy loam and loamy sand, which dry very fast, require high organic matter application and application of nutrients (Franken, 2010). The soil should not be too acid or alkaline, and the pH value should range between 5.5 and 8.5 (Ouwens *et al*., 2007; Franken, 2010).

The Jatropha plant responds positively to high organic matter contents in the soil, and applying of organic matter or organic fertilizer is therefore recommended (Ouwens *et al*., 2007). Organic materials are a major source of organic matter and plant nutrients. Studies have shown that the application of manure has positive effects on the physical and chemical properties of soil mainly due to increase in organic matter (Adeleye *et al*., 2010: Masto *et al*., 2007: Yolanda *et al*., 2014). The important roles of organic matter include being a rich source of essential plant nutrients (FAO, 2005), helps in improving moisture holding capacity of the soil, improves soil structure, soil aeration, water permeability, acts as pH buffer, contains metal-organic matter complexes that help in making available micro nutrients to crop (Agboola *et al*., 1998: Udoh *et al*., 2005: Ikeh *et al*., 2013).

Soil organic matter undergoes mineralization and releases substantial quantities of nitrogen, phosphorus, sulfur and smaller amount of

Quick Response Code

Journal homepage:
http://www.easpublisher.com/easjals/

Article History
Received: 25.05.2019
Accepted: 08.06.2019
Published: 29.06.2019

DOI: 10.36349/easjals.2019.v02i06.011

micronutrients (Rahman *et al.*, 2013). The quantity of soil organic matter depends on the quantity of organic materials introduced into the soil either by natural returns through roots, stubbles, sloughed-off root nodules and root exudates or by artificial application in the form of organic manures. The suitability of organic manures in improving crop production has been well reported (Bache and Heathcote, 1970: Imasuen *et al.*, 2015). Continuous use of only the inorganic fertilizers for increasing soil nutrients is usually accompanied on the long term by reduction in soil organic matter, increase in soil acidity, leaching losses, erosion, and degradation of soil physical properties (Obi and Ebo, 1995: Ojeniyi, 2000). Amendment by the use organic manures is considered less likely to have detrimental effect on soil physico-chemical properties compared with mineral fertilizers (Adeleye *et al.*, 2010). In recent times, organic manures in conjunction with or as an alternative to chemical fertilizers as a source of plant nutrients for cultivation of field crops has received worldwide attention due to rising costs of chemical fertilizers, rapid nutrient loss of added fertilizers and adverse environmental impacts from inorganic fertilizers. Accumulation of nutrients in soils, particularly nitrogen, phosphorus and several micronutrients increases the potential for the degradation of surface and ground water resources, especially when manure application is nitrogen based (Edwards and Daniel, 1992: Hao *et al.*, 2008). Organic manures have been proven to enhance efficiency and reduce the need for chemical fertilizers, to improve the soil fertility and soil health (Myint *et al.*, 2010).

To meet crop nutrient requirements, knowledge of soil characteristics following organic manure application is needed. Thus, it is pertinent to observe the some changes in soil properties and plant growth with time due to manuring. The study was carried out to observe the improvement of soil properties, jatropha growth, nutrient uptake and yield by application of organic manure

MATERIALS AND METHOD

The experiment was conducted at the Agricultural Vocational Training Centre, Otobi, Otukpo (Latitude 07 11^1N and Longitude 08 10^1E), Benue State during the 2009 and 2010 cropping seasons. The site was not used for any cropping activities for the past three years. The site is located at an elevation of 101 meters above sea level. This Location falls within the Southern Guinea Savanna Agroecological zone of Nigeria. The soil of the experimental site was classified as Typic Ustropepts and Typic Haplustults (USDA) or Eutric Cambisols and Haplic Lixisols (FAO) (FDALR, 1990).

There were four levels of the industrial organic fertilizer **(**Enpost®). The treatments were replicated three times in a Randomized Complete Block Design (RCBD) giving a total of 12 plots with each plot measuring 4 x 3 m with an alley of 0.5 m between plots and 1m between replications. The Enpost® manure was incorporated into the soil two weeks before planting jatropha seeds. Treatments were: 0.00 (control), 4.00, 6.00 and 8.00 t ha^{-1}. The land was manually cleared and ridged. The organic fertilizer was incorporated. Jatropha plant was used as a test crop. Planting was done in July, 2009. Jatropha plants were monitored for two cropping seasons. The seeds were manually drilled on rows to 3 cm depth after two weeks of incorporation of organic manure into the soil. The seedlings were later thinned to one per hole at 1 m plant –to –plant spacing three weeks after planting to give a plant population of 10,000 plants per hectare. Weeding was done manually at four weeks interval.

Soil samples were collected from the plough layer (0 – 20 cm) at the beginning of the experiment as composite. After harvest of the first and second cropping seasons, soil composite samples were collected on the basis of treatments. The soil samples were bulked, air-dried and sieved using a 2-mm sieve for routine chemical analysis, as described by Carter (1993). Particle-size analysis using the hydrometer method (Sheldrick, 1993). Soil pH was determined in a soil/water (1: 2) suspension using a digital electronic pH meter. Soil organic carbon was determined by the Walkley and Black procedure by wet oxidation using chromic acid digestion (Nelson and Sommers, 1996). Total N was determined using micro-Kjeldahl digestion and distillation techniques (Bremner, 1996), available P was determined by Bray-1 extraction followed by molybdenum blue colorimetry (Frank *at al.*, 1998). Exchangeable K, Ca and Mg were extracted with a 1 M NH_4OAc, pH 7 solution. Thereafter, K was analyzed with a flame photometer and Ca and Mg were determined with an atomic absorption spectro-photometer (Okalebo *at al.*, 2002). Cation exchange capacity (CEC) was determined using the procedures described by IITA (1979) and modified by Anderson and Ingram (1996).

The organic manure (Enpost®) was analyzed for nitrogen, phosphorus, Potassium, Magnesium, Calcium and Sodium. Total N was determined using macro-Kjeldahl method. Available phosphorus was determined by Bray-1 method. The exchangeable K and Na were determined on a flame photometer while Mg and Ca were determined on Atomic Absorption Spectrophotometer (AAS)

The leaf nutrient content analysis was done at week 6, 12 after planting in first season and 52 and 58 weeks after planting in second season. Leaf samples were collected, oven-dried at 700°C for 24 h and milled. Nitrogen was determined using micro-kjeldahl method. Samples were dry ashed using nitric-perchloric-sulphuric acid mixture for determination of P, K Ca and Mg. Phosphorus was determined using vanadolmolbdate colormetry, K and Na by flame photometer and Ca and Mg by EDTA titration (Tel and Hagarty, 1984).

The growth parameters (number of primary branches and plant height) were measured at week 6, 12 after planting in first season and 52 and 58 weeks after planting in second season and yield were measured after harvest of each year.

Data collected were subjected to analysis of variance (ANOVA) and significant means were compared using Duncan New Multiple Range Test (DNMRT) at 5% probability level.

RESULT AND DISCUSSION

Manurial effect on soil properties

Initial soil analysis was carried out to assess the soil fertility status at the study area before the conduct of the experiment and also nutrient analysis of organic manure used. The organic manure was quite high in organic matter (6.82 %), calcium and recorded 3.15 % nitrogen, 4.01 % magnesium and 1.98 % potassium. The results of the initial soil and organic manure analyses are presented in Table 1. The soils were loamy sand, the values of pH was 5.83. Organic carbon was 0.98 %, available P was 26 ppm the cations order of abundance was: Ca > Mg > Na > K. The total nitrogen present was 0.06 % indicating that it is low according to Bruce and Rayment (1982). In general, the fertility status of the soil was low for crop growth. This, according to Okore *et al.* (2005) has been attributed to the poor inherent nature of Nigerian soils and other environmental related constraints. The use of mineral fertilizers and organic manures are the most effective and convenient way to improve soil fertility.

Table.1 Initial soil analysis of soil and organic manures used

Nutrient element	Soil	Nutrient element	Enpost
Nitrogen (%)	0.06	Nitrogen (%)	3.15
Phosphorus (ppm)	26	Phosphorus (%)	13.92
Potassium (cmol/kg)	0.18	Potassium (%)	1.98
Magnesium (cmol/kg)	1.15	Magnesium (%)	4.01
Calcium (cmol/kg)	2.34	Calcium (%)	16.16
Sodium(cmol/kg)	0.65	Sodium (%)	0.71
Organic Carbon (%)	0.98	Organic Carbon (%)	6.82
CEC (cmol/kg)	3.61		
pH (H2O)	5.83		
Exch.A (cmol/kg)	1.01		
Sand (%)	71.25		
Silk (%)	20.45		
Clay (%)	8.3		

Table2. Physicochemical properties of soil after 1st and 2nd year harvest. There was an increase in soil pH and decrease in exchangeable acidity after harvests in plots treated with organic manure. This could be as a result of mineralization of organic matter to release exchangeable cations. Natschner and Schetmann (1991) and Agbede (2010) also reported that application of organic manure which contains high exchangeable calcium; potassium, magnesium and sodium, and the presence of these exchangeable bases in soil tend to increase soil acidity value. Ano and Agwu (2005) also reported that organic manure increased soil pH and reduced exchangeable acidity and increased exchangeable Ca and Mg.

The experimental results indicated that there was improvement in the soil organic matter content in all the treated plots with the highest (1.88 % and 1.86) recorded at 8.00 t ha^{-1} at the 1st and 2nd harvest respectively. The manurial effect on nutrient elements availability such as of nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg) and sodium (Na) in the soil after harvest were higher than those at the initial soil analysis except the control where the values decreased. Increases in soil nutrient contents adduced to organic manure are consistent with analysis recorded for manure in the present work. Adesodun *et al*., (2005) had found that application of organic manure to soil increased soil organic matter, N and P and aggregate stability. Ayuba *et al*., (2005) reported that different application rates of organic manure increased the soil pH, organic matter, N, available P, exchangeable K, Ca and Mg relative to control.

There were increases in cation exchange capacity (CEC) in all the treatments except the control. Treatment 8.00 t ha^{-1} recorded the highest values of CEC after harvest in both cropping season. This increase in cation exchange capacity is responsible for the increase and retention of exchangeable cations as observed in this experiment. Ibrahim and Fadni (2013) agreed that organic manures increased CEC for all treatments with cow manure + poultry increasing CEC by 51.04% over control, while cow manure and poultry manure increasing CEC by 28.64 and 32.10%, respectively. Lal and Kang (1982) have also reported that the higher the organic matter contents of the soil, the higher the cation exchange capacity. This contribution of organic manure to increase nutrient holding capacity of the soil is consistent with the findings of Davis *et al.,* (2006) and Duriugbo *et al.*, (2000).

Table.2 Physicochemical properties of soil after 1st and 2nd year harvest

Sample	pH	Org. C	Total N	Avail. P	Exch. Cations (cmol/kg)				CEC	Exch. A	Sand	Silt	Clay
	H_2O	%		ppm	Na^+	K^+	Ca^{2+}	Mg^{2+}	cmol/kg			%	
1ST YEAR													
0.00 t ha-1	5.64	1.19	0.05	23	0.52	0.18	3.25	1.52	3.4	1	71.28	20.09	8.63
4.00 t ha-1	6.12	1.63	0.13	27	0.6	0.28	4.47	2.12	4.4	0.96	70.25	21.04	8.71
6.00 t ha-1	6.34	1.66	0.16	30	0.66	0.32	6.92	2.11	4.5	0.94	70.12	22.56	7.32
8.00 t ha-1	6.21	1.88	0.18	31	0.67	0.37	7.14	2.12	5.1	0.94	69.87	18.2	11.93
2ND YEAR													
0.00 t ha-1	5.82	1.14	0.04	18	0.47	0.15	3.04	1.41	3.31	0.99	71.54	19.22	9.24
4.00 t ha-1	6.11	1.63	0.13	22	0.65	0.28	4.42	2.08	4.35	0.95	70.25	20.14	9.61
6.00 t ha-1	6.31	1.61	0.14	25	0.64	0.09	6.85	2.08	4.41	0.94	70.12	21.08	8.8
8.00 t ha-1	6.21	1.84	0.14	30	0.65	0.36	7.02	2.07	4.86	0.94	70.04	17.85	12.11

Manurial Effect on Growth Parameter

The statistical analysis of the data (Table 3) showed that organic manure significantly affected number of primary branch. The maximum number of branch was recorded in plots treated with 8.00 t ha^{-1} while the lowest number of branch was recorded in plots treated with no organic manure (control) which was statistically lower than all the plots treated with manure. The highest number of primary branch was recorded in the plot treated with 8.00 t ha^{-1} organic manure could be high nitrogen availability to the plant due to the application of poultry manure. The increase in the number of branch with increase rate of organic manure application due the direct role in plant nutrition the result also agree with Khalil *et al.*. (2005) who reported that organic manure having high nitrogen that improve the vegetative growth and make the nutrient available to the plant under stress condition. Also, Michael *et al.*, (2010) reported that organic manure has been found to enhance the number of leaves in lettuce by providing sufficient amount of nutrients that accelerate the growth of leaves.

Table.3 Manurial effect on growth parameter

	Number primary branches				Plant height (cm)				Leaf area (cm2)			
Treatments	6WAP	12WAP	52WAP	58WAP	6 WAP	12WAP	52 WAP	58 WAP	6 WAP	12 WAP	52 WAP	58WAP
0.00 t ha-1	4.00b	5.00c	7.00c	8.67c	38.27b	59.60b	143.57d	162.60c	137.80c	145.53c	144.53c	146.10c
4.00 t ha-1	5.67a	7.00b	9.33b	10.00b	50.10a	72.20a	157.50c	177.20b	146.77b	150.53b	149.13b	151.03b
6.00 t ha-1	6.67a	8.67a	11.67a	13.00a	53.30a	73.13a	160.47b	180.87ab	147.43b	151.07b	152.43a	150.90b
8.00 t ha-1	7.00a	9.33a	12.00a	13.33a	54.27a	73.37a	169.73a	182.70a	153.97a	156.37a	155.83a	155.13a

Values with different letters in columns are significantly (*P* = 0.05) different.
WAP=Weeks after planting.

Organic manure appears to have significant effect on plant height (Tab. 3). At 6 and 12 WAP, application of 8.00 t ha^{-1} recorded the tallest plant (54.27 and 73.37 cm respectively) and statistically similar to other plots that received organic manure but statistically higher than control that recorded shortest plants. Application of 8.00 t ha^{-1} obtained 169.73 cm height which was statistically higher than all the treatments at 52 WAP while at 58 WAP, it was statistically similar with 6.00 t ha^{-1} and they were higher than the control that recorded the shortest plant. This shows that poultry manure was easily available and in the best form for easy absorption by the plant roots, hence there was a boost in the morphological growth of the plant. The result corroborated with the findings of Ajari *et al.*, (2003) in okra production in which they reported that organic manure especially could increase plant height of crops when compared with other sources of manures. The poor development of vegetative characters observed in treatment without manure (control) further confirmed the report of Akanbi *et al* (2000) and Akanbi 2002, that nutrient, availability especially nitrogen determine plant vegetative grow.

The data regarding leaf area is presented in Table 3. The statistical analysis of the data showed that organic fertilizers significantly affect leaf area. The highest leaf area (153.97, 156.37 and 155.13 cm^2) at 6, 12 and 58 WAP were obtained in plots treated with 8.00 t ha^{-1} which was statistically higher than other treatments while the lowest leaf area was obtained in plots treated as control. The highest leaf area was recorded in plots treated with poultry manure could be due to efficient nitrogen availability as a result the plant uptake more nitrogen and in turn larger leaves were observed. The results also agreed with the Balyeri *et al.*, (2016) they studied that organic manure influenced growth, yield and nutritional quality of containerized aromatic pepper (*Capsicum annuum* L., var 'Nsukka Yellow'). They concluded that the poultry manure increased the leaf area due to sufficient nitrogen availability which in turn improve the vegetative growth of the crop these finding are also confirmed by Shah *et al*., (2016) who found greater leaf area with the application of organic manure.

Manurial effect on N, P and K uptake by Jatropha Leaves

Application of organic manure significantly (P ≤ 0.05) affected N, P and K concentration in Jatropha leaves (Tables 4). The nitrogen uptake at 6, 12 and 52 had similar trend where 8.00 t ha^{-1} had the highest concentration of uptake and statistically higher than treatments 0.00 t ha^{-1} and 4.00 t ha^{-1} but the same statistically with 6.00 t ha^{-1}. At 58 WAP, the plots that received 6.00 t ha^{-1} and 8.00 t ha^{-1} of organic manure were statistically higher than other plots. The control (0.00 t ha^{-1}) had lowest N uptake and statically lower than other treatments. It was observed that increased rate of organic manure increases N uptake. Increased uptake of N with higher dose of organic manure has been reported by several workers Sudha and Chandani (2002), Preetha *et al*., (2005).

Phosphorus uptake in Jatropha leaves at 6 WAP showed significant difference, plots that received 8.00 t ha^{-1} obtained highest uptake (0.39 %) and statistically higher than other treatments except 6.00 t ha^{-1}. At 12 and 52 WAP, 8.00 t ha^{-1} recorded highest uptake and statistically higher than other treatments. At 58 WAP, the trend is similar to 6 WAP. In all the treatments, control recorded lowest uptake and statistically lower than other plots that received organic manure.

Table 4: Nutrient uptake by Jatropha plant (%)

Treatments	Nitrogen				Phosphorus				Potassium			
	6 WAP	12 WAP	52 WAP	58 WAP	6 WAP	12 WAP	52 WAP	58 WAP	6 WAP	12 WAP	52 WAP	58 WAP
0.00 t ha^{-1}	2.11c	2.18c	2.34c	2.37c	0.27c	0.31c	0.35c	0.36c	2.23d	2.26c	2.33c	2.36c
4.00 t ha^{-1}	2.42b	2.49b	2.58b	2.59b	0.34b	0.39b	0.44b	0.46b	2.88c	3.01b	3.24b	3.28b
6.00 t ha^{-1}	2.48ab	2.53ab	2.65ab	2.65a	0.38ab	0.41b	0.46b	0.48ab	3.21b	3.33a	3.39a	3.42a
8.00 t ha^{-1}	2.53a	2.57a	2.68a	2.68a	0.39a	0.46a	0.52a	0.51a	3.26a	3.36a	3.42a	3.46a

Values with different letters in columns are significantly (P = 0.05) different.
WAP=Weeks after planting.

Potassium uptake at 6 WAP (3.26 %) was highest with the plots that received 8.00 t ha^{-1} and statistically higher than all other treatments. Treatments 6.00 t ha^{-1} and 8.00 t ha^{-1} were statistically similar at 12, 52 and 58 WAP and were higher statistically than other treatments. All plots treated with organic manure were statistically higher than the control which had no organic manure

Increased of K uptake was noticed with increased rate of organic manure. This observation was in agreement with Sharma and Mittra (1991) who reported increased K uptake with higher doses of organic manure.

Increase in the soil nutrient availability due to the application of organic manures might have led to higher N, P and K uptake. In addition, organic manure contained N, P and K resulting in release of higher quantities of these nutrients upon decomposition. Ojo *et al*., (2015) reported increases in the levels of P and N in maize plant tissues due to incorporation of poultry manure into the soil. This was linked to high content of N, P and K in poultry manure which are released upon its decomposition. Nahar *et al*., (2008) and Mandal *et al*., (2009) reported that organic manures incorporated into soil decompose and increase soil nutrient status thereby enhancing nutrient uptake by plants. Ewulo *et al*., (2007) and Khaled *et al*., (2012) reported that application of organic manures enhanced uptake of N, P and K by plants.

Table 5: Manurial effect on plant yield t ha^{-1}

Treatment	2009	2010
0.00 t ha^{-1}	0.42c	1.21d
4.00 t ha^{-1}	0.94b	1.58c
6.00 t ha^{-1}	1.00b	1.66b
8.00 t ha^{-1}	1.13a	1.83a

Manurial Effect on Seed Yield

In general, Jatropha crop undergoing various rates of organic manure exhibited increased yield of seeds in comparison to the control; the maximum increase being recorded in plants undergoing 8.00 t ha^{-1} treatment where the seed yield was 1.13 t ha^{-1} which was significantly higher than yield obtained from all other treatments in 2009 cropping season (Table 5). Treatments 4.00 and 6.0 t ha^{-1} obtained yield of 1.00 and 0.94 t ha^{-1} respectively which were statistically similar and higher than the control. The yield of 1.83 t ha^{-1} was recorded at 8.00 t ha^{-1} of organic manure which was significantly different from all treatments in 2010 cropping season. The control obtained the lowest Jatropha seed yield in both cropping seasons. The observed improvement in the yield of Jatropha could be attributed to the ability of the manure to increase soil nutrient thereby increasing Jatropha yield. This result agreed with Sharma (2004), who reported that organic manure improves plant height, cob size, grain yield and weight of maize. The yield increase with an increase organic manure rates suggests that the manure supplies nutrients that enhanced vigorous growth, which are important indices that culminate in increase in yield. This result agrees with Reddy *et al.*, (1990) who reported that application of higher doses of nitrogen resulted in higher seed yield. It also inconformity with Aliyu (2002, 2003) who reported significant response in yield to different types and rates of manure applications. Application of organic manure to soils with low fertility status enhanced favourable yield and growth parameters, which could be due to their rich nutrient concentrations. This finding agreed with the work of Moyin-Jesu and Ojeniyi (2006), which reported a rapid response in the yield and growth of okra with the application of organic manure. Hence, this finding highlighted the importance of organic fertilizer use for the enhancement of soil and crop productivity in the tropics.

CONCLUSION

The findings of this study showed that organic manure (enpost) improved the chemical properties of the soil and enhanced the agronomic performance of Jatropha plant. Nutrient uptake and seed yields were found in this study to peak when application rate of organic manure reached 8.00 t ha^{-1}. Application of organic manure at this rate is therefore recommended for Jatropha production as it gave maximum values of performance parameters and nutrient uptake.

REFERENCES

1. Heller J. (1996). Physic nut. *Jatropha curcas* L. Promoting the conservation and use of underutilized and neglected crops.1. Gatersleben, Germany: Institute of Plant Genetic and Crop Plant Research, Rome - Italy. International Plant Genetic Resource Institute. Pp 35, 36
2. Ouwens, K.D., Francis, G., Franken, Y.J., Rijssenbeek, W., Riedacker, A., Foidl, N., Jongschaap, R. & Bindraban, P. (2007). *Position paper on Jatropha curcas - State of the Art, Small and Large Scale Project Development.* Wageningen: FACT Foundation. http://www.fact-fuels.org/media_en/Position_Paper_on_Jatropha_Curcas.
3. Franken, Y. J. (2010). Plantation establishment and management. In: FACT Foundation. *The Jatropha Hanbook - From cultivation to application* (9-29). Eindhoven: FACT Foundation. http://www.snvworld.org/en/Documents/FACT_Foundation_Jatropha_Handbook_2 010.pdf
4. Adeleye, E. O., Ayeni, L. S., & Ojeniyi, S. O. (2010). Effect of poultry manure on soil physico-chemical properties, leaf nutrient contents and yield of yam (*Dioscorea rotundata*) on Alfisol in Southwestern Nigeria. *Journal of American Science*. 6(10), 871-878.
5. Masto, R. E., Chhonkar, P. K., Singh, D., & Patra, A. K. (2007). Soil quality response to long-term nutrient and crop management on a semiarid Inceptisol. Agriculture. *Ecosystems and Environment*, 118, 130-142.
6. Yolanda, M. S., Fidel. P. M., & Francisco, P. G. (2014). Effect of the application of manure of cattle on the properties chemistry of soil in Tizayuca, Hidalgo, Mexico. *International Journal of Applied Science and Technology*, 4 (3), 67-72.
7. Food Agricultural Organization FAO. (2005). The importance of soil organic matter: Key to drought-resistant soil and sustained food production. FAO Soils Bulletin 80. Rome.
8. Agboola, A. A., Ndaeyo, N. U., & Kalu, O. I. (1998). Soil fertility management alternatives to inorganic fertilizer use. In: Babalola O, Babaji GA, Mustapha S. (Eds). Soil management for sustainable agriculture and environmental harmony. Proceedings of the 24th Annual Conference of the Soil Science Society of Nigeria held at the Abubakar Tafawa Balewa University, Bauchi. 1-9.
9. Udoh, D. J., Ndon, B. A., Asuquo, P. E., & Ndaeyo, N. U. (2005). Crop production techniques for the tropics. Concept Publications Limited, Lagos, Nigeria. Pg 446.
10. Ikeh, A. O., Ndaeyo, N. U., Akpan, E. A., Udoh, E. I., & Akata, O. R. (2013). Evaluation of complementary use of organic manure for sustainable water yam production in Uyo, Southeastern Nigeria. American Journal of Research Communication. 1(2), 33-48
11. Rahman, M. H., Islam, M. R., Jahiruddin, M., Puteh, A. B., & Mondal, M. M. A. (2013). Influence of Organic Matter on Nitrogen Mineralization Pattern in Soils under Different Moisture Regimes. *International Journal of Agriculture and Biology*, (15), 55-61.
12. Bache, B. W., & Heathcote, R. G. (1970). Long-termeffects of fertilizers and manure on soil and leaves of cotton in Nigeria. Experimental Agriculture. (5), 241-247.
13. Imasuen, E. E., Chokor, J., & Orhue, E. R. (2015). Influence of poultry manure on some soil chemical properties and yield of okra. *Nigerian Journal of Agriculture, Food and Environment*. 11(2), 33-37
14. Obi, M. E., & Ebo, P. O. (1995). The effect of organic and inorganic amendments on soil physical properties and maize production in a severely degraded sandy soil in southern Nigeria. *Bioresource Technology*. (51), 117–123.
15. Ojeniyi, S. O. (2000). Effect of goat manure on soil nutrient and okra yield in a rainforest area of Nigeria. Applied Tropical Agriculture. (5), 20–23.
16. Edwards, D.R., & Daniel, T.C. (1992). Environmental Impacts of On-Farm Poultry Waste Disposal: A Review. *Bioresource Technology*, (41**)**:9-33. http://dx.doi.org/10.1016/0960-8524(92)90094-E
17. Hao, X., Godlinski, F., & Chang, C. (2008). Distribution of Phosphorus Forms in Soil Following Long-Term Continuous and Discontinuous Cattle Manure Applications. *Soil Science Society of America Journal*, **72**, 90-97. http://dx.doi.org/10.1016/0960-8524(92)90094-E
18. Myint, A. K., Yamakawa, T., Kajihara, Y., Myint, K. K. M., & Zenmyo, T. (2010). Nitrogen

Dynamics in a Paddy Field Fertilized with Mineral and Organic Nitrogen Sources. *American-Eurasian Journal of Agricultural and Environmental Sciences* (7), 221-231.
19. F.D.A.L.R. (1990). Soil Map of Nigeria. Soil Survey Division. Federal Department of land Resources. FMANR – Abuja.
20. Carter, M. R. (1993). Soil sampling and methods of analysis. Canadian Society of Soil Science. Boca Raton (FL): Lewis. 823 pp.
21. Sheldrick, B., Hand Wang, C. (1993). Particle-size distribution. In: Carter MR, editor. Soil sampling and methods of analysis. Ann Arbor (MI): *Canadian Society of Soil Science/Lewis*. p. 499–511.
22. Nelson, D. W., & Sommers L. E. (1996). Total carbon, organic carbon and organic matter. In: Sparks DL, editor. Methods of soil analysis. Part 3. 2nd ed. SSSA Book Series No. 5. Madison (WI): ASA and SSSA. p. 961–1010.
23. Bremner, J. M. (1996). Nitrogen-total. In: Sparks DL, editor. Methods of soil analysis. Part 3. Chemical methods. 2nd ed. SSSA Book Series No. 5. Madison (WI): ASA and SSSA. p. 1085–1121.
24. Frank, K., Beegle, D., & Denning, J. (1998). Phosphorus. In: Brown JR, editor. Recommended chemical soil test procedures for the North Central Region. North Central Regional Research Publication No. 221 (revised). Columbia (MO): Missouri Agric. Exp. Stn. p.21–26.
25. Okalebo J. R, Gathua K. W, Woomer P. L. (2002). Laboratory methods of soil and plant analysis. A working manual. 2nd ed. Nairobi (Kenya): TSBF-CIAT, SACRED Africa, KARI, SSEA. 128 pp.
26. IITA. International Institute for Tropical Agriculture. (1979). Selected methods for soil analysis. Manual series No. 1. Revised edition, IITA Ibadan, Nigeria. 70pp.
27. Anderson, J. M., & J.S.I Ingram. (1996). Tropical Soils Biology and Fertility. A Hand book of Methods, 2nd ed. CAB Interactional pp 57 –74.
28. Tel, D. A., & Hagarty, M. (1984). Soil and Plant Analysis. IITA Ibadan/University of Guelph, Ontario, Canada, pp: 277.
29. Bruce, R. C., & Rayment, G. E. (1982). Analytical methods and interpretations used by the Agricultural Chemistry Branch for soil and land use surveys. Queensland Department of Primary Industries Bulletin QB82004
30. Okore, I. K., Aiyelari, P. O., & Tijani-Eniola, H. (2005). Influence of organic and inorganic fertilizers on the yield of some arable crops in south west Nigeria Environ Tropic. An International Journal of the Tropical Environment 2 (1&2) 84-90.
31. Natschner, L., & Schwetmann, U. (1991). Proton buffering in organic horizons of acid forest soils. Geoderma, 48, 93 – 106.
32. Agbede, T. M. (2010). Tillage and fertilizer effects on some soil properties, leaf nutrient concentrations, growth and sweet potato yield on an Alfisol in Southwestern Nigeria. S*oil Tillage Res*. (110), 25 – 32
33. Ano, A.O., & Agwu, J.A. (2005). Effect of animal manures on selected soil chemical properties. *Nigerian Journal of Soil Science*, 15, 14 – 19.
34. Adesodun, J.K., Mbagwu, J.S.C., & Oti, N. (2005). Distribution of carbon nitrogen and phosphorus in water stable aggregates of an organic waste amended ultisol in southern Nigeria. Bioresource Technol. 96, 509-516.
35. Ayuba, S.A., John, C., & Obasi, M.O. (2005). Effects of organic manure on soil chemical properties and yield of ginger - research note. *Nigerian Journal of Soil Science*, 15, 136 – 138.
36. Ibrahim, K. H. M., & Fadni, O. A. S. (2013). Effect of Organic Fertilizers Application on Growth, Yield and Quality of Tomatoes in North Kordofan (Sandy Soil) western Sudan. *Greener Journal of Agricultural Sciences*, 3 (4), 299 – 304.
37. Lal, R., & Kang, B. T. (1982). management of organic matter in soils of the Tropical In: soil management Abstracts 302 – 400 (2), 152 – 178.
38. Davis, A. S., Jacob, D. F., & Wight, K.E. (2006). Organic matter amendment of fallow forest tree seedling nursery soils influence soil properties and biomass of sorghums cover crop. Purdue University, West Lafayette, IN 112-118
39. Duruigbo, C L., Obiefuna, J. C., & Onweremadu, E. U. (2007). Effect of poultry manure rates on the soil acidity in an Ultisol. International Journal of Soil Science 2 (2), 154-158.
40. Khalil, M.I., Schmidhalter, U., & Gutser, R. (2005). Turnover of chicken manure in some upland soils of Asia: Agricultural and Environmental Perspective. Proc. Intl. Workshop, January 2005, Hamburg. pp: 275-292.
41. Michael, T., Phiwokwakhe, D., Wahome, P.K., & Oseni, T.O., (2010). Study the Effects of organic fertilizers on growth, yield, quality and sensory evaluation of red lettuce.Abjna, 1(6), 1319-1324.
42. Ajari, O., Tsado, L. E. k., Oladiran, J. A., & Salako, E. A. (2003). Plant height and fruit yield of okra as affected by field application of fertilizer and organic matter in Bida, Nigeria. The Nigeria Agricultural Journal, 34, 74-80.
43. Akanbi, W. B., Adediran, J. A., Togun, A. O., & Sobulo, R. A. (2000). Effect of organic- base Fertilizer on the growth, yield and storage life of tomato (*Lycopersiconesculentus* Mill) *Bioscience Research Communication* 12 (4), 439-444.
44. Akanbi, W. B. (2002). Growth, nutrient uptake and yield of maize and okra as influenced by Compost and nitrogen fertilizer under different cropping systems. Ph. D Thesis, University of Ibadan. Pp. 1-7.
45. Shah, S.T., Ghafoor, F., Khan, N., Sajid, M., Amin, N., Shah, Z., Bibi, S., Ahmad, T., & Haq, F. (2016). Organic fertilizer affect the growth

attributes of weeds and swiss chard. Pak. J. Weed Sci., 22(3), 463-470.

46. Balyeri, P.K., Otitoju, G.T., Abu, N. E., & Umeh, S. (2016). Poultry manure influenced growth, yield and nutritional quality of containerized aromatic pepper. *Afr. J. Agric. Res*. 11(23), 2013-2023.
47. Sudha, B., & Chandini, S. (2002). Nutrient management in rice *(Oryza sativa* L.) *J. of Trop. Agric*. 40, 63-64.
48. Preetha, D., Sushama, P. K., & Marykutty, K. C. (2005). Vermicompost + inorganic fertilizers promote yield and nutrient uptake of amaranth *(Amaranthus tricolor* L.). *J. of Trop. Agric*. 43 (1-2), 87-89.
49. Sharma, A. R., & Mittra, B. N. (1991). Direct and residual effects of organic materials and phosphorus fertilizer in rice based cropping system. *Indian J. Agron.* 36, 299-303.
50. Ojo, A. O., Adetunji, M. T., Okeleye, K. A., & Adejuyigbe, C. O. (2015). Soil fertility, phosphorus fractions, and maize yield as affected by poultry manure and single superphosphate. *International Scholarly Research Notices, 2015*, 8. https://doi.org/10.1155/2015/616213
51. Nahar, Z., Mistry, K. K., Saha, A. K., & Khaliq, Q. A. (2008). Response of nitrogen levels on yield of sesame (*Sesamum indicum* L). *South Asian Association for Regional Cooperation Journal of Agriculture*, *6*(1), 1-7.
52. Mandal, A., Ashok, K. P., Singh, D., & Rginald, M. (2009). Effects of long-term organic and chemical fertilization on N and P in wheat plants and in soil during crop growth. *Agrochimica, Pisa*, *53*, 79-91.
53. Ewulo, B. S., Hassan, K. O., & Ojeniyi, S. O. (2007). Comparative Effect of Cowdung Manure on Soil and Leaf Nutrient and Yield of Pepper. *International Journal of Agricultural Research*, *2*, 1043-1048. https://doi.org/10.3923/ijar.2007.1043.1048
54. Khaled, A. S., Mona, G., El-Kader, A., & Zeinab, M. K. (2012). Effect of soil amendments on soil fertility and sesame crop productivity under newly reclaimed soil conditions. *Journal of Applied Sciences Research*, *8*(3), 1568-1575.
55. Sharma D.H. (2004). Fundamentals of Soil Science 7th edition UK Longman. pp 13
56. Reddy, T.R., Rao, M., & Rao, K.R,(1990). Response of soybean (*Glycine max* L.) to nitrogen and phosphorous. *Indian J Agron* 35, 310-311.
57. Aliyu, L. (2002). Analysis of the chemical composition of some organic manure and their effect on theyield and composition of pepper. Crop. Res. 23, 362 – 8
58. Aliyu, L. (2003). Effect of manure type and rate on the growth, yield and yield component of pepper (Capsicum annum L.) J. Sustain. Agric Environ. 5, 92 – 8
59. Moyin-Jesu EI, Ojeniyi SO. 2006. Effects of sole and amended plant residues on soil nutrient contents and yield of okra (Abelmoschus esculentum L.). *Discov Innov J*. 18 (4), 318–326.