Effects of type and rate of organic and mineral fertilizer application on the performance of *Sesame indicum L.* in the Southern Guinea Savanna of Nigeria

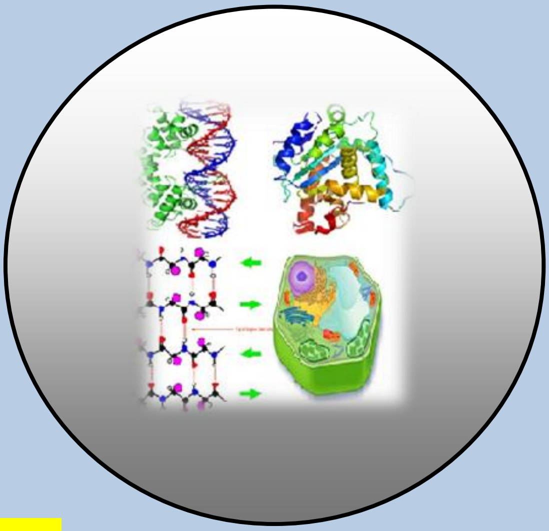
By

Ajibola, A.T., Modupeola T.O., Olatunji, O.O. and Akinleye, O.C.

ISSN 2319-3077 Online/Electronic
ISSN 0970-4973 Print

Journal Impact Factor: 4.275
Global Impact factor of Journal: 0.876
Scientific Journals Impact Factor: 3.285
InfoBase Impact Factor: 2.93
Index Copernicus International Value
IC Value of Journal 6.01 Poland, Europe

J. Biol. Chem. Research
Volume 32 (2) 2015 Pages No. 1027-1035



Journal of Biological and Chemical Research

An International Peer Reviewed / Refereed Journal of Life Sciences and Chemistry

Indexed, Abstracted and Cited in various International and National Scientific Databases

Published by Society for Advancement of Sciences®

J. Biol. Chem. Research. Vol. 32, No. 2: 1027-1035, 2015
(An International Peer Reviewed / Refereed Journal of Life Sciences and Chemistry)
Ms 32/2/148/2015

ISSN 0970-4973 (Print)
ISSN 2319-3077 (Online/Electronic)

http:// www.sasjournals.com
http:// www.jbcr.in
jbiolchemres@gmail.com
info@jbcr.in

RESEARCH PAPER

Received: 29/10/2015 Revised: 17/11/2015 Accepted: 21/11/2015

Effects of type and rate of organic and mineral fertilizer application on the performance of *Sesame indicum L.* in the Southern Guinea Savanna of Nigeria

Ajibola, A.T., *Modupeola T.O., Olatunji, O.O. and *Akinleye, O.C.
Department of Crop Production and Soil Science, Ladoke Akintola University of Technology. P.M.B. 4000, Ogbomoso, Oyo State, Nigeria.
*National Horticultural Research Institute, P.M.B 5432 Idi-Ishin, Jericho, Ibadan, Oyo State, Nigeria.

ABSTRACT

A field experiment was conducted at the Research Farm of Ladoke Akintola University of Technology, Ogbomoso, Nigeria to determine the effect of application of organic and mineral fertilizers on growth and yield of sesame plants and rates of Nitrogen fertilizer application on the performance of sesame var E8. Twelve treatment combinations of three types of fertilizers namely; tithonia compost, maize compost, urea and four rates of Nitrogen; 0, 60, 80, and 100 kg N/ha. Progressive increment in growth and seed yield parameters was observed as fertilizer rates increased up to 80 kg N/ha and decreased at 100 kg N/ha. Application of 80 kg N/ha produced the highest growth and yield of sesame. Application of 60, 80, and 100kg N/ha fertilizer resulted in 140, 350 and 170 % over the control. Tithonia compost produced the highest yield of sesame compared with maize compost and urea fertilizer. Generally, inorganic fertilizer (urea) resulted in lower yields compared to organic fertilizer (tithonia compost) in the production of sesame. Soil nutrient status was also enhanced as residual N increased slightly in all the treatment. However, phosphorus accumulation was highest with the application of tithonia compost at 80kg /ha. From the results of these experiments, it is indicative that application of tithonia compost at the rate of 80 kg N/ha is most suitable for the production of sesame and have the potential of improving the soils in the southern Guinea Savanna of Ogbomoso, Nigeria.
Key words: Sesame, Nitrogen Rates, Tithonia Compost and Maize compost.

INTRODUCTION

Sesame (*Sesamum indicum*) is an annual flowering plant with the genus Sesamum and family Pedaliaceae. It is an erect plant which grows between 50cm to 250cm tall depending on the variety, soil and environmental conditions (Sharma, 2005). It is an important oilseed crop with great commercial attributes by virtue of its oil having an edible quality and medicinal value. It yields 50-60% oil and the oil is highly stable against rancidity due to the presence of the natural antioxidants sesamin and sesamolin (Weiss, 2000). It is potentially capable of producing large quantities of seeds per unit area but the yield is low ha^{-1} due to lack of improved varieties and improper fertilization (Ahmad *et al*., 2001). In Nigeria, it is cultivated in the derived, northern and southern guinea, Sudan and Sahel savanna zones (Alegbejo *et al.*, 2003). The use of fertilizers is considered one of the most important factors to increase crop yields on per unit basis. The base element of all biological cells starts with nitrogen and its role cannot be substituted in crop production. Nitrogen is a component of protein and nucleic acids and an integral component of many other compounds essential for plant growth processes including chlorophyll and many enzymes. Its availability in sufficient quantity throughout the growing season is essential for optimum growth and when Nitrogen is sub-optimal, growth is reduced (Haque *et al.,* 2001 and Chen, 2006). Therefore, nitrogen deficiency or excess can result in reduced yield. The use of mineral fertilizers has not been helpful as it is associated with increased soil acidity and nutrient imbalance (Kang and Juo, 1980). Farming regions that emphasize heavy chemical application have led to adverse environmental, agricultural and health consequences (Shehata and El-khawas, 2003). One of the possible options to reduce the use of chemical fertilizers could be use of organic fertilizers (Azam *et al.,* 2011**)**. Organic manures can be used as an alternative for the inorganic fertilizers. They release nutrients rather slowly and steadily over a longer period and also improve the soil fertility status by activating the soil microbial biomass (Ayuso *et al*., 1996; Belay *et al*., 2001). Organic manure application sustains cropping system through better nutrient recycling and improvement of the soil physical attributes (El-Shakweer *et al*., 1998). Several organic materials have been reported as suitable soil amendments for increasing crop production (Agbede *et al.,* 2008; Ahmad *et al.,* 2001; Akanbi *et al.,* 2002). Nutrition studies in the tropics have shown that sesame perform well with the applications of organic or inorganic fertilizers (Olowe & Busari, 2000; Okpara *et al*., 2007). The objective of this study was to determine the growth and yield of sesame plant as influenced by the application of organic and mineral fertilizers.

MATERIAL AND METHODS

Field Experiment was conducted during the rainy seasons of 2011 at the Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Nigeria in the derived southern Guinea savannah agro-ecological zone of Nigeria 8^0 10'N and 40° 10'E. Ogbomoso area has a minimum temperature of 28°C and a maximum of 33°C. The humidity of the area is high (74%) all year round except in January when the dry wind from the north flows in. The annual rainfall is between 1150 mm-1250 mm. The experimental sites had been under cultivation of arable crops for several years before the experiment was set up. Ten core samples were randomly taken using 5mm soil auger at 0 -30 cm depth before planting. These were bulked, air-dried and sieved with 2 mm mesh sieve for analysis.

The soil pH in water was determined using soil water ratio of 1:2 by a pH meter with a glass electrode. Total N by Kjeldahl method, exchangeable K, Ca and Mg were extracted using ammonium acetate, K was determined on flame emission photometer and Ca and Mg by EDTA titration (Carter, 1993). Na was analyzed by using flame photometry. Available phosphorous was determined by Bray-1 extraction and determined colourimetrically by the molybdenum blue procedure (Bray and Kurtz, 1945). The pre-cropping soil sample used at the experimental location is sandy loam, well drained and has a slightly acidic pH 6.4 organic carbon (4.4%) available phosphorus (4.3mg/kg) and nitrogen (0.42%) (Table 1).

The treatments consist of four levels of fertilizer rates (0, 60, 80 and 100 N kg/ha) and three fertilizer types (tithonia, Maize compost and urea). The 12 treatment combinations were laid out in a randomized complete block design and replicated three times. The experimental plot was manually cleared and beds were constructed. The bed size was 3m by 3m. There were 12 beds in a replicated trial, giving a total of 36 beds. The organic fertilizers were incorporated two weeks before sowing. Sesame E-8 variety was used as a test crop, the seed is white in colour and early maturity at 90 days (Iwo *et al*., 2001). Four to six seeds of sesame were sown at 10cm intra-row spacing and spaced 60cm apart and was later thinned to one plant per stand at three weeks after planting. Hoe weeding was done at 3, 6, and 9 WAP to keep the experimental plots weed-free.

Data collection

Data collection commenced at 4WAP and continued on fortnight basis until maturity. Data were collected on growth and yield parameters. The growth parameters measured were plant height using measuring tape placed at the base of the main stem to the tip of the plant and the stem girth was measured by using vernier calliper at a height of 5cm above ground level. Data collection on number of branches commenced at 7WAP by direct counting of all developed branches per plant. Data collection on the number of pod per plant was done by direct counting. The crops were harvested when lower leaves, pods and stem turned to lemon yellow colour. During harvesting, 4 m^2 net plots were harvested separately by cutting the plants from ground level and these were bundled. Bundles of harvested plants were dried in sunshine. Later stalked bundles were inverted down and tapped with stick to separate the seeds. The seeds were dried, winnowed, cleaned and weighted. Seeds weight obtained from each net plot were recorded.

Data Analysis

All data collected were subjected to analysis of variance (ANOVA). The differences between treatment means were evaluated using Duncan's Multiple Range Test at 5% probability level.

RESULTS

Table 1 shows the physico-chemical properties of the soil before planting. The soil of the experimental site is sandy loam, well drained characterized by moderate pH 6.4, low in organic carbon (4.4), available phosphorus (4.3 g/kg) and nitrogen (0.42 g/kg) and exchangeable Ca (Akinrinde and Obigbesan, 2000) and below critical levels of some nutrients (Ibude *et al.,* 1988). This is in agreement with earlier observations that soils in south-west Nigeria were deficient in nutrients (Ojeniyi and Akanni, 2008; Agbede *et al.,* 2008).

Table 1. Pre-cropping physical and chemical properties of the soil samples used for the experiment.

Parameter	Value	Critical level*
pH (H_2O)	6.40	
Organic carbon (g kg $^{-1}$)	4.40	11.60
Total N (g kg $^{-1}$)	0.42	1.50
Available P (mg kg $^{-1}$)	4.30	8.50
Exchangeable K (cmol kg $^{-1}$)	1.32	0.16
Exchangeable Ca (cmol kg $^{-1}$)	1.35	1.50
Exchangeable Mg (cmol kg $^{-1}$)	2.29	0.28
Exchangeable Na (cmol kg $^{-1}$)	0.22	
Silt (%)	8	
Clay (%)	10	
Textural class	Sandy loamy	

Table 2. Effect of nitrogen rate on sesame plant height (cm).

	WAP					
Fertilizer level (kg N/ha)	2	4	6	8	10	12
NO	15.51b	20.28b	35.73b	73.15b	113.88a	127.38b
N1	14.71b	18.82b	32.43b	77.28b	115.2a	128.04b
N2	18.97a	24.36a	40.52a	88.67a	117.53a	144.06a
N3	15.7b	20.8b	36.73b	78.16b	105.47a	126.3b

Means with the same letter are not significantly different using Duncan's Multiple Range Test (DMRT) at 5% level of probability. N0 - 0 Nkg/ha, N1 - 60 N kg/ha, N2 - 80 N kg/ha, N3 - 100 N kg/ha, and WAP - weeks after planting.

Effect of nitrogen rates on growth and yield attributes of sesame

Results indicated significant differences in growth parameters among the treatments. Plant height exhibited a significant ($P < 0.05$) difference in all the Nitrogen rates applied at all sampling period except at 10 WAP (Table 2).

N rates significantly affected the stem girth of sesame throughout the period of sampling except at 2 and 4 WAP (Table 3). Maximum stem girth (125.11 cm) was recorded in N_2 (80 kg N/ha) treatment, which, was statistically similar to N_1 (60 kg N/ha) nitrogen rate (Table 2). Minimum stem girth (4.28 cm) was noted in the N_O (control) treatment. From 6 to 10 WAP stem girth increased linearly with increase in nitrogen rate to N2 (80 kg N/ha). Number of branches per plant, number of pod per plant and seed yield (kg/ha) exhibited a significant ($P < 0.05$) difference in all the Nitrogen rates. Maximum values were recorded in N_2 (80 kg N/ha) treatment, which, was significantly higher than the other nitrogen rates (Table 4). Number of branches per plant, number of pod per plant and seed yield (kg/ha) increased linearly with increase in nitrogen rate to N2 (80 kg N/ha). The rate of increase of number of branches per plant decreased from 125 % at 80 kg N/ha to 101 % at 100 kg N/ha over the control. The number of pod per plant and seed yield were 129, 242, 119 and 140, 350,170 % over the control at 60, 80, and 100kg N/ha

Table 3. Effect of nitrogen rate on sesame stem diameter (cm).

Stem girth (cm)					
Fertilizer level	Weeks After Planting				
(kg N/ha)	2	4	6	8	10
NO	2.03a	2.48a	2.77b	3.32b	4.23b
N1	1.96a	2.33a	3.02ab	3.77ab	4.47ab
N2	2.27a	2.64a	3.81a	4.57a	5.34a
N3	2.03a	2.18a	2.58b	3.64b	4.22b

Means with the same letter are not significantly different using Duncan's Multiple Range Test (DMRT) at 5% level of probability. N0 - 0 Nkg/ha, N1 - 60 N kg/ha, N2 - 80 N kg/ha, N3 - 100 N kg/ha, and WAP - weeks after planting.

Table 4. Effect of nitrogen rate on sesame number of branches/plant, number of pod/plant and seed yield (kg/ha).

Treatment	No of branches/plant	No of pod/plant	seed yield (kg/ha)
Fertilizer level			
(kg N/ha)			
N0	6b	33b	63.83b
N1	6ab	43b	89.50b
N2	8a	80a	223.38a
N3	7b	40b	108.33b

Means with the same letter are not significantly different using Duncan's Multiple Range Test (DMRT) at 5% level of probability. N0 - 0 Nkg/ha, N1 - 60 N kg/ha, N2 - 80 N kg/ha, N3 - 100 N kg/ha, and WAP - weeks after planting.

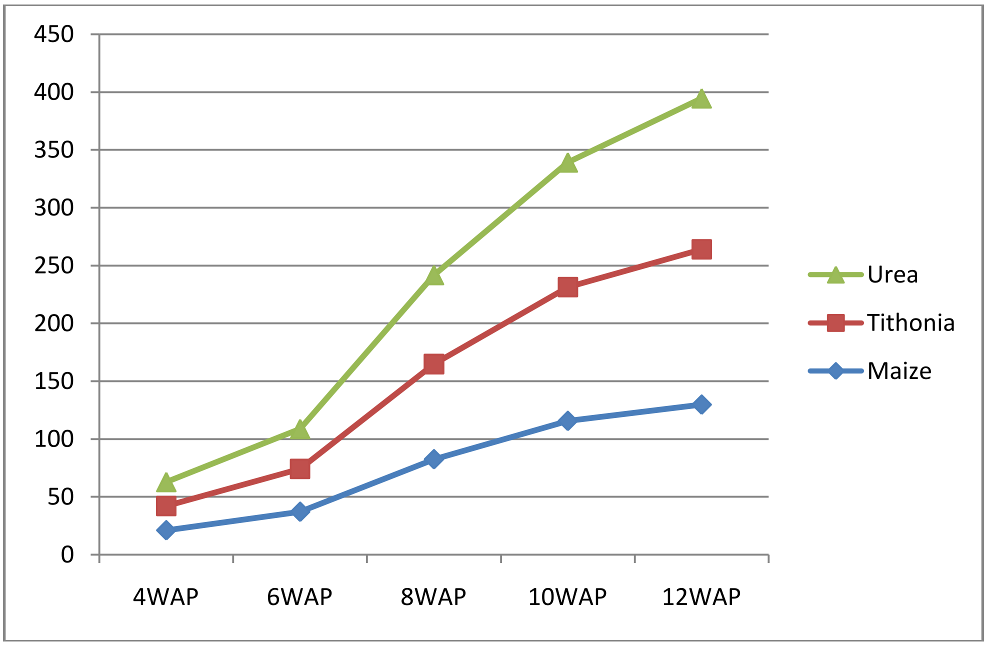


Fig 1. Effect of fertilizer types on sesame plant height.

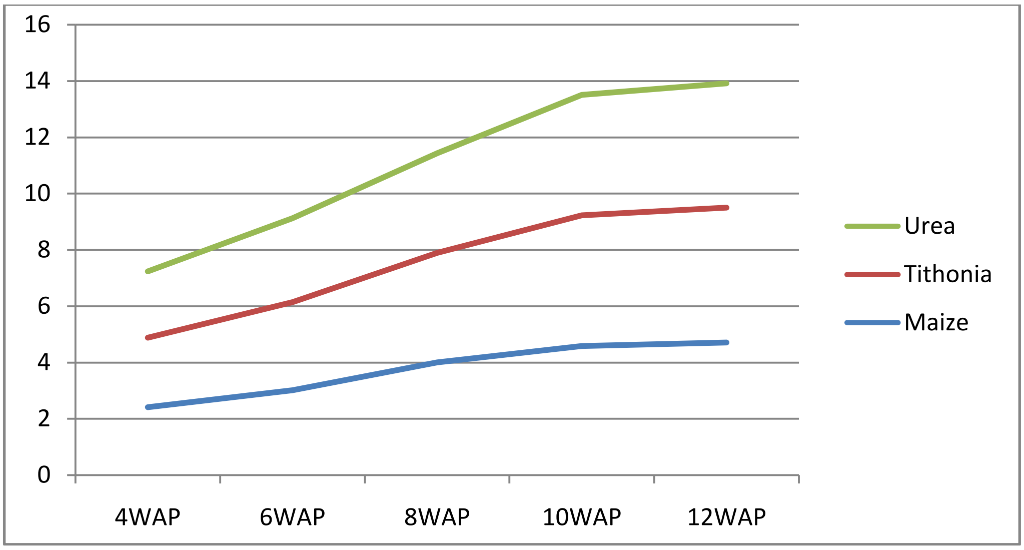


Fig 2. Effect of fertilizer types on sesame stem girth.

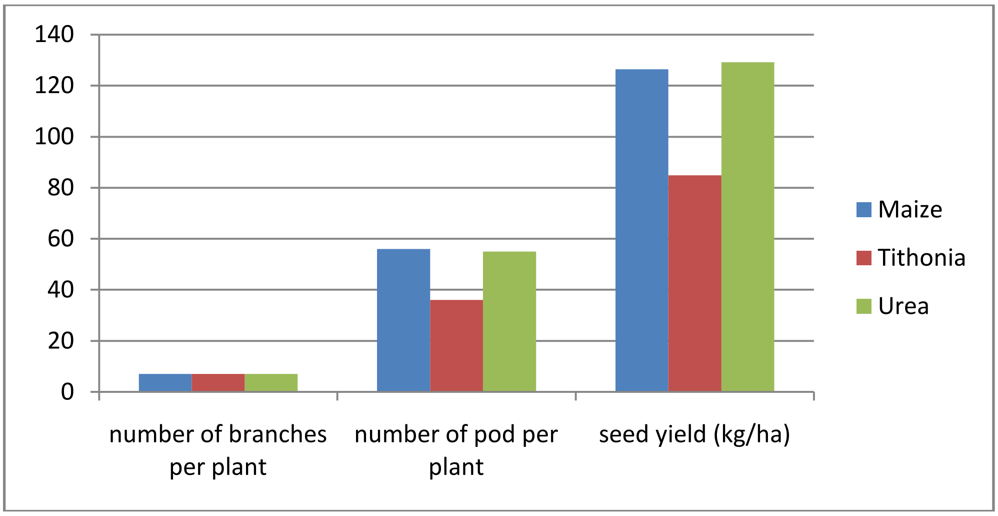


Fig 3. Effect of fertilizer types on number of branches/plant, number of pod/plant and seed yield (kg/ha).

Relative Effect of Different Source of Nitrogen fertilizer on Growth of sesame

Fertilizer types had significant effect on plant height and stem (Fig 1 and 2 respectively). Tithonia fertilizer recorded the highest values in plant height, stem girth while the least value was observed in urea. Significant differences were observed in number of pod/plant and seed yield except the number of branches (Fig 3). The highest values were observed in tithonia fertilizer treatment, while and the least values were observed in urea fertilizer treatment for number of pod/plant and seed yield.

DISCUSSION

From the results obtained, it was observed that growth, yield and yield attributes of sesame were significantly increased by the application of tithonia, maize and urea fertilizers. This could be attributed to the low nutrient status of the soil which was grossly low and nutrients inadequate for crop production and therefore required artificial supply of nutrients or application of fertilizer materials to meet sesame requirements for improved growth and yield of sesame as experimented.

These results are in agreement with other earlier researchers (Babajide *et al.,* 2008; Akanbi, 2002; Makinde *et al.,* 2007), who reported that the soils at the study areas are grossly inadequate in nutrients to support successful completion of the vegetative and reproductive stages of most tropical crops. The fertilizers have the ability to supply nutrients contained in them gradually to support crop growth which later translated to high growth and yield attributes (Aliyu, 2003; Haruna and Abimiku, 2012). Growth, and yield attributes of sesame were optimized at 80 kg N/ha application. This is not surprising as sesame plants grown with 80 kg N/ha compost has more nutrients for uptake, and biosynthesis and accumulation of photosynthates. This invariably led to the production of plants with higher plant height and stem girth. According to Togun and Akanbi, (2003), better plant performances are associated with plants that received adequate amount of fertilizer. This made available adequate amount of nutrients required for plants to successfully complete its vegetative and reproductive phases. This might be the reason for the observed poor performance of plants that were not fertilized.
In this study number of pod per plant and seed yield of sesame grown with organic fertilizers showed better growth and resulted in a higher number of pods and yield than those grown with chemical fertilizer. Similar results were obtained with vegetables (lettuce) (Xu *et al.,* 2005 ; Michael *et al*., 2010) .This is also in line with the work of Owen (2003), who reported that industrial fertilizers do not possess good characteristics of aggregating the soil particles, as a result, the plants produced by inorganic fertilizers showed relatively lower yield compared to organic materials.

CONCLUSION

It can be concluded from this research that application of tithonia compost produced the highest yield of sesame compared with maize compost and urea fertilizer. Inorganic fertilizer (urea) resulted in lower yields compared to organic fertilizer (tithonia or maize compost) in the production of sesame.

ACKNOWLEDGEMENTS

The technical assistance received by Akindele Ibukunoluwa Olaide and Adedokun Ayoade Ademola of the student of Ladoke Akintola University of Technology Ogbomoso, Nigeria is hereby acknowledged.

REFERENCES

Agbede, T.M., Ojeniyi, S.O. and Adeyemo, A.J. 2008. Effect of poultry manure on soil physical and chemical properties, growth and grain yield of sorghum in southwest Nigeria. *American-Eurasian Journal of Sustainable Agriculture 2, 72-77.*

Ahmad, A., M. Akhtar, A. Hussain and Musaddique, M. 2001. Genotypic response of sesame to nitrogen and phosphorus application. *Pakistan J. Agric. Sc.* 38: 12-15.

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, Department of Crop Protection and Environmental Biology University of Ibadan, Nigeria. 228

Akinrinde, E. A. and Obigbesan, G. O. 2000. Evaluation of the fertility status of selected soils for crop production in five ecological zones of Nigeria. Proceedings 26th Annual Conference of Soil Science Society of Nigeria, Ibadan. Pp. 279 -288.

Alegbejo, M. D., Iwo, G. A., Abo, M. E. and Idowu, A. A. 2003. A potential industrial and export oilseed crop in Nigeria. Journal of Sustainable Agriculture, Vol. 23 (1). The Haworth Press, Inc.

Aliyu, L. 2003. Effect of nitrogen and phosphorus on the chemical composition and Uptake of mineral elements by pepper (*Capsicum annum* L.). *Crop Research,* 25(2), 272-279.

Amon, B.O.E. 1965. The response by crops in maize/sweet potato intercropping system". Korean J. relation to nitrogen, phosphorus and potassium in Crop Sci., 46(1): 1-5.

Ayuso, M.A, Pascal. J.A, Garcia C., Hernandez, T. 1996. Evaluation of urban wastes for urban agricultural use. *Soil Sci. Plant Nutr*., 42:105- 111.

Azam, H., Gholamreza, H., Yosuf, S., Hedieh, B. and Khosro, M. 2011. Influence of bio organic and chemical fertilizers on medicinal pumpkin traits. *Journal of Medicinal Plants Research* Vol. 5(23), pp. 5590-5597.

Babajide, P. A., Olabode, O. S., Akanbi, W. B., Olatunji, O. O. and Ewetola, E. A. 2008. Influence of composted Tithonia mineral fertilizer on soil physic properties and performance of Tomato (Lycopersicon lycopersicum). *Research Journal of Agronomy* 2(4): 101-106.

Belay, A., Classens, A.S., Wehner, F.C., De Beer, J.M. 2001. Influence of residual manure on selected nutrient elements and microbial composition of soil under long term crop rotation. *S. Afr. J. Plant Soil*, 18:1-6

Bray, H.R., and Kurtz, L.J 1945. Determination of total organic and available phosphorus in soils. *Soil Science* 59: 39-41.

Carter, M. R. 1993. Soil Sampling and Methods of Analysis. Canadian Society of Soil Science. Lewis Publishers, London, pp.823.

Chen, J. 2006. The combined use of chemical and organic fertilizer and or biofertilizer for crop growth and soil fertility. International Workshop on Sustained Management of the Soil-Rhizosphere System for Efficient Crop Production and Fertilizer Use. October, Thailand, pp. 16-20.

El-Shakweer, M. H. A., El-Sayad, E. A., Ewees, M. S. 1998. Soil and Plant analysis as guide for interpretation of the improvement efficiency of organic conditioners added to different soils in Egypt. Communication in soil science and plant analysis. 29:2067-2088.

Haruna and Abimiku. 2012. Yield of Sesame (*Sesamum indicum* L.) as Influenced by Organic Fertilizers in the Southern Guinea Savanna of Nigeria. Sustainable Agriculture Research 1:66- 69.

Haque, M. M., Hamid, A. and Bhuiyan, N. I. 2001. International Conference on Nitrogen cycling in "Nutrient uptake and productivity as affected by West Africa's Ecosystems nitrogen and potassium application levels n 20. pp: 311-375.

Ibude, M. A, Unambra, R. P. A. and Udealor, A. 1988. Soil management strategies in relation to farming system development in the South Eastern Agricultural Zone of Nigeria. Paper presented at the National Farming system Research Workshop, Jos, Plateau State, Nigeria, 26-29 p.

Iwo, A. A., Idowu, G. A. and Misari, S. 2001. Recommendations for Registration and Release of Five Sesame (Benniseed) Varieties Submission to The Release Committee .April 2001 National Genetic Resources and Biotechnology ,Moor Plantation Ibadan.

Kang, B. T. and Juo, A. S. R. 1980. Management of low activity clay soils in tropical Africa for food production. In Terry E. R., Oduro, K. A. and Caveness, F. (eds) Tropical root crops: Research strategies for the 1980s. Ottawa, Ontario, IDRC pp: 129-133.

Makinde, E. A., Ayoola, O.T. and Akande, M. O. 2007. Effects of organo-mineral fertilizer application on the growth and yield of egusi melon. *Australian J. Basic Appl. Sci.,* 1:15-19.

Michael, T. M., Mduduzi M. H., Olusegun, T. O. and Thokozile, E. S. 2010. Effects of organic fertilizers on growth, yield, quality and sensory evaluation of red lettuce (*Lactuca sativa* L.) 'Veneza Roxa' *Agriculture and Biology Journal of North America* (6):1319-1324.

Ojeniyi, S.O. and Akanni, D.I. 2008. Effect of animal manures on soil properties, leaf nutrient composition, growth and yield of pepper *(Capsicum annum). Journal of Research in Agriculture 5(4), 86-90.*

Okpara, D.A., Muoneke, C.O. and Ojikpong, T.O. 2007. Effects of nitrogen and phosphorus fertilizer rates the growth and yield of sesame (*Sesamum indicum* L.) in the south eastern rainforest of Nigeria. *The Nigerian Agric. J.* 38: 1-11.

Olowe, V.I.O. and Busari, L.D. 2000. Response of sesame (Sesamum indicum L.) to Nitrogen and Phosphorous application in southern Guinea savanna of Nigeria. *Tropical Oilseed Journal* 5: 30-37.

Owen, P. 2003.Origin and distribution of lettuce.
http://www.calettuceresearchboard.org/Origin.html (16/08/2008).

Sabah El-khier, M. K., Ishag, K.A. and Yagoub, A.A. 2008. Chemical composition and oil characteristics of sesame seed cultivars grown in Sudan. *Research Journal of Agriculture and Biological Sciences*, 4 (6):761-766.

Sharma, P. B. 2005. Fertilizer management in Sesame (Sesamum indicum intercropping system in Tawab Commandarea, *Journal of Oilseeds Research*, 22: 63-65.

Shehata M.M and El-khawas S.A. 2003. Effect of biofertilizers on growth parameters, yield characters, nitrogenous components, nucleic acids content, minerals, oil content, protein profiles and DNA banding pattern of sunflower (*Helianthus annus* L. cv. Vedock) yield. *Pak. J.Biol. Sci.,* 6(14): 1257-1268

Togun, A.O. and Akanbi, W.B. 2003. Comparative effectiveness of organic based fertilizer to mineral fertilizer on tomato growth and fruit yield. *Compost Science and Utilization Vol. 11, No. 4:337-342.*

Weiss, E. A. 2000. Oilseed crops. 2nd Ed. Oxford: *Blackwell Science*. Oxford, U.K

Xu, H.L., Wang, R., Xu, R.Y., Mridha, M.A.U. and Goyal, S., 2005. Yield and quality of leafy vegetables grown with organic fertilizations. *Acta Hort*., 627: 25-33.

Corresponding author: Modupeola T.O. National Horticultural Research Institute, P.M.B 5432 Idi-Ishin, Jericho, Ibadan, Oyo State, Nigeria.
Email: atopson@yahoo.com