PAT December, 2019; 15 (2):203-211 ISSN: 0794-5213
Online copy available at www.patnsukjournal.net/currentissue
Publication of Nasarawa State University, Keffi

Effects of Phosphorus Fertilizer Sources on Growth, Yield and Nutrient Uptake of Cowpea *(Vigna Unguiculata* (L.) Walp) On Sandy Loam in Ondo, Nigeria.

Adegoke J.O., Ogunrewo O. M. and Olabode B. E
Department of Agriculture, Wesley University, Ondo, Nigeria.
Corresponding author: Julius. O. ADEGOKE, juliusgoke@yahoo.com
Tel:+234-8066630568

Abstract
Phosphorus (P) is important for cowpea production and is inherently low in many tropical soils. The resultant effect is poor yield. Practices recommended to ameliorate this include the application of mineral and organic fertilizers. This study evaluated the effectiveness of sole and combined applications of single super phosphate (SSP), Alesinloye compost (AC) and moringa leaves (ML) for growth, yield and nutrient uptake of improved variety of cowpea on sandy loam, in Wesley University, Ondo, Nigeria. A screen house (five kg soil/pot) study was carried out at the Agriculture Department, Wesley University, Ondo, Nigeria. Treatments consisted of control as well as single super phosphate (SSP), Alesinloye compost (AC), moringa leaves (ML) and their combinations (AC + ML, AC + SSP, ML + SSP) in ratio 1:1. All the fertilizer types were applied at 40 kg P_2O_5 ha^{-1}(P requirement of the test crop). Treatments were replicated four times in a completely randomized design using cowpea variety 07K-292-10, giving a total of 28 pots. Data on growth parameters (plant height, number of leaves), yield parameters (biomass, pod weight and grain yield) as well as nutrient uptake were analysed using ANOVA ($P < 0.05$) while treatment means were separated by Duncan's Multiple Range Test. Cowpea plants parameters increased in all fertilizer types over the non-treated control. However, plant height and number of leaves were significantly ($P < 0.05$) superior with combined use of ML + SSP and AC + SSP respectively. In terms of biomass yield, plant parameters increased significantly in the treatment that had sole application with single super phosphate having the highest yield. The combination of ML + SSP gave highest response and was significantly ($P < 0.05$) higher in pod yield, grain yield as well as nutrient uptake. Therefore, combined application of moringa leaves and single super phosphate at 40 kg P_2O_5 ha^{-1} is recommended for optimum production of the cowpea variety, 07K-292-10 on sandy loam soil in Wesley University, Ondo State and its environs.
Keywords: *cowpea variety, phosphorus fertilizer types, nutrient uptake, sandy loam.*

Introduction

The capacity of tropical soils to grow food and fiber has progressively decreased each year. This is largely due to the decline in soil fertility as a result of inherent fragile characteristic of the tropical soils (Adeoye *et al.,* 2005). Soil degradation leading to nutrient depletion has been considered a serious threat to agricultural productivity and a major cause of falling crop yields and per capita food production in sub-Saharan Africa (Banful, 2009). The traditional method of bush fallow and shifting cultivation are no longer sustainable due to population pressure and industrialization (FFD, 2012), hence the campaign for soil amendment inputs as alternatives to improve soil nutrient status, for better crop yield in the sub-Saharan Africa. The use of inorganic (mineral) fertilizers as soil amendment for supplying plant nutrients has been the conventional practice for a long time. However, the intensive use of these mineral fertilizers has been associated with declined soil organic matter content, increase in soil acidity, nutrient imbalance and degradation of soil physical properties leading to soil erosion, with resultant reduction in crop yield over time (Asawalam, 2009; Hepperly *et al.,* 2009; Awanlemhen and Ojeniyi, 2012). The long- term use of mineral fertilizers, especially the nitrogenous ones at high rates, could be harmful to soil microorganisms (Barabasz *et al.,* 2002; Mandic *et al.,* 2011) and consequently reduce normal development of crops. Cowpea (*Vigna uniguiculata* L. Walp) is a member of the plant family *Fabaceae*. It is an important grain legume cultivated with in the tropics and subtropics covering 12.5 million hectares with annual production of about 3 million tonnes (FAO, 2005). Although it occupies a smaller proportion of the crop area than cereals, it contributes significantly to household food security in west and Central Africa. Nigeria is one of the largest producers of cowpea with an average production of 2.92 million tons followed by Niger with 1.10 million tons (FAO, 2012). In addition, Nigeria contributes to about 58% of the world cowpea production producing 2.2 million metric tons of dried grain and 61% production in Africa. (IITA, 2009). The crop is the most widely cultivated pulse throughout the world and is found practically in every market especially in Nigeria. Cowpea is grown primarily for its cheap source of dietary protein, lysine and as a substitute for meat (Bressani, 1985).Virtually, all component of the crop are important source of food; the young leaves and shoots are consumed as spinach and provide one of the most widely used pot herbs in tropical Africa (Onwueme *et al.,* 1991). From a single plant, one may be able to have several products such as leaves, immature pods, as well as immature and matures seeds.

Phosphorus often comes from different sources which could be organic or inorganic. Common example of inorganic phosphorus sources are single superphosphate and triple superphosphate while rock phosphate, manure and composts are examples of organic sources. However, the use of inorganic phosphate fertilizer poses problems like unavailability in remote area, high cost and high risk in heavy rainfall thereby making organic sources of P good substitutes for the less available and expensive inorganic P fertilizers. Also farmers using mineral fertilizer for many years often notice that soil exhaustion shown by the sick appearance of plants, leaves discoloration, retarded growth and low yields (Neil and Ray, 1999). Organic materials such as farm yard manure, poultry manure, green manure, crop residue, water weeds, city waste etc. have been reported as a suitable substitute for inorganic fertilizers to maintain sustainable crop production and environmental quality (Pawar *et al.,* 2003). The complementary use of organic and inorganic fertilizers has been recommended for sustenance of long term cropping in the tropics. Nutrients from mineral fertilizers enhance the establishment of crops while those from mineralization of organic manures promoted yield when both fertilizers were combined (Ipimoroti *et al.,* 2002). Therefore, the objective of this study was to assess the effect of using different phosphorus fertilizer sources on growth, yield and nutrient uptake of cowpea.

Materials and Methods

The experiment was carried out between July and November, 2019 in the screen-house of the Department of Agriculture, College of Agriculture, Food Science and Technology, Wesley University, Ondo, Nigeria located latitude 7^0 20^1N and 3^0 5^1E. The soil samples collected from the field were taken to the laboratory for the determination of pre-cropping physicochemical properties. A representative sample of the soil was taken to the laboratory at Institute of Agricultural Research and Training (I.A.R.T), Ibadan for pre-cropping physical and chemical properties. The analysis included pH, total nitrogen, available phosphorus, organic carbon, exchangeable cations (Ca, K and Mg), micronutrients (Cu, Fe, Zn, and Mn) and particle size analysis. Samples of conventional compost and moringa leaves were also randomly taken for analysis. The cowpea variety used was the early maturing type 07K-292-10 sourced from International Institute of Tropical Agriculture (IITA), Ibadan. Each fertilizer was applied to meet the recommendation of the test crop, which is 40 kg P_2O_5/ha (Ajeigbe *et al.*, 2010). The treatments applied were as follows:

T_1 = Control (No soil additive)

T_2 = 40 kg P_2O_5/ha through mineral fertilizer only (SSP at 100%)

T_3 = 40 kg P_2O_5/ha through conventional compost only (Alesinloye compost (AC at 100%)
T_4 = 40 kg P_2O_5/ha through moringa leaves only (ML at 100%)
T_5 = 40 kg P_2O_5/ha through AC + SSP at 50:50
T_6 = 40 kg P_2O_5/ha through AC+ ML at 50:50
T_7 = 40 kg P_2O_5/ha through ML + SSP at 50:50

The organic materials were milled to powder so as to increase its surface area and enhance reactivity. They were weighed and mixed with the 5 kg capacity soil and allowed to mineralize for 2 weeks before seeds were sown. The soils were air dried, sieved with 2mm sieve and filled into 5kg polythene bags. The polythene bags were labeled according to their respective treatment combinations. They were randomly arranged on metal table and they were watered. Thinning was carried out after 9 days of sowing leaving two vigorous seedlings per pot. The first hand weeding operation was carried out at four weeks after sowing and other subsequent operations done as necessitated by weed occurrence. Cypermethrin was applied fortnightly at the rate of 2ml per litre of water to control insect pest attack from two weeks after sowing and continued until podding. The experiment involved seven fertilizer application replicated four times arranged in a completely randomized design (CRD) giving a total of 28 pots. The following data were collected: number of leaves per pot, plant height (cm), number of pod per pot, biomass yield and pod weight per pot. Nutrient uptake was calculated as described by Ombod and Isokari (1994) using the formula: Nutrient uptake = % nutrient content in plant tissue × DYM (g/plant); where DYM is the dry matter yield. Data collected were subjected to statistical analysis of variance using General Statistical Package (GENSTAT) 4th edition. Significantly different means were separated using Duncan's Multiple Range Test (DMRT) at 5 % probability level.

Results

The result of the pre-planting soil analysis is shown in Table 1. The soil collected from Wesley University, Ondo was slightly acidic. The result showed that the soil was low in N and P. Organic carbon was below the 20 g/kg considered as critical for soils of southwestern Nigeria (FFD, 2012), high in exchangeable calcium and magnesium, sufficient in exchangeable K and Na (Landon, 1984). The textural class was sandy loam. Moreover, the results of macronutrient and micronutrient content of conventional compost and moringa leaves are shown in Table 1. The result of the proximate composition (Table 1) of both Alesinloye compost and moringa leaves contained plant nutrients and carbon appreciably.

Effect of different fertilizer sources on cowpea plant height (cm)

The results of the fertilizer treatments on height of cowpea plants are presented in Table 2. The result showed that there was no significant difference ($p>0.05$) among the treatment means of cowpea plants at 3 and 5 weeks after sowing (WAS). However, there were significant differences among the treatment means across all the treatment means at 7 WAS. The 40 kg P_2O_5/ha ML+ SSP resulted into the highest plant height (19.55 cm) at 7 WAS which was not significantly different from others except the control treatment which gave the least mean plant height (13.25 cm).

Effect of different fertilizer sources on number of leaves of cowpea

At 3 weeks after sowing WAS, the result showed that there was no significant difference among the treatment means of cowpea plants. At 5 WAS, 40 kg P_2O_5/ha AC+ SSP resulted into highest value (19.5), which was not significantly different from others, except 40 SSP kg P_2O_5/ha

(14.8), 40 kg P_2O_5/ha ML (14.8) and the control treatment (14.0). At 7 WAS, 40 kg P_2O_5/ha AC+ SSP also gave the highest mean number of leaves (18.3) which was not significantly different from others except the control treatment which gave the least mean number of leaves (11.3).

Table 1: Some physical and chemical properties of soil, compost and moringa leaves used in the experiment.

Parameters	Soil	Conventional compost	Moringa leaves
pH (1:1, H_2O)	6.0	9.7	N/A
Org C (g/kg)	8.3	170	N/A
Total N (g/kg)	0.7	12	27.9
Available P (mg/kg)	6.7	8	4.2
Exchangeable base (cmolkg^{-1})			
K	0.3	17	18.5
Ca	1.3	3.2	19.2
Mg	0.8	1.0	1.9
Na	0.3	4	
Extractable micronutrients (mgkg^{-1})			
Mn	32.68	393	4.4
Fe	89	1670	52.9
Zn	1.04	186	10.6
Cu	0.67	78	7.5
Particle size distribution (g/kg)			
Sand	620	N/A	N/A
Silt	226	N/A	N/A
Clay	154	N/A	N/A
Textural class (USDA)	Sandy loam	N/A	N/A

N/A- not applicable

Table 2 Plant height (cm) of cowpea as influenced by different fertilizers sources.

	weeks after sowing		
Treatments (kg P_2O_5/ha)	3	5	7
Control	6.72	9.50	13.25c
Moringa leaves (ML)	8.22	11.62	15.95ab
Alesinloye compost (AC)	7.92	12.25	16.35a
Single Super Phosphate	8.67	11.82	14.95ab
ML+AC (1:1)	8.22	12.78	16.20a
ML+SSP (1:1)	8.32	13.10	19.55a
AC+SSP (1:1)	8.02	12.75	16.38a
	ns	ns	

ns: not significant; Means with the same letter(s) in a column are not significantly different at 5 % level of probability by Duncan Multiple Range Test (DMRT).

Table 3 Number of leaves of cowpea as influenced by different fertilizers sources.

Treatments (kg P_2O_5/ha)	weeks after sowing 3	5	7
Control	10.25	14.00b	11.25b
Moringa leaves (ML)	10.75	14.75b	16.50ab
Alesinloye compost (AC)	13.00	16.50ab	15.75ab
Single Super Phosphate	11.00	14.75b	15.25ab
ML+AC (1:1)	11.50	17.00ab	15.75ab
ML+SSP (1:1)	10.75	16.25ab	14.25ab
AC+SSP (1:1)	14.00	19.25a	18.25a
	ns		

ns: not significant; Means with the same letter(s) in a column are not significantly different at 5 % level of probability by Duncan Multiple Range Test (DMRT).

Effect of different fertilizer sources on dry matter yield (g/ pot) of cowpea plants

The results of the effect of different fertilizer sources on dry matter (g/ pot) of cowpea plants are presented in Table 4. The result revealed that there were significant differences among the treatment means. In terms of shoot, 40 kg P_2O_5/ha SSP gave the highest mean shoot weight (3.9 g/ pot) which was significantly different from others, but statistically at par with 40 kg P_2O_5/ha ML (2.8 g/ pot), 40 kg P_2O_5/ha AC (2.2 g/ pot), 40 kg P_2O_5/ha ML+SSP (3.7 g/ pot) and 40 kg P_2O_5/ha AC+SSP (2.5 g/ pot). In terms of root, 40 kgP_2O_5/ha SSP still gave the highest mean root weight (1.1 g/ pot) which was significantly different from control (0.4g) and 40 kg P_2O_5/ha ML+AC but statistically at par with other treatments.

Table 4. Dry matter yield (g / pot) of cowpea as influenced by different fertilizer sources.

Treatments (kg P_2O_5/ha)	Shoot	Root	Pod	Grain
Control	0.66c	0.43b	0.43c	0.34c
Moringa leaves (ML)	2.78ab	0.88ab	1.22bc	0.95bc
Alesinloye compost (AC)	2.16abc	0.64ab	1.61b	1.25bc
Single Super Phosphate	3.89a	1.14a	1.89b	1.37b
ML+AC (1:1)	1.59bc	0.47b	2.14b	1.36b
ML+SSP (1:1)	3.69ab	0.88ab	4.13a	3.47a
AC+SSP (1:1)	2.47abc	0.65ab	3.44a	2.74a

Means with the same letter(s) in a column are not significantly different at 5 % level of probability by Duncan Multiple Range Test (DMRT).

Pod dry weight of plants from 40 kg P_2O_5/ha ML+SSP gave the highest dry pod yield (4.13 g/ pot), but was not significantly different ($p>0.05$) from plants in pots treated with 40 kg P_2O_5/ha AC+SSP (3.44 g/ pot). However, 40 kg P_2O_5/ha ML+SSP was significantly different ($p<0.05$) from other treatments while the lowest mean pod yield (0.43 g/pot) was recorded in the unfertilized treatment. A similar result was obtained on grain yield. It was observed that 40 kg P_2O_5/ha ML+SSP gave the highest mean grain yield (3.47 g/ pot) but was not significantly different ($p>0.05$) from plants in pots treated with 40 kg P_2O_5/ha AC+SSP (2.74g/ pot). 40 kg P_2O_5/ha ML+SSP was significantly different ($p<0.05$) from other treatments while the lowest mean pod yield (0.34 g/pot) was recorded in the unfertilized treatment.

Phosphorus concentration (%) and uptake (g / pot) in cowpea plant as influenced by different fertilizer sources.

Phosphorus concentration in cowpea plant (%) as influenced by different fertilizer sources is shown in Table 5. Cowpea plant grown with 40 kgP_2O_5/ha ML+SSP gave the highest value (0.071 %) which was not significantly better than others, followed by 40 kgP_2O_5/ha SSP (0.054 %) which was not significantly different from 40 kgP_2O_5/ha AC+ML (0.052 %), 40 kgP_2O_5/ha AC (0.051 %), 40 kgP_2O_5/ha AC+SSP (0.046 %), 40 kgP_2O_5/ha ML (0.046 %), but significantly ($p<0.05$) higher than control treatment which resulted into lowest (0.039 %) value. In terms of P uptake, the result showed that 40 kgP_2O_5/ha ML+SSP gave the highest mean value (0.30 g / pot) which was not significantly different from 40 kgP_2O_5/ha SSP (0.28 g / pot), but was significantly higher than 40 kgP_2O_5/ha ML (0. 17 g / pot), 40 kgP_2O_5/ha AC+SSP (0.14 g / pot), 40 kgP_2O_5/ha AC (0.14 g / pot) and 40 kgP_2O_5/ha AC+ML (0.11 g / pot). The lowest P uptake (0.04 g/pot) was recorded in the unfertilized treatment.

Table 5. Nutrient content (%) and uptake (g/ pot) of cowpea as influenced by different fertilizer sources.

Treatment kgP_2O_5/ha	Nutrient content (%)	Nutrient uptake (g / pot)
	Phosphorus (P)	Phosphorus (P)
Control	0.03c	0.04c
Moringa leaves	0.04ab	0.17ab
Alesinloye compost	0.05ab	0.14ab
Single Super Phosphate	0.06a	0.28a
ML+AC (1:1)	0.05a	0.11ab
ML+SSP (1:1)	0.07a	0.30a
AC+SSP (1:1)	0.05ab	0.14ab

Means with the same letter(s) in a column are not significantly different at 5 % level of probability by Duncan Multiple Range Test (DMRT).

Discussion

In this study, it was evident that cowpea responded to soil amendment with different fertilizer sources and it was observed in the growth, biomass yield, nutrient content and nutrient uptake of the test crop which differed significantly ($p<0.05$) among the different fertilizer sources. The higher values of the fertilizer treated cowpea in height, biomass yield, nutrient content and nutrient uptake over the control indicated that the soil was low in fertility, thus the observed response to added fertilizers. This suggests the need for these fertilizer materials as nutrient supplier to the soil. The highest plant height cowpea was observed from the combined application of 40 kgP_2O_5/ha moringa leaves and single super phosphate while the unfertilized pots recorded the lowest plant height. This could be due to an improvement in soil fertility as a result of the presence of adequate quantity of organic matter and micro nutrients in the moringa leaves that was used for the experiment. This finding is in agreement with the investigation of Olusegun, (2014) who found that combined application of organic manure and inorganic nitrogen fertilizer resulted in the highest height of cowpea as compared to sole application of either organic manure or inorganic nitrogen fertilizer. The maximum number of leaves per plant were recorded in the combined application of 40 kgP_2O_5/ha Alesinloye compost and single super phosphate. This might be due to the slow but consistent release of plant nutrients from Alesinloye compost aided by inorganic nitrogen fertilizer that could have helped the soil microorganisms in the faster decomposition of the poultry manure which leads to the availability of plant nutrients. This confirmed the report of Eghball *et al.* (2004), AyanfeOluwa *et al.* (2015) that organic materials are known to release nutrients slowly and guarantees the longer supply of nutrients. This is because the nutrients contained in organic fertilizers would first ingested by the soil microorganisms and the nutrients released gradually as the microorganisms die (Abou Ed-magd *et al.,* 2005; Deenik, 2006). The highest grain yield was produced by combined application of 40 kgP_2O_5/ha moringa leaves and single super phosphate, which was not significantly different from addition of Alesinloye compost and single super phosphate. This might be due to integration of organic manure and nitrogen fertilizer that benefits the plants in supplying balanced nutrients and improvement in the soil physical and chemical properties. Olusegun (2014) reported that plant nutrients from inorganic fertilizers enhance the establishment of crops while those from mineralization of organic manure promoted yield when both fertilizers were combined. Similarly, Yoganathan *et al.,* (2013) reported that the highest grain yield of cowpea was obtained by combined application of poultry manure and inorganic nitrogen fertilizer than single application of poultry manure and inorganic nitrogen fertilizer. Also Adeniyan and Ojeniyi (2005) reported similar results. The combined treatments 40 kgP_2O_5/ha moringa leaves and single super phosphate promoted significantly ($P < 0.05$) higher P uptake than the sole organic or inorganic treatments. This may be due to the fact that the combined treatments improved the soil environment which was efficiently exploited by the cowpea plants as compared to the sole organic or inorganic treatments. The higher uptake of P was attributed to continuous and steady supply of available nutrient throughout crop growth period because application of organic and inorganic inputs. Similar findings were also reported by Tiwari *et al.,* (2007) and Sunilkumar *et al.,* (2014).

Conclusion

Combined application of organic and inorganic fertilizers was observed to be the best management system in sustainable agriculture for increasing cowpea growth, yield and decrease the cost of nitrogen mineral fertilizers. On the other hand, the excess use of Inorganic nitrogen fertilizers in agriculture can lead to soil deterioration over time and groundwater pollution. The excellent performance of mixture of 40 kgP_2O_5/ha moringa leaves + SSP and Alesinloye compost + SSP was attributed to its inherent higher nutrient content and steady increase in nutrient release when applied as soil amendment.

References

Abou Ed-magd, M. M., Hoda, M. A. and Fawzy, Z. F. (2005). Relationship, growth of broccoli easing N, P and K Ratio in a mixture of N P K fertilizer. *Annual of Agricultural Science, Moshotohor* 43.2:791-805.

Adeniyan O. and Ojeniyi S. (2005). Effect of poultry manure, NPK 15-15-15 and combination of their reduced levels on maize growth and soil chemical properties. *Nigerian Journal of Soil Science*, 15(1), 34-41.

Adeoye, G. O., Ojobor, S. A. and AdeOluwa, O. O. (2005). Evaluation of potential of compost of rice wastes, cow dung and poultry manure for production of rice. *Proceeding of the*

29th Annual Conference of the Soil Science Society of Nigeria. Abeokuta, Nigeria. 213-217.

Ajeigbe, H. A., Mohammed, S. G., Adeosun, J. O. and Iheodioha, D. (2010). Improved agronomic practices for cereal production. In: Farmers' guide to increased productivity of improved legume-cereal cropping systems in savannas of Nigeria. Eds. IITA, Ibadan, Nigeria. Pp 11-22.

Asawalam, D. O. and Onyegbule, O. (2009). Effects of some local mining materials and organic manure on some soil chemical properties and growth of maize. *Nigerian Journal of Soil Science* 19.2: 71-76.

Awanlemhen, B. E. and Ojeniyi, S. O. (2012). The effects of oil palm bunch ash on growth, yield and nutrient availability of maize. *Nigerian Journal of Soil Science* 22.2: 132-136.

AyanfeOluwa, O. E., AdeOluwa, O. O. and Aduramigba-Modupe, V. O. (2015). Residual fertilizer value of OBD-plus compost for maize (Zea mays) production. *International Journal of Plant and Soil Science* 6.3: 162-167.

Banful, A. B. (2009). "Operational details of the 2008 fertilizer subsidy in Ghana-preliminary report". Ghana Strategy Support Program (GSSP) – International Food Policy Research Institute 11-12.

Barabasz W, Albinska D, Jaskowska M and Lipiec J (2002). Biological effects of mineral nitrogen fertilization on soil microorganisms. *International Journal of Environment and Pollution* 11.3: 193-198.

Bressani, R. (1985). The protein of grain amaranth. *Food and Nutrition Bulletin:* 13-38.

Deenik, J. (2006). Nitrogen mineralization potential in important agriculture soils of Hawaii. Soil and crop management 15.5pp

Eghball, B., Ginting, D. and Gilley, J. E. (2004). Residual effects of manure and compost application on corn production and soil properties. *Agronomy Journal* 96: 442-447.

Federal Fertilizer Department (FFD) (2012). Fertilizer use and management practices for crops in Nigeria. Produced by the Federal Ministry of Agriculture and Rural Development (FMA&RD). Chude, V. O., Olayiwola, S. O., Daudu, C., and Ekeoma Eds. Abuja. Chapter 1: 40-41.

Food and Agriculture Organization FAO, (2005). Cowpea production database for Nigeria, 1990-2004. Food and Agriculture Organization. *http://www.faostat.fao.org/*

Food and Agriculture Organization FAO, (2012). Grassland species index. *Vignaunguiculatahttp://www.fao.org/ag/AGP/AGPC/doc/Gbase/data/pf000090.htm*

Hepperly, P., Lotter, D., Ulsh, C. Z., Siedel, R. and Reider, C. (2009). Compost, manure and synthetic fertilizer influences crop yields, soil properties, nitrate leaching and crop nutrient content. *Compost Science Utilization* 17:117-126.

International Institute of Tropical Agriculture. (2009). Research for Development: Cereals and legumes system.

Ipimoroti R. R, Daniel M. A and Obatolu C. R (2002). Effect of organic mineral fertilizer on tea growth at Kusuku Mabila Plateau Nigeria. Moor Journal of Agricultural Resources 3: 180-183.

Landon, J.R. (1984). *Booker Tropical Soil Manual. A handbook for soil survey and agricultural land evaluation in the tropics and subtropics*. Booker Agriculture International Limited, U.S.A, New York. pp. 450.

Mandic, L., Djukic, D., Beatovic, I., Jovovic, Z., Pesakovic, M. and Stevovic, V. (2011). Effect of different fertilizers on the microbial activity and productivity of soil under potato cultivation. *African Journal of Biotechnology* 10.36: 6954-6960 DOI:10.5897/AJB11.947.

Niel, B and Ray, R. W. (1999). The nature and properties of soil, prentice hall incorporation pp 881.

Olusegun O. S. (2014). Influence of NPK 15-15-15 fertilizer and pig manure on nutrient dynamics and production of cowpea (*Vigna unguiculata* L. Walp) *American Journal of Agronomy and Forest*ry, 2(6), 2014, 267-273.

Ombod, R. and Isokiari, (1994). Self sufficiency in local fertilizer production for Nigeria. In: proceedings of the third African Soil Science Society Conference, Ibadan. May 10 – 14. Pp. 34-36.

Onwueme, I. C. and Sinha, T. D. (1991). Field crop production in Tropical Africa. CTA Ede, Netherland. 8: 552.

Pawar, V. M., Parbhani, S. N., Puri, M. O. and Rahuri, K. V. (2003). Organic farming. In organic production. Pp. 1-12.

Sunilkumar, K., Gowda, A., Nagaraj, R., Veeranagappa, P. Jayaprakash, R. and Patil, S. (2014). Influence of integrated nutrient management on growth, yield, nutrient uptake and economics of vegetable soybean. *International. Journal for Crop Improvement,* 4(1): 24-27.

Tiwari, D. K. Khaddar, V. K., Rajpoot, R. S. and Gupta, S. B. (2007). Effect of decomposed city waste under integrated nutrient management system on yield and nitrogen uptake by soybean. *Journal of Plant Science,* 20(1): 295-298.

Yoganathan R, Gunasekera H, Hariharan R. (2013). Integrated Use of Animal Manure and Inorganic Fertilizer on Growth and Yield of Vegetable Cowpea (*Vigna uniguiculata*). Paper presented at the Proceedings of World Academy of Science, Engineering and Technology 2013.