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General Information

Background Brief: The Nigerian Journal of Technological Research (NJTR) is the official journal of the Federal University of Technology, Minna, Niger State, Nigeria. It was first published in June 1989.It has since made giant strides in its effort to provide an avenue for the dissemination of relevant modern up-to-date research information in the core areas of discipline available in The University at inception; namely, Pure and Applied Sciences, Engineering Technology, Environmental Technology and Agricultural Technology.

Philosophy: As a strictly scientific and technological journal, it tends to provide information on problem solving technology to its immediate environment and the international community.

Development: The journal being responsive to the dynamic nature of research and development in the Federal University of Technology, Minna and its environs, has widen its scope of information dissemination to include but not limited to Information Communication Technology (ICT), Management Technology, Educational Technology and Entrepreneurship. It has developed electronic communication procedures to ensure that, it has the capacity to reach a larger community at a faster rate. It is the anticipation of the journal that scientific data which will provide very current information to problem solving in the identified areas of The University program will be found in it.

Management: The Nigerian Journal of Technological Research has a unique management structure which enables it to carry out its functions promptly. This include; The Management Board, Editorial Board, Editorial advisory Board, Regional editors, Associate editors and a Business Manager. These groups bring to beer their vast knowledge which ensures the quality and reputable academic output from the journal.

Finally, The Management Board and The Editorial Board of The Nigerian Journal of Technological Research believe firmly in quality of information that will benefit mankind, hence their commitment to ensuring productivity and quality of information dissemination.

Editorial Comments.

The current global trend on research development requires a coordinated approach to gathering and dissemination of vital data. Volume 11 no 2 2016 of the Nigerian Journal of Technological Research has critically keyed into this trend. The approach has allowed us to have a wider horizon in the type of manuscript to consider and the approach to ensure that this elicit the semblance of best practices in scientific research publication.

Only in the last edition our authors, reviewers and readers were notified of the ScholarOne platform as it relates to The Nigerian Journal of Technological Research of The Federal University of Technology, Minna. The journal is fully keyed into this platform which represents one of the most active and vibrant manuscript handling platforms around.

With this development, the process of subjecting the Nigerian Journal of Technological Research to evaluation alongside other reputable journals around the world is now in place. It will be easy for evaluation since the entire process is transparent and well documented. Various institutions are therefore encouraged to take advantage of this giant stride in the life of the journal to enjoy the numerous benefits this platform can offer.

The management of The Federal University of Technology, Minna, continues to ensure that this journal being the official journal of The University is not left to waste away and this effort is greatly commended by the Editorial Baord. This has given members of the Board the encouragement to work even harder for better presentation of the various editions. Consequently, we like to apologise to numerous authors who were trapped in the process of updating the journal website. Please be assured that your manuscripts will be treated fairly well.

Editorial Board.

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Effects of different fertilizer inputs on the growth and yield of soybean planted on an Alfisols in Minna, Southern, Guinea Savanna zone of Nigeria

Uzoma, A.O., Nkor, S.M., Adekanmbi, A.A., Afolabi, S.G., Odofin, A. J. and A. Bala
Departments of Soil Science and Land Management, School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Nigeria.

Abstract

Effects of different fertilizer inputs on the growth and yield of soybean planted on an Alfisols in the Teaching and Research Farm of the Federal University of Technology, Minna during the 2011 cropping season. Minna lies within the southern Guinea savanna zone of Nigeria on longitude of 06°27'E and latitude of 09°32'N. Treatments consisted of five fertilizer combinations as follows: Control at 0 kg ha^{-1}, single supper phosphate (SPP) at 30 kg ha^{-1}, Rock phosphate (RP) at 30 kg P ha^{-1}, Agrolyzer at 900 g ha^{-1} and combinations of SSP at 30 kg Pha^{-1} and single super phosphate at 30 kg Pha^{-1} and urea at 20 kg N ha^{-1}. The experiment was arranged in a Randomized Complete Block Design with 3 replicates. Result revealed that TGX 1448-2E plants supplied with sole phosphorus or in combination with either agrolyzer or urea produced better response compared with zero fertilizer application. Plants supplied with SSP were taller and heavier than those receiving rock phosphates. Pod weight, shoot biomass, nodule number, haulms weight, grain yield and plant height decreased when plants received an inclusion of Urea to single super phosphate compared with sole SSP and its agrolyzer inclusion respectively. Plants supplied with single super phosphate and urea however flowered earliest at 45 days while Pod number per plant was high when single super phosphate was supplied solely or in combination with agrolyzer. Nodule numbers were higher in plants that received single super phosphate and rock phosphate respectively but poor as a result of N inclusion to phosphorus may be as a result of the presence of Nitrogen. Urea applied at the rate of 20 kg N ha^{-1} may just be enough to suppress nodulation as evidenced by reduction in nodule number compared with the value obtained when agrolyzer was included.

Keywords: Growth, nodulation, yield, soybean, fertilizer inputs, urea, nitrogen, phosphates, agrolyzer
E-mail: uzo_ozo@yahoo.com: alextunji1@yahoo.co.uk: ooreoluwa14@gmail.com
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Introduction

Soybean (*Glycine max (L)merr*) sometimes referred to as "greater beans" is a leguminous vegetable of the pea family that grows in tropical, subtropical and temperate climate and are native to East Asia (Multilingual Multiscript Plant Name Database, 2012). It is the richest source of plant protein known to man (Odusanya, 2002). Industrial product of Soybean includes oil, soap, plastic, inks, crayon, solvent and clothing. Soybean oil is a source of biodiesel in the United State (Bio diesel magazine, 2008).

It has the capacity to improve soil fertility by fixing nitrogen through nitrification which is done by nitrogen fixing bacteria resident in the root nodules of Soybean (Onyibe *et. al.*, 2006). It can ameliorate nutrient situation, improve income, enhance productivity of other crops, like legumes, and provide ecological services such as structure improvement, erosion protection and biological diversity (Jensen and Nielsen, 2003). It protects the environment from allelopathic tendencies of agricultural chemicals (Shala and Stacey, 2001).

Soybean needs either inoculation with specific effective strains of *Bradyrhizobium Japonicum* or addition of nitrogen fertilizer, and other essential nutrient elements. Nitrogen is ones of the major nutrients required by plants and is often the most limiting under cultivation. It is however expected that under normal condition, and as a legume, Soybean will need no nitrogen fertilizer as the nodule bacteria will fix sufficient nitrogen for optimum growth. Studies have shown however that until nodulation occurs, the soybean plant depends on soil nitrogen for growth and hence the need to apply an initial dose of exogenous nitrogen at the rate of 20-25 kg N ha^{-1} to give a starter N-effect. Soybean planted where a large amount of wheat straw has been freshly incorporated into the soil may respond to a starter application of 10 to 20 pounds of nitrogen. The wheat straw causes a temporary tie-up of the soil nitrogen by microorganisms decomposing the straw. On newly leveled land being planted to Soybean for the first time, an application of 30 to 40 pounds of nitrogen per acre may be necessary.

Phosphorus is a limiting factor to soybean growth as the process of nitrogen fixation needs phosphorus. The deficiency can limit nodulation by legumes and P fertilizer application can overcome the deficiency (Carsky *et. al.*, 2001). Successful cultivation of Soybean in the tropics requires the application of micro nutrient in the form of agrolyzers. Metals such as zinc, iron and manganese have vital roles in plant's life cycle and are very important for normal growth of plants (Fageria, 2007). Others like molybdenum and Boron affect nodulation and N_2 fixation of legumes substantially. This study has been designed to determine the effects of different fertilizer inputs on growth and yield of soybean planted in an Alfisols in Minna, southern Guinea savanna zone of Nigeria.

Materials and Methods

Study area

This study was conducted on the Teaching and Research farm of School of Agriculture and Agricultural Technology, Federal University of Technology located along kilometer 10 Minna – Bida Road, from the month of July to November 2011. It lies approximately on longitude of 06°27'E and latitude of 09°32'N. Mean annual rainfall of this sub-humid tropical climate is 1200mm (90% of the rainfall is between the month of June and August), the temperature rarely falls below 22°C; the peaks are 40°C (February to March) and 30°C (November to December) (Ojanuga, 2006).

Soils in Minna are derived from the basement complex rock and range from shallow to very deep soils overlaying deeply weathered gneisses and magnatite, some are underlain by iron pan to varying depth. They are strong brown to red or clay with often gravelly loamy sand or sandy surface soil layer (*FDALR*, 1990). Predominant soil type is the ferruginous tropical soils which are basically derived from the basement complex rocks as well as from old sedimentary rocks. Such ferruginous tropical soils are ideal for cultivation of millet, maize, guinea corn and groundnut. Vegetation is characterized by woodlands and tall grasses interspersed with tall dense species.

Soil sampling, analysis and land preparation

With the aid of soil auger, soil samples were collected from the field prior to planting from 20 random points, at depth 0-20cm, air dried, lightly crushed and sieved with a 2mm sieve and bulked to obtain a composite sample. Sub-samples were taken thereafter for determination of physico-chemical properties by standard methods as follows: soil particle size distribution was determined by the hydrometer method (Bouyoucous, 1962). pH was measured by using pH meter in both water and 0.01M $CaCl_2$ (soil solution ratio 1 : 2.5) (Roswell, 1994). Total nitrogen was estimated by Kjedhal method (Bremner and Mulvaney, 1982) and organic carbon in the soil by dichromate oxidation and titration with ferrous ammonium sulphate (Walkey, 1947). Available P was determined calorimetrically after Bray-1 extraction. Exchangeable bases were extracted with neutral 1N NH_4OAC. Total Na^+ and K^+ were measured by using a flame photometer. Ca^{2+} and Mg^{2+} by Na EDTA Titration (Agbenin, 1995) exchangeable acidity was extracted with 1N KCl.

Total land area of 24.5m by 25m i.e. 0.06125 hectare was cleared, ploughed, harrowed and ridged. The land was divided into three blocks. Each of the blocks was further divided into plots of size 4.5 m by 3 m with 0.5 m space between the plots. The spacing between blocks was 2 m while spacing between replicate was 1m. The reference soybean variety used (TGX 1448-2E) was obtained from N2AFRICA 2010 PROJECT. TGX 1448-2E is promiscuous medium maturing, high biomass and high grain yielding, dual purpose and drought resistant.

Treatment and Experimental Design

Treatments were as follows: Control at 0 kg ha^{-1}, single supper phosphate (SPP) at 30 kg ha^{-1}, Rock phosphate (RP) at 30 kg P ha^{-1}, Agrolizer at 900 g ha^{-1} and combinations of SSP at 30 kg Pha^{-1} and single super phosphate at 30 kg Pha^{-1} and urea at 20 kg N ha^{-1}. The experiment was arranged in a Randomized Complete Block Design as shown in figure 1.

Planting and crop management

The field was ploughed, harrowed and ridged on the 16th of July...

seed of variety (TGX 1448-2E) was graded and planted on the 11th of August, 2011, at an intra-row and inter-row spacing of 5x75cm spacing. The plants were thinned to one plant per stand at 2 weeks after planting (WAP). The weeding was manual at 2, 6 WAP and when necessary.

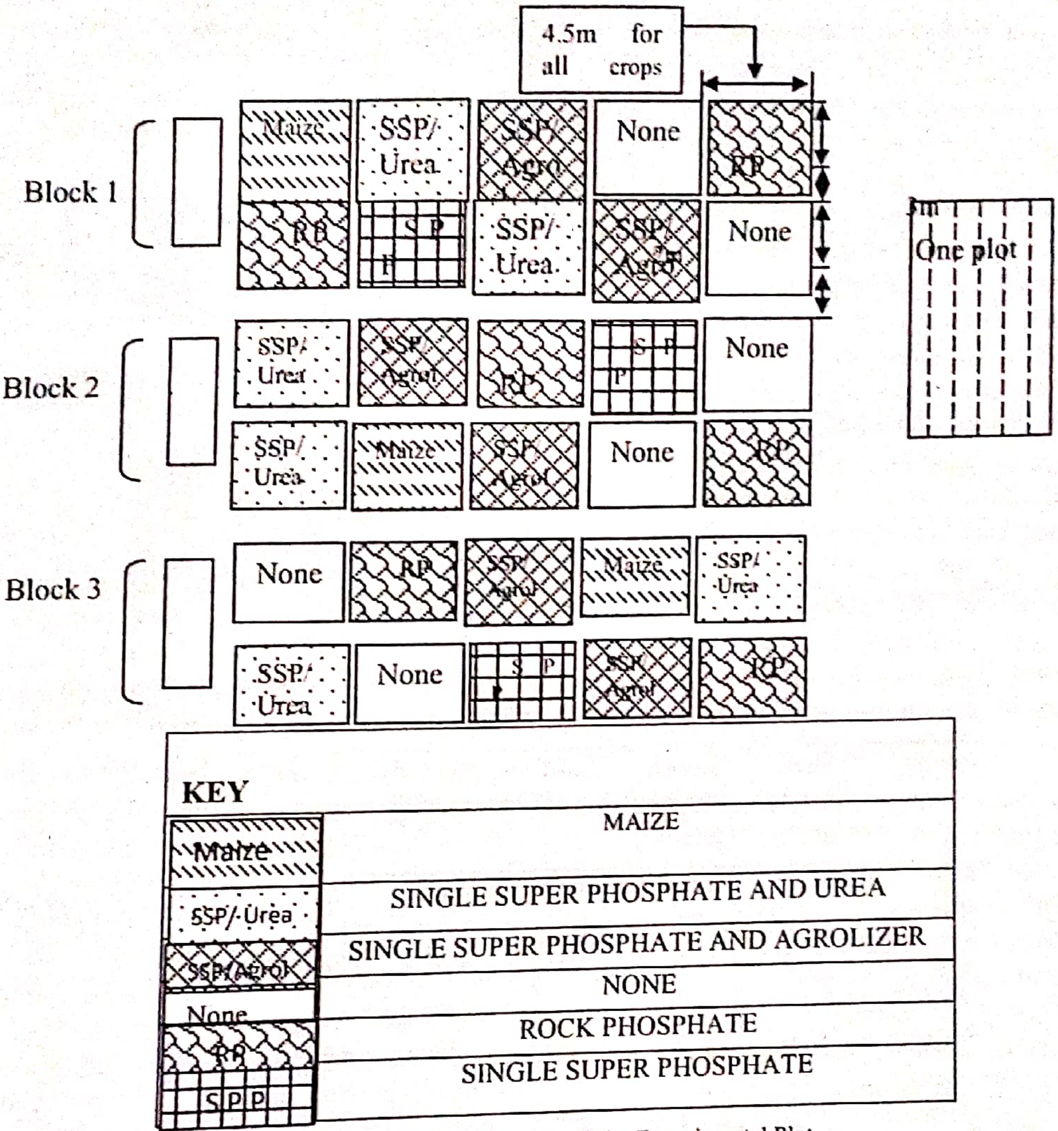

Figure: 1 Layout of the Experimental Plot

Tissue sampling and harvesting

Shoot biomass of soybean was sampled at 6 WAP, by destructively removing eight plants at random from the inner ridge leaving 50 cm at the borders and the following data were taken: leaf number per plant, plant height, pod number per plant, pod weight per plant, grain yield per hectare, 100- seed weight, haulms weight per plant, number of nodules per plant, nodule weight per plant, days to 50 % flowering and podding. Harvesting was done at physiological maturity; threshing was done manually and the seeds carefully winnowed to separate the haulms. Both haulms and seeds were weighed separately in the laboratory.

Statistical analysis

One-way analysis of variance (ANOVA) was used to determine treatment effect at 5 % level significance. Duncan multiple test was used to separate me

Results and discussion

Physico-chemical properties of soil

Results of the physical and chemical properties of the soil at 0-20 cm depth are shown in (Table 1). Soil was classified as sandy clay loam and according to Esu's description of critical limits for interpreting levels of analytical parameters (Esu, 1991), the soil was further described as slightly acidic in pH, organic carbon was low (6.50 g kg^{-1}), available phosphorus was medium

(16.1 mg kg) and total Nitrogen was high (>0.25 kg^{-1}). Exchangeable Ca (3.10 cmol kg^{-1}), exchangeable Na (0.29c mol kg^{-1}), exchangeable Mg (1.00 cmol kg^{-1}) were medium while exchangeable K (0.48 cmol kg^{-1}) was high.

Table 1: Physical and chemical properties of the soil at the experimental farm prior to planting of soybean

Parameters	Value
Sand (g kg^{-1})	758.80
Salt g (kg^{-1})	7.00
Clay (g kg^{-1})	234.20
	Sandy Clay loam
pH in $CaCl_2$	6.41
PH in H_2O(1:2.5)	6.91
Available P (mg kg^{-1})	9.00
Total Nitrogen (g kg^{-1})	0.28
Organic C (g kg^{-1})	6.5
Exchangeable cations (cmol kg^{-1})	
Mg^{2+}	1.00
Ca^{2+}	3.10
K^{+}	0.48
Na^{+}	0.29
Exchangeable Acidity (cmol kg^{-1})	
AL^{2+} +H^{+}	1.38
ECEC	6.25

Table 2: Growth and nodulation of TGX 1448-2E as affected by fertilizer inputs

Inputs	Plant height (cm)	Shoot biomass (g plt^{-1})	Leaf number	nodules number	Nodules weight (g plt^{-1})
SSP	45.3^{a}	7.3^{a}	32^{ab}	13^{a}	.05^{a}
RP	38.7^{a}	5.3^{a}	27^{bc}	13^{a}	.05^{a}
SSP &Urea	34.7^{a}	4.7^{a}	29^{bc}	10^{a}	.03^{a}
SSP& Agrolizer	38.0^{a}	5.7^{a}	35^{a}	11^{a}	.07^{a}
None	30.3^{a}	3.3^{a}	26^{c}	8^{a}	.03

Means with different letters indicated in the columns are significantly different ($p < 0.05$)

Table 3: Timeliness of flowering, podding and yield of TGX 1448-2E as affected by fertilizer inputs

Inputs	Days to 50% flowering	Days to 50% podding	Pod weight (g plt^{-1})	Pod No plt^{-1}	Haulms Weight (g)	100 seed weight	Grain yield (kg ha^{-1})
SSP	47^{b}	60^{d}	85^{a}	368^{a}	37^{a}	14^{a}	723^{a}
RP	46^{c}	61^{c}	75^{a}	317^{a}	32^{a}	14^{a}	678^{a}
SSP &Urea	45^{d}	59^{e}	65^{a}	313^{a}	25.7^{a}	14^{a}	598^{a}
SSP & Agrolizer	46^{c}	62^{b}	68^{a}	322^{a}	28.7^{a}	13^{a}	596^{a}
Control	49^{a}	63^{a}	64^{a}	227^{a}	27^{a}	12^{a}	579^{a}

Means with different letters indicated in the columns are significantly different ($p < 0.05$)

SSP
Fertilizer

Fertilizer

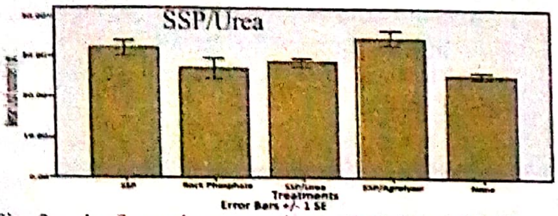

Fig 2: leaf number per plant of TGX 1448-2E as affected by fertilizer inputs

Fertilizer

Figure 3: Days to 50% flowering of TGX 1448-2E as affected by fertilizer inputs

Fertilizer

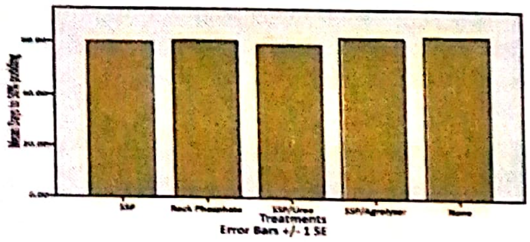

Figure 4: Days to 50% podding of TGX 1448-2E as affected by various fertilizer inputs

Growth, nodulation and yield of TGX 1448-2E as affected by fertilizer inputs

The bulk of soybean production in Nigeria is in the southern guinea savanna agroecology (Chiezey *et. al.*, 2001). Akande *et. al.* (2007) has emphasized the importance of evaluating the performance of newly developed soybean genotypes on nutrient deficient soils plagued with erratic rain supply. Though studies have shown that soybean can be grown on nutrient starved soils, it is expected that little sacrifices in nutrients be made to complement the poor inherent nutrient status of the soil. How much of nutrient required will depend on the variety and the prevailing environmental conditions. This result has demonstrated that TGX 1448-2E plants supplied with sole phosphorus or in combination with either agrolyzer or urea produced better response compared with zero fertilizer application. The increase in leaf number as a result of the inclusion of agrolyzer to single super phosphate suggests that the assimilation of P was enhanced by micronutrient availability (Agbenin, 2003). Table 2 revealed that plants supplied with SSP were taller and heavier than those receiving rock phosphate, implying that the phosphorus in the SSP was efficiently used probably as a result of the solubility of SSP in water (Havlin *et. al.*, 1999) and reduced P-fixation in the acidic soils of Minna (Jones and Wild, 1975).

Decrease in pod weight, shoot biomass, nodule number, haulms weight, grain yield and plant height when plants received an inclusion of Urea to single super phosphate compared with sole SSP and its agrolyzer inclusion respectively, suggests that urea applied at the rate of 20 kg N ha^{-1} was not necessary in this case. Inherent soil N content of 0.28 g kg (Table 1) was probably enough to initiate response of the plants to phosphorus application. Plants supplied with single super phosphate and urea however flowered earliest at 45 days, suggesting that urea application at the rate of 20 kg N was essential for floral initiation. This may also imply that phosphorus at the rate of 30 kg P ha^{-1} increased the translocation of photosynthesis towards the flowers as sinks. Inclusion of agrolyzer to phosphorus also improved days to 50% flowering probably because of the role micro nutrients play in floral initiation (Fageria, 2007)

Pod number per plant was high when single super phosphate was supplied solely or in combination with agrolyzer due to the presence of phosphorus in the nutrition of the plants. Pod formation is a function of nutrient assimilation and translocation. An excessive supply of Nitrogen has been reported to increase foliage and decrease floral parts (Seong-Tao choi *et al.*, 2012). Urea inclusion at the rate of 20 kg N ha^{-1} was high enough to depress podding compared with agrolyzer inclusion. Starter N of 20 kg N is necessary when N is limiting but not in the case of a high inherent N content of 0.28 g kg of soil. Although the plants flowered earlier as a result of urea inclusion to the single super phosphate, they did not translate to higher pod number. (Table 3).

Nodule numbers were higher in plants that received single super phosphate and rock phosphate respectively because of the essential role P plays in nodule formation (He *et al.*, 2002). Bunemann *et al.* (2004) have demonstrated that nodules of soybean are good sinks for phosphorus. The poor nodulation as a result of N inclusion to phosphorus may be as a result of the presence of Nitrogen. Urea applied at the rate of 20 kg N ha^{-1} may just be enough to suppress nodulation as evidenced by reduction in nodule number compared with the value obtained when agrolyzer was included. The highest yield of 723 kg ha^{-1} recorded by plants treated with single super phosphate alone is not comparable with the yield of 2,104.9 kg ha^{-1} reported by Uzoma et al. (2012). The reason for this disparity may be because of lateness in planting and residual effect of previous fertilizer treatments.

In conclusion, single super phosphate fertilizer gave the best growth, nodulation and yield averagely and inclusion of either agrolyzer or urea to phosphorus may be unnecessary if it does not translate to yield increase. The area of land cultivated was previously used for a similar experiment. The residual effect of previous fertilizer treatments may be responsible for lack of better response of TGX1448-2E to single super phosphate combined with either urea or agrolyzer.

References

Agbenin, J. O. (1995). Laboratory Manual for Soil and plant Analysis. (Selected method and Data Analysis) published by the author. 140pp.

Agbenin J. O (2003). Extractible iron and aluminium effect on phosphate sorption in a savanna Alfisol. *Soil Science Society of America Journal*, 67: 587 - 595.

Akande S. R., Owolade, O. F and J. A. Ayanwole (2007). Field evaluation of soybean varieties at Ilorin in the southern guinea savanna ecology of Nigeria. *African Journal of Agricultural Research*, (2): 356 - 359.

Biodiesel Magazine, (2008). 2009 Biodiesel Industry Directory, Fifth Edition 2008, BBI International, Grand Forks.

Bouyoucous, G. J. (1962). Hydrometer method improved for making particle size analysis of soils. *Agronomy Journal*. 54: 464-465.

Bremner, J. M. and C. S. Mulvaney (1982): Nitrogen-total. P 595 - 624. In A.L. page *et al.* (ed) Methods of Soil Analysis part 2, 2nd ed. Agronomy.Monograph. 9. A S A and SSSA, Madison, WI.

Bünemann, E. K., Bossio, D. A., Smithson, P. C., Frossard, E. and A. Oberson (2004). Microbial community composition and substrate use in a highly weathered soil as affected by crop rotation and P fertilization. *Soil Biology and Biochemistry*. 36:889-901

Carsky, R. J., Singh, B. B and R. Oyewole (2001). Contribution of early season cowpea to late season maize in the savanna zone of West Africa. *Biol. Agric. Hort*., 18, 303-315

Chiezey, U.F (2001). Pod abortion and grain yield of soybean (Glycine max L. Merrill) as influenced by nitrogen and phosphorus nutrition in the northern Guinea savanna zone of Nigeria. *Tropical oil seeds Journal*. 6: 1-10.

Fageria N.K (2007). Soil fertility and plant nutrition research under field conditions: Basic principles and methodology. *Journa of. Plant Nutrition*. 30, 2, 203-223.

FDALR (1990). Federal Department of Agriculture Land Resources, Soil report vol.2 166pp

Havlin, J.L., Beaton, J.D., Tisdale, S.L and Nelson, W.L (1999). Soil Fertility and Fertilizers. 6th Edition. Prentice Hall. Upper Saddle River, NJ. 499 p.

He, Z. L., Bian, W and J. Zhu (2002). Screening and identification of microorganisms capable of utilizing phosphate adsorbed by goethite. Comm. Soil Sci. Plant Anal. 33:647-663.

Jensen, E.S and H. Hauggaard-Nielsen (2003) How can increased use of biological N_2 fixation in agriculture benefit the environment? *Plant Soil* 252:177-186

Jones, M.J and A. Wild (1975). Soil of West Africa Savanna. Commonwealth Agricultural Bureaux, Harpenden.U.K. pp.24.

Ojanuga, A. G. (2006). Agro ecological zone of Nigerian manual. FAO?NPFS, Federal Ministry of Agriculture and Rural Development, Abuja, Nigeria, Pp 32.

Odusanya, R. (2002). Powerful benefits of soybeans: Food, beverages and seasonings. Saturday punch (column 1) Nigeria, P.33.

Onyibe J. E., Kamara A.Y and L O. Omoigui (2006). Guide to Soybean Production in Borno State. International Institute of Tropical Agriculture, Ibadan.

Roswell, D. A (1994). Soil science method and cations Longman scientific and technical, Singapore, *Soil Biology and Biochemistry* 23:709-713.

Seong-Tao Choi, Doo-Sang Park, Seong-Mo Kang. and Seong-Koo Kang (2012) Soil Management, Fertilization, and Irrigation: Influence of Leaf-fruit Ratio and Nitrogen Rate on Fruit Characteristics, Nitrogenous Compounds, and Nonstructural Carbohydrates in Young Persimmon Trees, *Horticultural Science*, 47:410-413.

Shala and Stacey, (2001). United States Department of Agriculture: Economic Research Service. Food Security Assessment, Regional Overview Information Bulletin.

Uzoma, A.O, Okoh, J.,Bala, A., Adeboye, M.K.A. and A. O. Osunde (2013). The impact of various fertilizer inputs on the growth, nodulation and yield of soybean(*Glycine max*) cultivated on an alfisol in Minna, Southern Guinea savanna of Nigeria. *Nigerian Journal of Soil Science Society,23 (2): 157-167*

Walkley, A. (1947). A critical examination of a rapid method for determining organic carbon in the soil-effect of variation in digestion condition and of inorganic soil constituent. *Soil Science Journal*. 63:251-264.