EFFECTS OF ALBIT® BIOREGULATOR AND NPK FERTILIZER ON THE YIELD AND NUTRITIONAL COMPONENTS OF COWPEA (*VIGNA UNGUICULATA* L. WALP)

ANJORIN S. T.*, SULE-OTU ABDULAZEEZ AND SALAKO E. A.

Department of Crop Science, Faculty of Agriculture, University of Abuja, Nigeria

Correspondence author's e-mail: oyindamola35@gmail.com

Article received: 22nd May, 2015; Article accepted: 15th July, 2015.

ABSTRACT

This study assessed the yield and the nutritional quality of Abuja local cowpea (Vigna unguiculata L.) variety applied with Albit®bioregulator, NPK fertilizer and Seedplus® fungicide/insecticide and Albit® + Seedplus®. It was conducted on the experimental field of Teaching and Research Farm, Faculty of Agriculture, University of Abuja, Abuja-Nigeria. The experiment was laid out in a Randomized Complete Block Design (RCBD) with 3 replications and 5 treatments. It was observed that the number of pods at 83, 90 and 97 days after sowing (DAS) in the control was significantly ($p \leq 0.05$) lower than the treated plots and the cowpea applied with NPK fertilizer had the highest number of pods at 90 and 97 days. The dry pods yield at 124 DAS from the cowpea applied with Albit® (0.2ml/l of water), Albit® + Seedplus®, and NPK fertilizer(142.4 kg/ha) were significantly ($p \leq 0.05$) higher than the Seedplus® only and control. The cowpea applied with NPK fertilizer (142.4 kg/ha) or Albit® + Seedplus®; had relatively higher seed yield than the control plots. The proximate analysis of the harvested plant, showed that cowpea crops treated with NPK fertilizer or Albit®bioregulator had significantly higher crude protein and fibre contents than those treated with Seedplus®, Albit®+Seedplus® and the control. It was indicated that in order to boost the cowpea yield, growers could use Albit®bioregulator+ Seedplus® as input in cowpea production in place of NPK chemical fertilizer.

INTRODUCTION

Cowpea (*Vigna unguiculata* L. Walp) is the most important food legume grown in the tropical savannah zones of Africa. Cowpea is a preferred staple food in many regions of Africa. Its desirability reflects the fact that the leaves, immature pods, fresh seeds and dry grain can be eaten or marketed (Nkouannessi, 2005).The mature grain contains 23-25% protein, 50-67% starch, B-vitamins such as folic acid which is important in preventing birth defects, and essential micronutrients such as iron, calcium, and zinc (Langyintuo*et al*., 2003).

The low yield of cowpea in Nigeria, at 0.05 to 0.30 metric tonnes (MT).hectare (ha)-1 (Omotosho, 2014), indicates that the farmers are operating at less than 15% production efficiency. The three essential macronutrients – N, P and K, which are the major growth limiting nutrients, are very important in the biogeochemical cycles and processes that affect soil fertility (Steinshamn*et al*., 2004; Fang *et al*., 2005). Plant utilization of fertilizer N is impacted by the N cycle in the plant-soil system. In a similar manner, plant use of P and K fertilizers are impacted by the biogeochemical cycles. The use of inorganic fertilizers has been the conventional way of fertilizer application to crops.

Albit® - a novel plant growth regulator and bio-fungicide is reported to have improved germinability and seedling vigour, improve vegetative growth, accelerates maturity and yield of cereals and vegetables (Albit Biotechnology LLC, 2008). Albit® is composed of hydrolysate of microorganisms (*Bacillus megaterium H Pseudomonas aurefaciens);* microelements, growth substances (poly-beta-hydroxybutyrate (6.2g PHB L^{-1}) and terpenes, extracted from plant shoots (Zlotnikov, 2006; Anjorinand Salako, 2010).Albit® is formulated as an alternative farm input to synthetic fertilizer and fungicide which are less environment-friendly.

The nutritional health potentials and economic prospects are incentives for recent efforts in sole cowpea production for which appropriate nutrient management recommendations must be available. Studies were, therefore, carried out at Abuja, Nigeria to evaluate the effect of Albit®, Seedplus®, Albit® + Seedplus® and NPK fertilizer on the pods and grain yield and the nutritional profile of cowpea using the popular Abuja local white variety. This is an attempt to search for a sustainable alternative to the use of inorganic fertilizers.

MATERIALS AND METHODS

Study site

The research was carried out during the wet seasons (July-November) of 2013 in the University of Abuja Teaching and Research Farm, University of Abuja Main Campus, (Latitude 9°2´N and Longitude 7°0´ E,elevation of 322.6m above the sea level,with a temperature ranging from 18.45°C - 36.05°C and the annual total rainfall of 1100mm – 1600mm, located in the Southern Guinea Savannah agro ecological zone of Nigeria

Sources of Experimental Materials

The Abuja local cowpea seedswith white seed coat colour,was obtained from a farmers shop in Gwagwalada-Abuja. It had moderate maturity period, semi-prostrate, photosensitive and large seeded.

TheAlbit® used wasmanufactured by Albit® Scientific and Industrial LLC prospect Nauka 5 Pushchino, Moscow oblast 142290 Russia and obtained from a distributor FALPAS Ventures Limited. The Seedplus®30WS (10% carbendazim, 10% imidacloprid,10% metalaxyl, 600g/kg) was used as seed treatment againstseed-borne pest while Karate® (lambda-cyhalothrin, 5% EC, 0.5kg/ha) EC was a broad spectrum insecticide applied.

Field Experimental Layout and Design

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The experimental plot was cleared and laid out accordingly. The gross plot comprised of 5 rows spaced 50 cm apart and 4 m long ($10\ m^2$), while the net plot was made up of the three inner rows and 4 m long (6 m^2). Each experimental plot had 0.5 m^2 path way to prevent Albit®/insecticides drifts and inter-plot interference and 1 m between each block.A total of 96m^2 area size (24m × 4m) was covered. Cowpea seeds were planted 0.15 m apart within row. The treatments Albit®, Albit+Seedplus®, Seedplus®, NPK fertilizer and the control were accordingly allocated to each experimental plots.

Seed treatment and sowing

Cowpea seeds were pre-soaked for 2hours in Albit® (0.2ml/l of water) and werethen thoroughly mixed. At 3 WAS, 0.2ml Albit/l of water were foliar applied. Seedplus® was applied by pouring the seeds in a plastic container and mix with the Seedplus (1.25 g 0.5 kg^{-1} seeds)®. Cowpea was sown on fresh manually cultivated ridges, two seeds per hole at a spacing of 0.75m by 0.50m and at a depth of 2.5cm. Sowing was carried out on the 31st/07/2013. NPK fertilizer 15:15:15 application was later carried out 28 days after emergence. Application rate of NPK fertilizer was 142.4 kg/ha (i.e. 0.00356 kg/plant) before planting as recommended by FCTADP (2008) for cowpea production in the North Central States of Nigeria. Planting was done by dibbling three seeds per hill at the depth of 3 cm. Spraying of Karate® was carried out as early as 21DAS based on insect populations reaching locally determined economic threshold. This was repeated at 10 days interval.

Data collection

From the three middle ridges, three cowpeas per plot were tagged for the collection of data on number of pods.Data on yield components were collected weekly after sowing (WAS) from the tagged samples.

Pods and grain yield

Number of pods per cowpea plants was taken at 83, 90 and 97 DAS by direct counting and recording. The pods were picked from the net plots at 121 DAS, sundried for a week and weighed with weighing balance. The pods were shelled and the dry weight was recorded before taken for proximate analysis in Advanced Chemistry Laboratory of Sheda Science and Technology Science Complex, Sheda Abuja.

Proximate Analysis Procedures

Determination of moisture content, Ash Value, Crude Fibre (using Trichloracetic acid Method), Crude Lipids, Crude Protein were done as described by AOAC (1990).

Determination of the soil physico-chemical properties

Soil samples from the uninoculated experimental sites were randomly taken at the depth of 0 - 30 cm, bulked and analyzed for physical and chemical properties. This was in accordance with standard procedures in use at the Department of Soil Science Laboratory, Federal University of Technology, Minna as described below:

i. the soil sample was air-dried, crushed gently to pass through 2 mm mesh sieve. The fine earth fraction (<2 mm in diameter) was collected and used for particle size and all chemical determinations;
ii. soil pH values were determined in both distilled water (H_2O) and in potassium chloride (KCl) solution using a soil/liquid ratio of 1:2. The pH values were read using a Beckman zeromatic pH meter;
iii. organic carbon (OC) was determined by the modified Walker-Black Wet Combustion Method. The percentage OC was calculated by multiplying the value for organic carbon by the convectional Van Bemellar factor of 1.724 which is based on the assumption that soil organic matter contains 58% of carbon;
iv. particle size was mechanically analyzed using the Bouyoucous hydrometer method.
v. total nitrogen was determined by the micro Kjeldahl method of Bremner and Mulvancy (1982) using Na_2SO4^{-2} catalyst mixture;
vi. exchangeable bases(Ca, Mg, Na, and K) and Cation Exchange Capacity (CEC) were determined by ammonium acetate (NH_4OAC) extraction methods;
vii. base saturation was obtained by dividing the sum of the bases (Ca, Mg, Na, and K) by the CEC and multiplied by the quotient 100

$$base\ saturation = 1 + \frac{TEB}{CEC} x \frac{100}{1}$$

Where TEB = Total Exchangeable Bases;
CEC = Cation Exchange Capacity

viii. exchangeable acidity (H^+ and Al^{3+}) was determined by the titrimetric method using 1 N KCl extract i. e 74.5 g of KCl/L (Mclean, 1982);
ix. phosphorus was estimated by using Bray I phosphorus solution method.

Statistical analysis

Data collected were subjected to Analysis of Variance (ANOVA) and separation of treatment means tested at 5% probability level by Duncan Multiple Range Test (DMRT) test at 5% probability level using the GENSTAT Discovery Edition 4 [GENSTAT, 2009].

RESULTS

The physical and chemical properties of surface (0-20 cm) layer of soils in the experimental sites are shown in Table 1. The soil sample was physically characterized as grayish brown, loam textural class (10YR3/2). Analysis of variance (ANOVA) of the data collected on the parameters measured showed that there were significant ($p \leq 0.05$) difference in the number of pods, dry pod weight and grain yield per the cowpea plants due to treatment effects. There were also significant ($p \leq 0.05$) difference in the nutritional profile of the seeds due to the Albit® and NPK fertilizer application.

Effects of Albit®, NPK fertilizer and Seedplus® on the pods and grain yield of Cowpea

The cowpea plants applied with NPK fertilizer had significantly ($p \leq 0.05$) higher number of pods at 90 and 97 days after sowing (DAS), while there was least number of pods/plant in the untreated plots (Table 2).The number of pods (90 and 97 DAS) per plants applied with NPK fertilizer were significantly ($p \leq 0.05$) higher than those treated with Seedplus®, albit or those in the untreated plots. There was no significant ($p \geq 0.05$) difference in the pod yield and dry grain yield per plants applied with NPK fertilizer, Albit® + Seedplus® orAlbit®

Table 1. Chemical characteristics of soil sample (0 – 20 cm depth) from the experimental site

Soil property	Value
% Organic carbon	6.04
% Organic matter	1.02
pH (H_2O) suspension 1:2	5.65
pH (KCl) suspension 1:2	5.50
Total nitrogen (g Kg^{-1})	0.80
Extractable P (mg Kg^{-1})	4.49
Exchangeable cations (cmol$\pm$ Kg^{-1})	
Ca	2.20
Mg	4.01
K	0.50
Na	0.38
Exchangeable acidity (c mol$\pm$ Kg^{-1})	
Al^{3+}, H^+	0.50
ECEC (cmol$\pm$ Kg^{-1})	6.82

Effect of Albit®, NPK fertilizer and Seedplus® on the nutritional components of cowpea *V. unguiculata*

The moisture content of the seeds from the Seedplus® treated plots was significantly ($p \leq 0.05$) higher than those treated with Albit®, Albit® + Seedplus®, NPK fertilizer and the control (Table 3). The ash content of the seeds applied with NPK fertilizer and Seedplus® only were significantly higher ($p \leq 0.05$) than from other treatments. The crude fibre content in cowpea applied with Albit® only was significantly ($p \leq 0.05$) higher than the seeds from other treatments. The crude lipid content in the seeds applied with NPK fertilizer and the control plots was significantly ($p \leq 0.05$) higher than the rest treatments. The carbohydrate content in the cowpeas applied with NPK fertilizer was significantly ($p \leq 0.05$) lower than other treatments. The carbohydrate contents in the cowpeas applied with Seedplus® only or in the control were higher than those treated with Albit® or NPK fertilizer. However, the content in the cowpea applied with Albit® + Seedplus® and Albit® were not significantly ($p \geq 0.05$) different from each other.

DISCUSSION

The experimental site has been used for arable crop cultivation whose features - minimal mechanized tillage and inorganic fertilizer application practices- have been indicted for aiding soil degradation through rapid soil organic matter depletion (Lal, 1999). The soil was slightly acid to neutral sandy loams with low total N and exchangeable cations. The available P was 4.49 mg.kg-^{1} which are lower than 7.0 mg.kg-^{1} established by Kang and Nangju (1983) as the critical soil available P level for cowpea. Olatunji *et al.* (2012) reported from their two seasons study that inorganic NPK fertilizer significantly reduced soil pH and increased N and P content of the soil. This study indicated that the number of pods increased under NPK fertilizer application. The importance of an externally applied N to the growth and grain yield of cowpea was reported by (Abayomi *et al.*, 2008) that the application of NPK fertilizer i.e. (30kg N, $15P_2O_5$, $15K_2O$ ha^{-1}) significantly enhanced early vegetative growth and improved yield. This was attributed to the stimulating effect of nitrogen on root activity and rooting pattern. Brady and Weil (2008) reported that grain yield response to P application was significant and so stressed its importance in improvement of vegetative characters such as plant height and early flowering. Taura and Fatima (2008) also reported that the cowpea plants applied with NPK fertilizer during vegetative period had earlier onset of flowering than those dependent on symbiotic N fixation. However, the combination of pig dung and NPK (16:16:16) fertilizer significantly increased the plant growth and yield of cowpea, over application of NPK alone or the untreated plots. Maximum yield of 1.4 t/ha was obtained with application of 8 t/ha Pig Manure + 60 kg NPK.

Table2: Effects of Albit®, NPK fertilizer and Seedplus® on the number of pods, pod yield and grain yield of cowpea

Treatment	Number of pod/plant (83 das)	Number pod/plant (90 das)	Number of pod/plant (97 das)	Pod yield (124 das)(kg/ha)	Dry grain yield 131 das (kg/ha)
ALBIT®	12.80^{B}	13.23^{B}	13.88^{B}	791.05^{AB}	680.70^{A}
SEEDPLUS®	14.67^{A}	16.13^{B}	17.73^{B}	643.80^{BC}	475.79^{B}
ALBIT® + SEEDPLUS®	14.50^{A}	15.60^{B}	15.60^{B}	851.4^{A}	626.102^{A}
NPK FERTILIZER	16.60^{A}	18.77^{A}	18.77^{A}	746.57^{AB}	598.52^{A}
CONTROL	9.73^{C}	8.00^{C}	8.00^{C}	538.79^{C}	366.77^{c}

Values are expressed as mean of these replicates (n=3); DAS= Days after sowing; Values with different superscripts down the column are significantly different from each other ($p \leq 0.05$) by Duncan Multiple Range Test (DMRT).

Table 3: Effect of Albit, NPK fertilizer and Seedplus on the nutritional components of cowpea (*V. unguiculata)* seeds

Treatment	Moisture content %	Ash content %	Crude fibre content %	Crude protein content %	Crude lipid content %	Carbohydrate content %
Albit®	7.8000^{b}	0.9500^{b}	4.0150^{a}	18.7450^{b}	1.4500^{b}	66.0400^{b}
Seedplus®	9.0150^{a}	1.1000^{ab}	3.7600^{b}	17.8400^{c}	1.9500^{b}	65.3100^{ab}
Albit® + Seedplus®	8.0750^{b}	1.0500^{a}	3.8050^{b}	17.8050^{c}	1.5500^{b}	66.9400^{b}
NPK Fertilizer	8.0500^{b}	1.3000^{a}	3.1450^{c}	19.5900^{a}	2.7750^{a}	64.0400^{c}
Control	7.6100^{b}	0.8750^{b}	3.6 250^{c}	17.8250^{c}	3.0250^{a}	67.2400^{a}

Values are expressed as mean of 3 replicates (n=3); Values with different superscripts down the column are significantly different from each other ($p \leq 0.05$) by Duncan Multiple Range Test (DMRT).

Cowpea applied with Albit® + Seedplus® had a high number of pods indicating that this combination increase cowpea yield and these was in line with Yakhtanigova (2009) who reported that for a pronounced effect, seed treatment with Albit® should be followed with foliar sprayings and other pesticides. Dzemo*et al.,* 2010, Egho, 2010, Degri*et al.,* 2012, reported that the application of seed treatment pesticide on cowpea seeds protected the cowpea against soil-borne pest and ensures optimal pod and seed protection. According to Kandyba and Lazarev (2001), the optimal range of concentration for the biochemical pre-soaking Albit® should be between 0.2 - 0.4 ml L^{-1} H_2O depending on the nature of the seed.

In Russia, enhanced growth of crops was obtained when Albit® seed treatments were combined with fungicides such as Vitavax 200 (carboxin + thiram) or Fenoram (carboxin). Usage of Albit® decreased chemical fungicide and fertilizer consumption and eventually increased yield, quality and economic returns of crop produce.Pre-soaking Albit® seed treatment was reported to have made up 50-60% of total Albit® effect, the rest been obtained through foliar spraying. Combination of Albit® with chemical fungicides seems to have led to synergistic effects (Tenyaev and Donskova, 2008). Use of Albit® with only half of application rate of fungicides provided the same protective effect, as full dose of fungicides in cereals. In a test in all Russia Institute of Plant Protection of Moscow State University (2004), Albit® was reported to have the ability to induce resistance to wide range of both fungus and bacterial infections.

The control plot showed the highest moisture content and the lowest moisture content was obtained under NPK fertilizer application. Cowpea applied with NPK fertilizer had significantly ($p \leq 0.05$) higher percentage of crude protein (CP), crude lipid and ash content than the control. This was in agreement with the report of (Manga *et al*., 2004) that protein content can be increased with any of the NPK fertilizer application. The increase in CP might be because N is an important element in protein synthesis. This observation was in agreement with earlier reports of Abidin (2006). Albit® bioregulator has proven to be a promising agrochemical input in improving seedling quality of cereal crop. This indicated the superiority of integrated approach to crop management over a one way approach. The level of NPK fertilizer appeared to have no significant effect on carbohydrate content of cowpea. Sultana (2003) also found no significant effect of NPK fertilizer application on carbohydrate contents of cowpea. Similar results were also reported by Khan *et al.* (1992) in cowpea forage studies.

CONCLUSION

This preliminary study indicated that the pods and grain yields from the cowpea applied with Albit®(0.2ml/l of water) + Seedplus®, Albit® and NPK fertilizer (142.4 kg/ha) were significantly ($p \leq 0.05$) higher than those treated with Seedplus® only or those in the control. The cowpeasapplied with NPK fertilizer displayed significant increased crude protein and reduced crude fibre content. Those applied with Albit® had the highest ranges of crude fibre content while the cowpeas from the control plots had the highest carbohydrate contents. It proved preferable for cowpea farmers to substitute NPK fertilizer for Albit® + Seedplus® if improved yield and cowpea crude protein are the target.Confirmatory experiment involving various cultivars across Nigerian different agroecologies is essential.

REFERENCES

Abayomi, Y. A., T. V. Ajibade, O.F. Sammuel and B. F. Saadudeen, (2008). Growth and Yield Responses of Cowpea (*Vigna unguiculata* (L.) Walp) Genotypes to Nitrogen Fertilizer (NPK) Application in the Southern Guinea Savanna Zone of Nigeria. *Asian Journal of Plant Sciences,* 7: 170 - 176.

Abidin, J. E., A. Y. Kamara, and L. O. Omoigui. (2006). Guide to cowpea production in Borno State, Nigeria. Promoting Sustainable Agriculture in Borno State (PROSAB), Ibadan, Nigeria.36 pp.

Albit Biotechnology LLC (2008). An innovative biopesticide for organic and traditional farming ProspektNaoka 5, Pushino,Moscow Oblast. 142290. Russia.

Anjorin, Toba Samuel and Salako Adebayo Ezekiel (2010).Germinability and seedling vigour of some arable crops treated with Albit® bioregulator and Superhormai® fungicide. *African Journal of Microbiology Research,* 4(19):1928 - 1938.

AOAC (1990) Official methods of Analysis 12th ed. Association of Official Analytical Chemistry, Washington, D.C., USA.Ayanlaja SA (2002). Soil nutrient management research on the humid.

Brady, N. C. and Weil, R. R. (2008).The Nature and Properties of Soils.14 ed. Pearson-Prentice Hall, Upper Saddle River, NJ. 990 pp.

Bremner J. M. and Malvaney, C. S. (1982). Nitrogen total. In Pager, A.L. Miller, R.H., Keeney, D.R. eds., Methods of Soil analysis Part 2.Chemical and Microbiological properties. *American Society of Agronomy,* Madison, WI, USSA p. 595 - 624.

Degri, M. M ,Maina, Y.T. and Richard, B. I. (2012). Effect of Plant Extracts on Post Flowering Insect Pests and Grain Yield of Cowpea (*Vigna unguiculata*(L.) Walp) in Maiduguri, Semi – Arid Zone of Nigeria. *Journal of Biology, Agriculture and Health Care,* 2(3):46 – 51

Dzemo, W. D, Niba, A. S and Asiwe, J. A. N. (2010).Effect of Insecticide Spray Applications on Insect Pest Infestation and Yield of Cowpea (*Vignaunguiculata*(L.)Walp) in the Transkai, South Africa. *African Journal of Biotechnology* 9:1673 – 1679.

Egho, E. O. (2010). Studies on the Control of Major Insect Pests and Yield of Cowpea (*Vigna unguiculata* (L.) Walp) Under Calendar and Monitored Application of synthetic Chemical in Abraka, Southern Nigeria. *Archives of Applied Science Research,* 2 (4):224 – 234.

Fang, M. Shihua L., Rongfeng J., Xuejun L., Xiangzhong Z., Keith W., Goulding T., Fusuo Z. (2005). Nitrogen input, 15N balance and mineral N dynamics in a rice–wheat rotation in southwest

China. *Nutrient Cycling in Agroecosystems* 79, 255 – 265.

FCTADP (2009). Federal Capital Territory Agricultural and Rural Development Authority: Annual Report,2009, Abuja, Nigeria.

Kang, B. T. and D. Nangju (1983). Phosphorus response of cowpea (*Vigna unguiculata*, L, Walp). *Tropical Grain Legume Bulletin*, 27: 11 - 16.

GENSTAT(2009). GENSTAT Discovery Edition 4, Release 7.2DE. Lawe Agricultural Trust Rothamsted Experimental Station, UK

Kandyba, E. V, Lazarev V. I. (2001). Biopreparations as a means of increasing productivity (SakharnayaSvekla).ZAO NPP PitBIOTEKh, 136 Tul'skoeshosse, Efremov, Tula region 301840, Russia.

Khan, M. J., Tareque, A. M. M. and Shajalal, M. (1992). Effect of inoculation and nitrogen fertilizer on yield chemical composition, *in vitro* organic matter digestibility and energy content of cowpea (*Vigna unguiculata*) forage. *Indian J. Anim. Nutr.*, 9(3): 177 - 180.

Lal, R., Kimble, J .M. and Stewart, B. A. (EDS) (2009). Global climate change and tropical ecosystems. Advances in soil science, CRC press, New York, p. 157 - 165.

Langyintuo, A.S., Lowenberg-Deboer, J., Faye, M., Lambert, D., Ibro, G., Moussa, B., Kergna, A., Kushwaha, S., Musa, S. and Ntoukam, G. (2003). Cowpea supply and demand in west and central Africa. *Field Crops Research*, 82:215 - 231.

Mclean,E. O.(1982). Soil pH and lime requirement. In Pager A.L.editor. Methods of Soil Analysis part 2. 2nd edAgron.Monog. vol. 9, Madison, WI: ASA and SSSA. p. 199- 224.

Minchin, F. R., Summerfield, R. J. and Neves, M. C. (1981).Nitrogen nutrition of cowpea (*V. unguiculata* (L.)Walp): Effects of timing of inorganic nitrogen application. *Trop. Agric*. (Trinidad), 58: 1 - 12.

Nkouannessi, M. (2005).The genetic, morphological and Physiological evaluation of African Cowpea genotypes: M+.Sc. thesis, University of the Free State, Bloemfontein.

Olatunji, O. ., Ayuba, S. A. Arijembe, B. C. and Ojeniyi, S. O. (2012). Effect of NPK and poultry manure on cowpea and soil nutrient composition.*Nigerian Journal of Soil Science*. 22 (1):108 – 113.

Omotoso, S. O. (2014). Influence of NPK 15-15-15 fertilizer and pig manure on nutrient dynamics and productivity of cowpea *Vigna unguiculata* L., Walp. American *Journal of Agriculture and Forestry*, 2(6): 267 – 273.

Steinshamn, H., Thuen, E., Bleken, M. A., Brenoe, U. T., Ekerholt, G., and Yri, C. (2005).Utilization of nitrogen (N) and phosphorus (P) in an organic dairy farming system in Norway. *Agric. Ecosys. Environ.*104: 509 - 522.

Sultana, M. N. (2003). Effects of *Rhizobium* inoculum and nitrogen fertilizer on yield and nutrient quality of cowpea (*Vignaunguiculata*) forage at different stages of maturity. M.Sc. (A.H). Thesis, Dept. of Animal Nutrition, Bangladesh Agricultural University, Mymensingh.

Taura D. W. and Fatima, M. S. (2008). Effects of organic and inorganic fertilizers on the vegetative reproductive parts of some selected varieties of cowpea (*Vigna unguiculata*). *African Journal of General Agriculture*, 1595-6984.

Tenyaev, A. V. and Donskova N. M. (2008). Good seed - good seedlings. Ryazan' Region Station of Plant Protection, Izdatel'stvoKolos, Publishers, Russia. p. 1 - 6.

Yakhtanigova, Z. M. (2009). Effect of growth regulators on productivity of various corn subspecies in the Piedmont zone of Kabardino-Bulkaria. *Russian Agricul. Sci.*, 25: 2 p. 84 - 85.

Zlotnikov, A. K. (2006).BiopesticideAlbit® for increasing yield and protection of agriculture's against diseases. Ed. Prof. A. Melkumova. All-Russia lnstitute of Plant Protection. Russia.p. 1 - 5.