American-Eurasian Journal of Sustainable Agriculture, 2(3): 219-224, 2008
ISSN 1995-0748

This is a refereed journal and all articles are professionally screened and reviewed

ORIGINAL ARTICLES

Effects of Cocoa Pod Husk Amendment on Soil and Leaf Chemical Composition and Growth of Cashew (A*nacardium occidentale* L.) Seedlings in the Nursery

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Agele, S.O. & Agbona A.I.; Effects of Cocoa Pod Husk Amendment on Soil and Leaf Chemical Composition and Growth of Cashew (A*nacardium Occidentale* L.) Seedlings in the Nursery, *Am.-Eurasian J. Sustain. Agric., 2(3): 219-224, 2008*

ABSTRACT

Screen house and open nursery field experiments were conducted at the Teaching and Research Farm of the Federal University of Technology, Akure Nigeria (year) to study the effect of cocoa pod husk [CPH] amendment on soil and plant nutrient concentrations and seedling growth of cashew (*Anacardium occidentalis*, L.). The treatments consisted of application of five levels of cocoa pod husk (0, 3, 6, 9 and 12%) that represents 100, 97, 94, 91 and 88% of pure soil respectively. Growth parameters such as seedling emergence rate, number of leaves per plant, plant height, stem girth, biomass components (root, stem, leaf), leaf area, total chlorophyll analysis, root volume, root length and plant dry weight. In both experiments, the addition of CPH to soil increased soil pH, organic carbon, and organic matter, percent nitrogen, potassium, sodium and calcium. CPH also influenced the increase in the value of % ash, nitrogen, potassium and sodium in the cashew leaves. The effects of 3% level and 97% of pure top soil were significant on growth characters and soil and leaf nutrient contents. It is therefore recommended that CPH amended soil substrates at 3% by volume for cashew seedling production.

Key words: Cashew, Cocoa, Amendment

Introduction

Cashew (*Anacardium occidentale* L) a member of the Anacardiaceae is a semi domesticated tropical nut tree. It is a native of Brazil where it was introduced to other parts of the humid tropics by the Portuguese (The Hindu, 2002). In the tropics, cashew is grown under wide range of ecological conditions (Opeke, 1982), and the crop is especially grown in large areas in Mozambique, Tanzania and Nigeria (Akinwale and Olorode, 1987). The nut is attached to the lower portion of the cashew apple which is conically shaped. The nut is rich in Biotin (an energy booster) and Vitamin B. Biotin is required for the building up of acetyl-co-A carbocylase which coordinates the building of starch in the body (Tzai *et al.,* 2004). The apple contains vitamin C, calcium and Iron more than any other fruits such as citrus, avocados and bananas (FAO, 2006). There are more than 200 registered patents of different uses of cashew shell oil. One of the most important uses is in the manufacturing of different brake oil and brake linings. The shell oil is used in manufacture of numerous materials with heat resistant property, friction acids and caustic products. For example clutch, plates, special isolators, varnish and plastic materials. The wood is insect repellent and used in making book cases and packing crates. The gum Arabic and used as insect repellent in book bindings (ARC, 2004).

Nigeria is an important cashew producer; the crop is an important export commodity because of the high foreign exchange earning derivable from the crop. Nigeria is one of the leading producers of cashew in Africa, Nigeria produces 15,000 MT and other West African countries produce 10,000 MT (EDB, 1999). In Nigeria, cashew is of huge economic and Industrial importance, as a an important export commodity and a high foreign

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exchange earner, between 3 and 5.8 million US dollars per annum was realized from the annual report of 9,800 - 11, 200 tonnes of cashew thus contributes about 1.6 billion naira to the economy (Adeyemi, 1996). However, this level of performance of cashew is reported to be still low (Adeyemi, 1996, Hug Vito *et al*., 2001). In Nigeria, it is common practice to raise improved seedlings of tree crops in the nursery using rich top soil obtained from virgin and fallow forest soils. In recent times, there has been scarcity of rich and matured top soil to grow young cocoa seedlings on a large scale as a result of urbanization and deforestation practices and the continued decline in fertility of field soils (MoyinJesu and Atoyosoye, 2002) Same condition is applicable to cashew since a cocoa and cashew nursery practice follows the same trend. This trend has prompted the use of soils of low fertility status (derived form marginal soils). The fertility of these soils are often supplemented with the application of mineral fertilizer and consequently results in toxicity problems, nutrient leaching and degradation of soil physical and chemical property (Nottidge *et al*, 2005). To arrest this situation, resource poor farmers adopt the use of organic sources of plant nutrients such as wood ash, livestock manure and composts (Northwood, 1996, MoyinJesu and Atoyosoye, 2002). There has also been increasing interests in organic crop production involving the application of organic manures such as plant residues and livestock wastes and composts (Hugo *et al*. 2001). Crop residues such as cocoa pod husk (CPH), oil palm bunch refuse, tea waste, rice bran and other plant wastes and livestock droppings (farm yard manure) are frequently used for crop production in Nigeria (MoyinJesu, 1999). Hugo *et al*. (2001) emphasized the combined use of organic manure livestock waste and plant residues with a controlled level of chemical fertilizers to raise cashew seedlings. Nottidge *et al*, (2005) suggested that further research work be conducted to study effect of plant residues as organic fertilizers. The scientist at the Cashew Research Station (CRS) at Kerala agricultural University, Madakkuthara, India, have developed package of organic technologies of tea waste origin for raising cashew seedlings, an organic package may sustain cashew production for a long term and fetches a premium price for this crop in the International market (The Hindu, 2002).

Cocoa pod husk (CPH) manure contains Ca, P, K, and also sizeable amount of useful organic constituents (Obatolu and Agboola, 1991). Moyinjesu and Atoyosoye (2002) found out that cocoa pod husk (CPH) manure is effective in raising cocoa seedlings in the nursery. Souza (2001) reported positive response of cashew to the application of rice straw manure. About 60% (wet basis) of cocoa (*Theobroma cacao*) pod is made up of husk. Gill and Duffus (1986) reported that about 220,000 metric tones of dry cocoa pod husk were produced in Nigeria. Thus annually, an estimated 8,000,000 tons of cocoa pod husks are discarded during harvesting from which 64,000 - 94000 tons of K, Ca and P are obtainable (Eegunjobi , 1975). Farmers are faced with the problem of disposal of CPH after harvesting. CPH also constitute a barrier for easy movement and serves as abode for pests and disease causing organisms on the farm. Information is abundant on the use of CPH as a source of fertilizer for the production of other fruit tree crops (Eegunjobi and Larinde, 1975; Adv Dappah *et al.,* 1994); Moyinjesu and Atoyosoye, 2002). However, the use of CPH manure for growing cashew seedlings in the nursery has scantly reported. This paper reports the effects of CPH amended soil on the chemical composition of soil and leaves, and on the growth of cashew seedlings.

Materials and methods

The effect of cocoa pod husk (CPH) amended soil substrates on the seedling growth of cashew (*Anacardium occidentale*, L) examined in the screen house and field in March 2004 and March 2005 respectively. The experiment took place at the Federal University of Technology, Akure (Lat. 7^0 N; 5^0 10^0 E) in the rain forest zone of Nigeria. Treatment consisted of application five levels of cocoa pod husk (0, 3, 6, 9 and 12%) that represents 100, 97, 94, 91 and 88% of top soil respectively. Cocoa pod husk was obtained from the Teaching and Research Farm of the Federal University of Technology, Akure. The dried cocoa pod husks were crushed (using hammer) and later milled into a fine powder using household milling machine. The seeds of cashew *(Anacardium occidentale* L.) (Jumbo Brazilian variety), used for this experiment was obtained from the Tree Crops unit of the Oyo State Ministry of Agriculture.

Topsoil for the two experiments was collected under a fallow vegetation at Teaching and Research Farm of the Federal University of Technology, Akure. The soil was air-dried, sieves to remove stones, pebbles, plant roots and other debris and later treated using kaocide a fungicide. The treated soil was later mixed with measured quantity of ground cocoa pod husk to obtain 0,3,6,9, and 12 percentages of the weight of soil. This was done by measuring 50 cups (which is 25cm in height and 20cm in diameter). The 50 cups of soil and represent this as %, 48 ½ cups of soil with 1 ½ cups of CPH, represents 3%, 47 cups of soil with 3 cups of CPH represents also 6%, 451/2 cups of soil with 41/2 cups of CPH was measured for 9% and 44 cups of top soil with 6 cups of CPH was recorded for 12%. All these mixtures were filled into black polythene bags of size (15 x 24 cm). The substrates (top soil amended with different volumes of CPH were arranged in a completely randomized design (CRD) with three replicated. The polybags were later watered thoroughly and allowed to stand for one week before planting to give room for microbial activities. The polythene bags containing top soil and CPH were watered to field capacity and cashew seeds that have been soaked for 48hours in order to break dormancy were planted. One seed was planted emergence commenced from one week after planting (WAP). Other agronomic practices carried out include watering was done twice a week throughout the period of the experiment. Weeds were controlled through hand picking.

Soil and CPH samples collected for the experiment were sieved with 2mm sieve range before being subjected to laboratory analysis. The chemical composition of cocoa pod husk is presented in Table 1. Leaf samples were collected form cashew seedlings under the different treatments for chemical analysis. Soil sample were taken from each polybag treated with different levels of cocoa pod husk using hard trowel at 20 weeks after sowing. The soils were air-dried, sieved with 2 mm sieve for routine analysis of organic matter, total N, available P, exchangeable K, Ca, Mg and Na contents. Soil organic matter was analyzed by Walkley and Black method (Walkley and Black, 1934). Nitrogen content in the soil was analyzed after Kjeldahl digestion, and total N was determined after Kjeldahl digestion (NO_3-N reduction and digestion) (Grace *et al*., 1993). Nitrogen was determined using mocr-Kjeldahl method using K2SO4 and CuSO4 mixture as digestion catalyst and phosphorus was determined in a spectrohotometer (model Novaspect II). Mineral elements were determined from the ash which was dissolved in 10 ml of 10% HCL filtered and diluted to 100 ml with 0.01% HCl. Potassium was determined using flame photometer (Jenway model PFP7). Calcium and magnesium were analyzed by pipetting 10 ml of sample into 250mls conical flask, 50 ml of deionized water, 5 ml of 20% potassium hydroxide (20% KOH) to act as buffer, 5 drops of 2% potassium cyanide (KCN) and 10 drops of hydroxylamine hydrochloride ($OH.NH_2.Hcl$) were added one after the other sequentially. Little quantity of a mixture of 50 g of sodium chloride and 0.5 g of muroxide were added to serve as indicator. The solution was titrated with 0.01M EDTA, and the titre value was recorded for Ca^{++} and Mg^{2+}.

Leaf samples were taken from the middle and upper parts of the cashew seedlings at the 16 week after sowing from each treatment replicates, parked into labeled envelopes, oven dried at about 70 ^{0}C. The nutrients in the leaves were extracted with water. Percent N was determined by micro Kjedahl method (Jackson 1964). The percent P was determined by using Vanado-molybate yellow coloration and the content was read on Spectronic 20 at 442 Um. The percent K and Ca were read on the flame photometre using appropriate element filters while the percent Mg was determined on atomic absorption spectrophotometry (Jackson, 1958).

Table 1: Chemical composition of cocoa pod husk.

pH (water)	Organic C (%)	% Ash	Organic Matter (%)	N (%)	C:N	P (%)	Mg (%)	K (%)	Ca (%)
5.85	3.60	26.00	75.00	1.80	0.23	0.19	1.68	3.78	1.38

Data were collected substrates and cashew seedling growth parameters during the course of the experiment were subjected to analysis of variance (ANOVA) while treatment means were separated using Duncan Multiple Range Test at 5% (Steel and Torrie,1980).

Results and discussion

The results of the chemical compositions of the cocoa pod husk (CPH) amended soil before the experiment are shown in Table 2a and b (screen house and open nursery). From these results (Table 2a), the values of organic matter, total nitrogen and potassium in the soil amended with various fractions of cocoa pod husk (CPH) were approximately ten times higher than in control (top soil alone) in both the screen house and open nursery experiments. In the screen house experiment, the soils amended with various percentages of CPH have considerable high amount of calcium and organic matter (Table 2a). In the open nursery, the CPH amended substrates has lower organic matter compared to screen house (Table 2b). In Tables 3a and 3b are presented the results of the chemical analysis of various top soil CPH mixtures at the end of the experiment of both the screen house and open nursery. Increases soil pH, organic matter, total nitrogen for both experiments were obtained. The physical analysis of the soil before planting shows that the soil used is sandy loam and the bulk density is lower in screen house soil than in the open nursery. In the screen house, top soil alone (control) and 3 and 6% soil constitution by CPH enhanced seedling emergence of cashew, 12% CPH amended substrates had lowest seedling emergence. The result of the chemical analysis of cashew leaves raised both in the screen house and open nursery is shown in Table 3a and b for both screenhouse and open nursery experiments. There were increases in the concentration of N, P and K with increases in the level of CPH added to the soil. The effect of CPH amendment on leaf nutrient composition of cashew in the open nursery was similar to what is obtained in the screen house (Table 3a). There were significant (P = 0.05) increases in leaf nutrient composition between the control (no CPH added) and 12% levels of CPH amendment. In both experiments, the concentration of calcium, magnesium and organic matter in the leaf samples with increase in proportion of CPH added to the soil. In the open field, increases in the proportion of CPH in the soil did not significantly affect final percent seedling emergence. In the screen house, differences obtained among the treatments on the response of plant height to CPH amendment were not significant. In the screen house, 3% of CPH in the substrates produced highest value of plant height. Increased proportion of CPH in the soil depressed plant height beyond the control. In the open field, the control produced highest value of plant height. The effect of CPH amendment varied on the number of leaves produced by cashew seedlings. In the screen house, 6% CPH amendment produced the highest number of leaves followed by 3% amendment. Similarly, in the open nursery, 3 and 6% amendment produced the highest number of leaves, while 12% amendment produced the least number of leaves in cashew. The effect of soil amendment with various proportion of CPH was not significant on cashew leaf area. In the screen house and in the open nursery. Non-significant differences were however obtained among the treatments in the values of cashew seedling root length obtained for the two experiments under the various substrates. In the screen house, CPH amendment influenced root development of cashew seedlings. Cashew seedlings grown on soil amended with 12% CPH produced the least shoot yield while 3% CPH amendment produced the highest root biomass. The result of effect of cocoa pod husk amendment on shoot dry weight is presented on Table 4. Soil amended with 3% CPH produced the highest shoot dry weight while cashew seedlings grown on soil amended with 12% CPH produced the least shoot yield in the two experiments.

Table 2: Pre-planting soil chemical composition (screen house and open field nursery)

Experimental sites	pH (water)	C (%)	Organic matter (%)	N (%)	C:N	P (%)	Ca^{2+} (cmol/kg)	Mg^{2+} (cmol/kg)	K^{+} (cmol/kg)	Na^{+} (cmol/kg)
Screenhouse	6.67	1.83	3.15	0.12	15.25	0.05	4.00	1.10	0.66	0.99
Open field	6.71	1.06	1.83	0.05	21.2	0.16	4.10	0.40	0.43	0.53

Table 3a: Chemical composition of the soil substrates (screen house) after the experiment (2004)

% Cocoa pod husk amendment	pH (water)	C (%)	Organic matter (%)	N (%)	C:N	P (%)	Ca^{2+} (cmol/kg)	Mg^{2+} (cmol/kg)	K^{+} (cmol/kg)	Na^{+}(cmol/kg)
0	6.00	2.05	3.53	0.13	15.76	0.06	3.30	1.40	0.47	0.56
3	6.21	2.33	4.02	0.14	16.64	0.06	3.40	2.10	0.74	0.63
6	6.32	2.32	3.98	0.15	15.40	0.04	3.90	2.20	0.87	0.67
9	6.59	2.41	4.15	0.16	15.06	0.03	4.00	2.20	1.17	0.83
12	6.92	2.51	4.22	0.17	14.76	0.04	4.10	2.30	1.44	0.92
SE	0.32	0.15	0.24	0.01	0.65	0.01	0.31	0.33	0.34	0.13

Table 3b: Chemical composition of the soil substrates (Open nursery) after the experiment (2005)

% Cocoa pod husk amendment (%)	pH (water)	C(%)	Organic Matter (%)	N (%)	C:N	P(%)	Ca^{2+}(cmol/kg)	Mg^{2+}(cmol/kg)	K^{+}(cmol/kg)	Na^{+}(cmol/kg)
0	7.63	1.20	1.90	0.06	20.00	0.10	3.30	0.50	0.35	0.65
3	7.34	1.45	2.00	0.07	20.71	0.12	3.40	0.60	0.48	0.96
6	8.05	1.85	2.70	0.09	20.55	0.12	3.90	0.60	0.78	1.04
9	8.35	2.00	3.40	0.10	20.00	0.14	4.00	0.70	1.13	1.23
12	7.89	2.30	3.75	0.12	19.17	0.15	4.10	0.70	1.13	1.24
SE	0.35	0.39	0.74	0.02	0.54	0.02	0.33	0.07	0.32	0.24

Table 4: Effect of pod husk amended soil on growth attributes of cashew (Screen house and open field experiments)

	SCREENHOUSE						OPEN FIELD NURSERY					
Percent CPH	Total root length (cm)	Shoot dry wt (g)	Percent emergence (%)	No. of leaves/ plant	Plant height (cm)	Leaf area (cm^2)	Total root length (cm)	Shoot dry wt (g)	Percent emergence (%)	No. of leaves/ plant	Plant height (cm)	Leaf area (cm^2)
0	24.9	14.5	82	21	35	3.9	25.4	14.4	91	14	31	3.35
3	27.6	14.5	90	24	39	4.1	29.0	15.0	86	16	35	3.10
6	28.0	13.7	98	26	40	3.5	32.1	14.7	83	15	35	3.25
9	23.9	12.0	88	22	34	4.1	25.5	11.3	80	13	33	3.20
12	26.8	10.2	76	19	31	4.5	25.5	10.5	76	11	20	2.73
LSD (0.05)	NS	NS	*	*	*	*	*	*	*	NS		

Discussion

The soil used in raising cashew in the experiment the control is low in organic matter, nitrogen, organic carbon, phosphorus and potassium (Table) compared to nutrient status following amendments with 3% to 12% CPH. A critical level of 0.13% of soil N was recommended for cocoa seedlings by Moyinjesu and Atoyosoye, (2002). This threshold was lower than what was obtained from control of both experiments, hence the addition of different percentage of CPH as to soil improved soil N status and increased the performance of cashew seedlings. Addition of CPH improves soil pH in both experiments, this was supported by Moyinjesu and Atoyosoye, (2002) who also found that CPH improves the soil pH and performance of cocoa seedlings in the nursery. Soil amendment with CPH also led to increases in organic carbon, potassium, sodium and nitrogen. Obatolu (1995). reported similar findings about the effects of soil amendment with CPH on soil fertility status and cocoa seedling performance. Hugo Vitor *et al.,* (2001) reported similar result from their study of the effects of other organic waste materials as sources of soil nutrients. In this study and in both experiments, CPH increased the value of percent Ash, N, K and Na in the cashew leaves over that of the control. In both screen house and open nursery field experiments, the effects of soil amendment with various proportions (3 – 12%) of cocoa pod husk on plant height, number of leaves, root and shoot dry weight varied. Moyinjesu and Atoyosoye (2002) reported that cocoa pod husk sole and in amended with cattle manure enhanced leaf nutrient status of oil palm bunch, cocoa, coffee and okra. The levels of basic cations (K, Ca, Na and Mg) are high in the CPH amended substrates in this study. This could be the reason why nitrogen and phosphorus are not available for the seedlings grown with 9% and 12% CPH amended soil. This could explain the yellowness of the leaves in these treatments. Substrate derived from 3% amended soil appears to provide the best medium in terms of adequacy of soil nutrients for cashew growth. Soil amendment with different proportions of CPH influenced root length, shoot wet weight, and shoot dry weight of cashew. Also, appreciable effect on plant height, number of leaves was also obtained, 3% level of CPH amendment possibly offered stable medium in terms of soil pH and nutrient status and hence the positive response throughout the stages of cashew in the two experiments. Moyinjesu and Atoyosoye (2002) recorded significant response of cocoa seedlings to CPH in terms of growth characters. The high performance of cashew under 3% level of amendment on growth characters may be due to its low C:N ratio which aids easy decomposition of the CPH and for the fact that the high level of k in both experiment which could negatively influence the Ca and Mg availability due to high K/Ca, P/Mg and K/Mg ratio. The high level of K in the two experiments may lead to nutrients – imbalance and hidden toxicity for crops (Moyinjesu and Atoyosoye, 2002). This could be the reason why substrates conforms high level of CPH recorded lower germination and subsequent lower growth compared to lower levels on cashew seedlings in these experiments.

Conclusion

It is concluded that CPH at 3% by volume as substrate is effective for raising cashew seedling in the nursery as it enhanced soil, leaf and growth of cashew seedlings. It is therefore recommended that CPH soil substrates at 3% by volume for Jumbo Brazilian variety of cashew is desirable for improving soil nutrients availability and for sustainable cashew seedling production. This research finding is a pointer to opening the way for organic cashew production in a cheap manner as peasant farmers are poor thus sourcing for CPH will not be a problem in lieu of inorganic fertilizers and this corroborates with the fact that we need to shift our attention form chemical fertilizers for good health of cashew apple and cashew nut consumers.

References

Adeyemi, A.A.A., 1996. Evaluation of some selected herbicides on the central of spear grass (*Imperata cylindrica* L Ravechel) in cashew (*Anacardium occidentale* L.) Plantation - Nigerian Journal of Tree Cop Rsearch, 1(2): 5-29.

Adv-Dappah, H.K.J. Cobbina and E.O. Asare, 1994. Effect of coco pod ash on the growth of maize. Journal of Agric Science, Cambridge 132: 31-33.

Akinwale, S.A and O.Olorode, 1987. The use of Metric ordination Techniques in the characterization selected accessions of cashew (*Anacardium ocidentale* L). Nigerian Journal of Tree Crops Research, 1(2): 88-113.

ARC- Institute for Tropical and Subtropical crops. 2004. Cultivating cashew nuts. Private Bag X11208, Nelspruit 1200.6p. Lttp://www.nda. Agric. Za/docs/cashew/cashew. Htm.

EDB. (Export Development Board). 1999. Quaterly news letter, 1st quarter 1999, EDB, Sri-Lanka 42, Naven Mawaitha, Colomboz, Sri-Lanka.

Eegunjobi O.A., 1976. On the possible utilization of discarded cocoa (*Theobroma cacao* L). Pod husks as fertilizer and Nematicides. In Ibadan Nematologia Mediterranea, 541-547.

Eegunjobi, O.A. and M.A. Larinde, 1975. Nematodes and maize growth in Nigeria II. Effect of some amendments on populations of P *branchyurus* and on the growth and production of maize (*Zea mays* L.) in Ibadan Nematologia Mediterranea, 3(1): 65-75.

FAO, 2006. Cashew Lttp:11 www. Fao. Org/ag/ags/ agsi/cashew/cashew. Ltm.

Grace, P.R., I.L. MacRae, and R.J.K. Meyers, 1993. Temporal changes in microbial biomass and N mineralization under simulated field condition Soil Biol. Biochem., 25(12): 1745-1754.

Hugo Vitor; Lima; Rosainne de Laurdes, silva de fernandes. Vera Lucia, Baima and Oliveira, 2001. Growth of seedling dwarf precocious cashew- influenced by organic and mineral fertilizations. Rev. Bras. Fruit. 23(2): 391-395 ISSN 0100-2945.

Jackson, M.L., 1958. Soil chemical analysis. P. 86-92. Englewood Clifts N.J. Prentice Hall Inc.

Jackson, M.L., 1964. Soil chemical analysis p. 57-67. Englewood Clifts, N.J. Prentice Hall inc.

Moyinjesu, E.I and B. Atoyosoye, 2002. Utilization of agricultural waste for the growth, leaf and soil chemical composition of cocoa seedlings in the nursery. Pertanika J. Trop. Agric. Sci., 25(1): 53-62 University Putra Malaysia.

Moyinjesu, E.I and E.F. Charles, 2003. Raising Oil palm seedlings in Urban Cities using sole and amended woodash and sawdust Manurial treatments. Pertanika. J Trop. Agric. Sci. 26(1): 19-25. University Putra Malaysia press.

Northwood, P.J., 1996. Some observations on flowering and fruit in the cashew *Anacardium occidentale.* Tropical Agriculture, Trinidad 43(1): 35-41.

Nottidge, D.O, S.O. Ojeniyi and D.O. Ajawalam, 2005. Comparative effect of plant residues and NPK fertilizer on nutrient status and yield of maize (*Zea mays* L) in a humid utizol. Nigerian Journal of soil Science. 15.1-8.

Obatolu, C.R and A.A. Agboola, 1991. The potential of Siam weed (*Chromolaena odorata*) as a source of organic matter for soils in the humid tropics in proc. International symposium by the Laboratory of soil fertility and soil Biology, Katholieke University et Leuven (K.U) and International Institute of Tropical Agriculture (IITA) held in Leuken. Belgium 4-6.

Obatolu, C.R., 1995. Nutrient- balance sheet after coffee and maize cropping on an alfisol supplied with organic fertilizer in Ibadan Nigeria. In: Proceedings of the 3rd African Soil Science Conference University of Ibadan 21-26th.

Steel, R.G.D and J.A. Torrie, 1980. Principles and procedures of statistics. A. Biological Approach. 2nd edition (International student Edition) Mc Graw- Hill Book Company Inc. New York.

The Hindu, 2002. Cashew and organic production. The Hindu newspaper Thursday August 8, 2002. ''Organic Technologies for cashew'' Online edition The Hindu @ Vsnl. Com.

Tsai, C.J., Leitzmann,W.C. Willet and E.L. Giovannucci, 2004. Frequent nut consumption and deceased risk of *Cholecy tectomy* in women. (AM J.lin Nutr) Jul, 80(1): 76-81.

Walkley, A and I.A. Black, 1934. An examination of degtagjaroff method for determining soil organic acid filtration method. Soil Science. 37: 29-38.