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Effects of Sole and Amended Agricultural by Products on Soil Fertility and the Growth and Chemical Composition of Budded Rubber

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ABSTRAK

Satu eksperimen telah dijalankan untuk menentukan kesan sekam koko yang diperbaiki dan yang tidak menggunakan abu tandan kelapa sawit dengan najis ayam itik, ayam belanda, arnab dan sekam yang digunakan pada tangkai akar getah (tunas getah yang dicantumkan pada akar) di kawasan zon hutan hujan Akure, Nigeria. Ada tiga belas rawatan pembaikan organik dijalankan pada 6t/ha dengan baja 300 kg/ha sebagai rujukan pembaikan dan kawalan (tanpa baja, tanpa najis binatang). Rawatan disusun dalam aturan blok lengkap rawak (RBC) dan direplikakan sebanyak tiga kali. Rawatan pembaikan tanah organik juga dianalisis secara kimia dan parameter tunas getah direkodkan bagi ketinggian, jumlah dedaun, jumlah limfa, kawasan daun, nilai N, PL, K Ca, pH Mg tanah dan bahan organik (O.M) pada tanah dan daun. Keputusan menunjukkan ada peningkatan yang signifikan (P<0.05) pada kawasan dan jumlah daun, jumlah limfa, tanah dan nilai N, P, K, Ca, Mg dan pH tanah dan bahan organik (O.M) tunas getah di bawah rawatan pembaikan berbanding rawatan kawalan. Rawatan menggunakan tandan kelapa sawit dan najis ayam itik menghasilkan limfa daun yang tertinggi. Penggunaan baja NPK, sekam (betari sisa kilang) dan rawatan kawalan, mengurangkan jumlah limfa daun sebanyak 50%, 42% dan 92%. Pembaikan abu kelapa sawit + najis arnab juga menaikkan min ketinggian tunas pokok getah dengan 56% dan 46% berbanding najis ayam itik dan baja NPK. Abu tandan kelapa sawit dan hampas sekam koko meningkatkan K dan Mg pada tanah dan daun berbanding sekam sementara itu najis ayam belanda meningkatkan N, P, K, Ca, Mg pH tanah dan O.M pada tunas, tanah dan daun getah berbanding najis ayam itik dan arnab.

ABSTRACT

An experiment was out to determine the effectiveness of sole and amended cocoa husk, oil palm bunch ash with poultry, turkey, rabbit manure and spent grain on budded rubber root stock (grafted bud rubber on a root stock) in the field at Akure in the rainforest zone of Nigeria. There were thirteen organic amendment treatments applied at 6t/ha with 300 kg/ha fertilizer as a reference treatment and a control (no fertilizer; no manure). The treatments were arranged in a randomized complete block (RBC) design and replicated three times. The soil organic amendment treatments were also chemically analysed while the parameters recorded for the budded rubber were plant height, leaf number, number of nodes, leaf area, soil and leaf N, PL, K Ca, Mg Soil pH and Organic matter (O.M). The results showed that there were significant increases (P<0.05) in plant height, leaf area, leaf number, nodes number, soil and leaf N,P,K,Ca, Mg Soil pH and organic matter (O.M) of budded rubber under different organic amendment treatments compared to the control treatment. Oil palm bunch ash + poultry manure treatments had the greatest number of leaf nodes. Use of NPK fertilizer, spentgrain (sorghum based brewery waste) and control treatments reduced mean leaf node number by 50%, 42% and 92% respectively. The amendment oil palm ash + rabbit manure also increase the mean plant height of budded rubber by 56% and 46% compared to the poultry manure and NPK fertilizer respectively. Oil palm bunch ash and cocoa husk residues increased the soil and leaf K and Mg compared to the spent grain while the turkey manure increased growth of budded rubber, soil and leaf N, P, K, Ca, Mg Soil pH and O.M. more than poultry and rabbit.

INTRODUCTION

Rubber, (*Hevea brasiliensis*) is a member of the family Euphorbiaceae and is mainly cultivated for its latex production. The family also contains plants such as castor oil plant (*Ricinus comunis*), cassava (manihot esculentum) and many other species of tropical importance.

The genus Heavea contains a number of species but *Hevea brasiliensis* is the only species with very high isoprene content in its latex. The latex produced by the tree in processed into commercial forms of rubber and has contributed enormously to the economies of Nigeria, Asian and other tropical countries in term or raw-materials for tire industries, foreign exchange earnings and provision of employment opportunities.

In spite of the utilization and importance of the crop, the rubber production in Nigeria is facing serious problems at present because the tree area aging and there is a scarcity of new rubber seedlings or budded rubber to replace over 532,364 hectares of aging and low production rubber trees in the field. This replacement is becoming difficult because ofa continuous decline in soil fertility.

Efforts to improve soil fertility using different types of inorganic fertilizers such as Urea, sulphate of ammonia and NPK tog row rubber seedlings or budded types, are limited by the cost of these materials, scarcity at the farmers' level and continued deterioration of soil properties (Folorunso *et al.* 1995).

Umoti (1990) reported that cocoa, rubber and oil palm removed large amounts of plant nutrients in the nursery and field. High productivity of these crops could be achieved and sustained by massive application of inorganic fertilizers. However, inorganic fertilizers are becoming very expensive (N1500.00 or US$15.00 per bag) which poses a constraint to low income farmers who produce the major percentiles of rubber, oil palm and cocoa in Nigeria.

Therefore, the complimentary use of organic fertilizers materials derived from oil palm, cocoa, rice, maize, cassava crops and animal wastes such as poultry and turkey manures could help to reduce the high cost of fertilizers. Due to their natural abundance, organic amendments such as oil bunch ash, wood ash spent grain (sorghum based brewery waste) and their amended forms with turkey and poultry manures as fertilizers have been used for growing maize, cassava and okra crops in Nigeria (Oladokun 1986; Folorunso 1999).

Based on an extensive literature review, it is concluded that there is scarcity of research information pertaining to the of oil palm bunch ash, wood ash, spent grain nad their amended forms with turkey and poultry manures for growing rubber either in the nursery or field. Therefore, there is a strong justification to investigate the use of these wastes to grow budded rubber in the field.

The objectives of the research were as follows:

i. To determine the effect of different organic amendments on the performance of budded rubber in the field
ii. To determine the effect of organic amendments on the soil and leaf chemical composition of rubber in the field.

MATERIALS AND METHODS

The experiment took place at Akure (Lat 7°N[1], 5° 10E[1]) in the rainforest zone of Nigeria. The annual rainfall is 1300mm and the mean termperature is 70°F while the soil is a sandy laom, skeletal, kaolinitic isohyperthermic oxic paleustalf (alfisol) or Ferric Luvisol (F.A.O).

Source and Preparation of the Organic Amendments Used

Oil palm bunch ash and wood were obtained from the oil palm and cassava processing units of Federal College of Agriculture, Akure respectively. Cocoa husk was collected form the college cocoa farms while the spent grains (sorghum based brewery waste) were collected from a nearby local brewery.

The turkey, poultry and rabbit manures were collected form the college livestock farms. The organic residues were processed to allow decomposition and reduction of C/N ratio. The dried cocoa husk were ground a hammer mill while the spent grain was chopped into pieces, and allowed to decompose. The turkey, poultry and rabbit manures were stored individually to allow for mineralisation and placed under shade.

Generally, all the organic wastes readily available, sustainable and inexpensive for growing comemrical quantities of budded rubber in the field.

Field Experiment

The budded rubber root stocks were bought form Rubber Research Institute of Nigeria (RRIN) Benin, Edo- State. The field site was cleared and the planting lines for the budded were marked with pegs.

There were thirteen organic amendment treatmnets viz:spent grain, rabbit manure, turkey manure, spent grain + turkey manure, oil palm bunch ash + rabbit manure, cocoa husk + turkey manure with a field recommended chemical fertilizer NPK 15 – 15 – 15 treatment applied at 300kg/ha and a control (no fertilizer no manure).

The organic amendments were applied at 6t/ha for the ordinary forms of spent grain, rabbit manure, turkey and oil palm bunch ash while their amended froms were applied at a ratio of 50:50% by weight (3tha- 1 each).

Planting holes were dug 30cm deep and filled with top soil halfway. Then each organic amendment was added and allowed to decay for ten days before planting one budded rubber root stock per hole at a spacing of 6m x 3m. The 4^{th} week after planting, sprouting of the scions occurred.

Weeding began 2 weeks after planting and every 3 weeks until experiment was terminated. 10ml a.i. of Karate/10L of water was sprayed on them (sprouted scions of rubber) to control termite attacks.

Five weeks after planting measurements or counts of plant height, nodes number, leaf area, stem girth and leaf number were made and these measurements or counts were representative leaves of the plant and this was used to calculate total leaf area (cm^2) per plant. (4.8 and 32 weeks after planting), also these measurements were done insitu.

Representative leaf samples were taken at 20 weeks after planting for each treatment, placed in labelled envelopes and oven dried at 70°C for 48 hours. Two grams of dried leaf samples were weighed into crucible and dry-ashed in a muffle furnace at 45°C for 6 hours.

The resulting ash was solubilized into solution and analyzed for phosphorus (P) using vanado-molybdate colouration and read on spectronic 20 at 442Um while the % K, Ca and Na were determined using a flame photometer. Magnesium content was determined with an atomic absorption spectrophotometer (Jackson 1958). The % N was determine using the micro-Kjeldahl method (Jackson 1964).

Soil Analysis Before Planting

30 core soil samples were collected from 0-15cm depth on the site, mixed thoroughly and the bulk samples were taken to the laboratory air-dried sieved with 2mm sieve and ready for routine analysis.

The soil pH (1:1 soil/water and 1:2 soil/ 0.01M $Cacl_2$) was determined using a glass/ calornel system (Crockford and Nowell 1956). Organic carbon determination was done using wet dichromate method (Walkley and Black 1934). The organic C ws multiplied by 1.723 to get organic matter (0.M).

The exchangeable cations were extracted using 1M NH_40 (ammonium acetate) solution and the amount of K, Ca and Na contents were determined on flame photometer using appropriate element filters while Mg content in the extract was read on atomic absorption spectrophotometer (Jackson 1958). The exchangeable acidity (H^+ and $A1^{3+}$) was measured from 0.01 M KCI extracts by titrating with 0.1 M HCI (Mclean 1965).

Total nitrogen was determined by micro-kjedahl method (Jackson 1964) and the soil available phosophorus was extracted using Bray Pi extractant (Murphy and Riley 1962) and the concentration measured on a spectronic 20 at 882Um.

Soil Analysis After Planting

Soil samples were taken from each treatment plot using soil auger, air-dried, sieved with 2mm sieve for routine analysis of total N, available P, exchangeable K, Ca, Mg and Na contents, soil pH and O.M as described earlier under soil analysis before planting.

Statistical Analysis

The data collected from the treatment effects of the organic amendments on the growth parameters such as plant height, leaf area, stem girth, leaf number, nodes number, leaf and soil N,P,K,Mg, Soil pH and O.M were analysed using an ANOVA F-test and their means were separated and compared along the treatment effects using Duncan Multiple Range Test (DMRT) at 5% level.

RESULT

Soil Analysis Before Planting of Budded Rubber

The physical and chemical properties of the soils used for growing rubber are presented in Table 1. Using the established soil critical levels in Southwest Nigeria for rubber production, the soils are low in organic matter when compared with the critical level of 3% O.M (Agbooda and Corey 1973). The total nitrogen was less than 0.14% considered as optimum for cocoa and rubber production (Obatolu 1989).

The available P was below the 10mg/kg P which is to be the optimum for crop production (Agboola and Corey 1973). The exchangeable

K, Ca, Mg and Na contents were below, 0.20, 0.25 and 0.18 mg/kg that are considered as adequate for cocoa, oil palm and rubber crops (Agboola 1974).

The low values of soil N, P, K, Ca, Mg and Na and O.M were indications of the low inherent soil fertility. Budded rubber root stocks planted on such would respond favourably to the application of the organic amendments. The soils were sandy loam in texture, skeletal, kaolinitic, isohyperthemic oxic paleustalf (Alfisol or Ferric Luvisol (FAO) or Akure series (local classification).

Chemical Composition of the Organic Fertilizer Materials Used

Table 2 presents the chemical properties of the organic materials used for growing budded rubber root stocks in the field. The poultry manure had the highest N, K and Mg levels when compared to turkey and rabbit manures while turkey manure had the highest P, Ca and Na levels.

The oil palm bunch ash had the highest %N, K, Ca Mg and Na levels when compared to cocoa husk and spent grain. Spent grain is fairly low in N, K, Ca, Mg and Na levels except in %P. The prior processing of the organic amendment treatments before application reduced their C/N ratio.

Leaf Number of Budded Root Stocks

The leaf number of budded rubber root stocks between 4 and 32 weeks after planting (WAP) under the different organic fertilizer treatments is presented in Table 3. There were significant increases ($p<0.05$) in leaf number of budded rubber under the different organic treatments compared to the control treatment.

The amended oil palm bunch ash+spent grain treatments increased the leaf number of budded rubber by 26% and 64% compared to the sole oil palm bunch ash and spent grain respectively. The amended spent grain + turkey manure and cocoa husk+spent grain treatments increased leaf number of budded rubber by 71% and 81% respectively when compared to the control treatment.

The NPK fertilizer treatment increased the leaf population of budded rubber by 48% compared to spent grain treatment. However, the amended cocoa husk+spent grain increased the leaf number of budded rubber by 20% compared to NPK fertilizer. Of all sole residue treatments, poultry manure resulted in the greatest increase in leaf number then spent grain and turkey manure.

Leaf Area of Budded Rubber

TABLE 1
Chemical analysis of the soil before the experiment

PH					Exhangeable Cations			
H_2O	$Cacl_2$	Organic matter	N	P	K	Ca	Mg	Na
		%		mg/kg	mmol/kg soil			
5.80	5.30	0.45	0.08	7.62	0.09	0.11	0.17	0.16

TABLE 2
Chemical analysis of the organic fertilizers used for the experiment

Organic Material	N %	Available P %	K	Exchangeable Cations Ca	Mg	Na
				%		
Spent grain	0.78a	0.64c	0.12a	0.118a	0.20a	0.14b
Rabbit manure	2.67c	0.86e	0.29b	0.30b	0.18	0.16c
Turkey manure	4.08d	0.93f	0.42c	0.60c	0.17a	0.13b
Poultry manure	5.92e	0.75d	0.48c	0.54c	0.35b	0.09a
Oil palm bunch ash	1.54b	0.42b	2.40e	1.25e	0.78d	0.21d
Cocoa pod ash	1.44b	0.21a	1.26d	0.91d	0.48c	0.17c

TABLE 3
The leaf number of budded rubber at 4.8 and 32 WAP under different organic amendments

Treatments	Weels After Planting			
	4	8	32	Mean
Control (No fertilizer)	1	2	4	2.33k
NPK 15-15-15	6	10	15	10.3f
Poultry manure	6	12	18	12.00d
Rabbit manure	4	6	10	6.66h
Turkey manure	3	5	10	6.00i
Oil palm bunch ash	5	11	17	11.00f
Spent grain	3	4	9	5.30j
Spent grain + Cocoa husk	7	12	20	13.0b
Spent grain + Oil palm bunch ash	8	14	23	15.0a
Cocoa husk + turkey manure	5	11	17	11.00ef
Oil palm bunch ash + poultry manure	5	10	16	10.30f
Oil palm bunch ash + rabbit manure	6	10	16	10.66f
Spent grain + poultry manure	6	11	17	11.33c
Spent grain + rabbit manure	6	12	20	12.66c
Spent grain + turkey manure	4	8	12	8.00g

Treatment means followed by the same letters are not significantly different from each other using Duncan Multiple Range Test at 5% level.

TABLE 4
The leaf area (Cm^2/tree) of budded rubber at 4, 8 and 32 and WAP under different organic amendments

Treatments	Week After Planting			
	4	8	32	Mean (Cm^2)
Control	48	75	100	74.30m
NPK 15-15-15	118	236	590	314.90c
Poultry manure	81	160	398	213.00i
Rabbit manure	68	134	335	179.00k
Turkey manure	85	170	424	226.30h
Oil palm bunch ash	78	156	390	208.00j
Spent grain	61	123	308	163.90b
Spent grain + cocoa husk	97	194	484	258.40e
Spent grain + oil palm bunch ash	138	263	698	366.50a
Cocoa husk + turkey manure	128	255	638	340.60b
Oil palm bunch ash + poultry	91	181	453	241.50g
Oil palm bunch ash + rabbit manure	104	207	519	276.50c
Spent grain + poultry manure	85	170	426	227.00h
Spent grain + rabbit manrue	105	209	523	279.00e
Spent grain + turkey manure	114	227	568	3030.00d

Treatment means followed by the same letters are not significantly different from each other using Duncan Multiple Range Test at 5% level.

The leaf of budded rubber root stocks between 4 and 32 weeks after planting (WAP) increase significantly ($p<0.05$) under the different organic fertilizers as presented in Table 4. The amended oil palm bunch ash+spent treatment increased the mean leaf area of budded rubber in the field by 24% compared to the spent grain+rabbit manure. It also increased the leaf area of budded rubber by 43% compared to the sole form of oil palm bunch ash treatment.

The amended oil palm bunch ash+spent grain increased the leaf area of budded rubber by 14% compared to NPK fertilizer while the same parameter increased by 80% when compared to the control treatment. Among the sole residues used, poultry manure increased the leaf most, when compared toe the spent grain and rabbit manure respectively.

Nodes Number of Budded Rubber

Table 5 shows the number of nodes of budded rubber increased significantly (p<0.05) between 4 and 32 weeks after planting (WAP) under the different organic fertilizer treatments. The amended oil palm bunch ash + poultry manure increased the mean nodes number of budded rubber by 50%, 42% and 92% compared to the NPK fertilizer, spent grain and control treatments respectively.

Oil palm bunch + rabbit manure increased the nodes number of budded rubber 29% and 53% compared to the oil palm bunch + poultry manure and oil palm bunch ash (sole form) respectively. Poultry manure treatment also increased the nodes number 27%, 45% and 55% compared to turkey manure, rabbit manure and spent grain treatments respectively.

Plant Height of Budded Rubber

Treatments had significant (<0.05) effect on plant height 32 weeks after planting (Table 6). The amended oil palm bunch ash + rabbit manure increased the plant height of budded rubber by 56% and 46% compared to the poultry manure and NPK fertilizer respectively. The same treatment increased the plant height of budded rubber by 85% compared to the control treatment.

The poultry manure treatment increased the plant height of budded rubber by 53% compared to the spent grain treatment.

DISCUSSION

Soil used for planting of budded rubber trees in the field were generally low in pH, O.M. N,P,K, Ca and Mg which could be responsible for the poor growth of budded rubber as shown in the control treatment. The observation was supported by Agboola (1982) who had reported that poor growth of rubber trees was noticeable in undertilized soils, hence, it is expected that the application of spent grain, oil palm bunch ash, turkey, poultry and rabbit manures and cocoa pod husk alone or in combination iwht manures to the soil would increase growth of budded rubber.

The increase in plant height, leaf area, nodes number, leaf number of budded rubber grown with the sole and amended organic fertilizers could be due to their rich chemical composition and this finding agreed with Umoti (1990) and Folorunso (1999) who reported that oil palm

TABLE 5

The increase in node number of budded rubber between 4 and 32 weeks after planting under different organic treatments

Treatments	Week After Planting			
	4	8	32	Mean (Cm^2)
Control	0	0	1	0.33h
NPK 15-15-15	1	2	3	2.00g
Poultry manure	1	4	6	3.66d
Rabbit manure	1	2	3	2.00g
Turkey manure	1	2	5	2.66e
Oil palm bunch ash	1	2	4	2.33f
Spent grain	0	1	4	1.66g
Spent grain + cocoa husk	1	3	6	3.33d
Spent grain + oil palm bunch ash	2	4	6	4.00c
Cocoa husk + turkey manure	2	4	8	4.66b
Oil palm bunch ash + poultry	2	4	6	4.00c
Oil palm bunch ash + rabbit manure	2	5	10	5.66a
Spent grain + poultry manure	1	2	5	2.66e
Spent grain + rabbit manrue	1	2	4	2.33f
Spent grain + turkey manure	1	2	5	2.67e

Treatment means followed by the same letters are not significantly different from each other using Duncan Multiple Range Test at 5% level.

TABLE 6
The increase in plant height (cm) of budded rubber between 4 and 32 WAP under different organic residues

Treatments	4	8 WAP	32	Mean
Control	4.30	6.00	9.00	6.42i
NPK 15-15-15	10.00	20.00	37.00	22.37d
Poultry manure	8.00	16.70	30.00	18.23f
Rabbit manure	9.00	17.00	32.00	19.34ef
Turkey manure	7.00	16.00	29.00	17.58f
Oil palm bunch ash	6.00	14.00	24.60	14.81g
Spent grain	5.60	13.00	22.00	13.54g
Spent grain + cocoa husk	10.00	18.90	33.00	20.64e
Spent grain + oil palm bunch ash	11.60	23.00	43.00	25.88c
Cocoa husk + turkey manure	6.10	11.00	19.00	12.04h
Oil palm bunch ash + poultry	12.00	28.00	41.20	27.06b
Oil palm bunch ash + rabbit manure	15.50	40.00	69.00	41.5a
Spent grain + poultry manure	10.00	23.80	39.00	24.28c
Spent grain + rabbit manure	10.00	19.30	35.00	21.46de
Spent grain + turkey manure	10.00	19.00	35.00	21.33d

TABLE 7
The leaf chemical composition of budded rubber at 20 weeks after planting under different organic residues

Treatments	N	P	K%	Ca	Mg	Na
Control (no fertilizer)	0.90k	0.141	0.20m	0.20k	0.15kl	0.10h
NPK 15-15-15	2.90b	0.61b	0.65b	0.20k	0.101	0.10h
Poultry manure	2.78c	0.35j	0.33j	0.41f	0.21j	0.15g
Rabbit manure	2.22g	0.35j	0.32j	0.30hi	0.25i	0.11h
Turkey manure	1.72h	0.27k	0.25L	0.28j	0.33h	0.14g
Oil palm bunch ash	1.35i	0.29k	0.28k	0.30hi	0.42de	0.39d
Spent grain	1.25j	0.27k	0.24L	0.36g	0.18k	0.10h
Spent grain + cocoa husk	2.35f	0.40hi	0.44ef	0.38g	0.32h	0.20f
Spent grain + oil palm bunch ash	2.46e	0.42h	0.45e	0.53e	0.48d	0.23f
Cocoa husk + turkey manure	2.40c	0.35j	0.36i	0.32h	0.37fg	0.41d
Oil palm bunch ash + poultry	2.85b	0.53c	0.50c	0.58b	0.53c	0.22f
Oil palm bunch ash + rabbit manure	3.20a	0.69a	0.95a	0.84a	0.86a	0.93a
Spent grain + poultry manure	2.70c	0.45f	0.42g	0.49d	0.64b	0.54b
Spent grain + rabbit manure	2.60d	0.45f	0.48d	0.44e	0.34h	0.50c
Spent grain + turkey manure	2.60d	0.43fg	0.40gh	0.48d	0.39f	0.26

Treatment means within each group followed by the same letters are not significantly different from each other using Duncan Multiple Range Test at 5% level.

bunch ash, cocoa husk and spent grain applied in sole form or amended poultry manure and pig manure at 6t/ha increased significantly the plant height, leaf area and leaf number of oil palm, rubber and coffee trees.

The nutrient contents in leaves of budded rubber in the control plots were below the critical of 0.25%P, 1.19%K, 0.8% Ca and 0.7% Mg as reported by Jones and Eck (1973), thus the leaves of the budded rubber exhibited deficiency symptoms of N (yellow colouration), P (purple colouration) and K (burnt leaf margin).

The application of turkey poultry and rabbit manure, oil palm bunch ash, spent grain and cocoa husk (either solely or amended forms) increased the leaf N,P,K, Ca and Mg contents of budded rubber compared to controls which may be related to their chemical composition (Table 2). This observation agreed with the views of Adu-Daaph *et al.* (1994) who reported that cocoa husk and oil palm bunch ash were good sources of P,K,Ca, Mg and Na when soil applied.

However, increased leaf and soil chemical

TABLE 8
The soil chemical composition of the field planted to budded rubber at 52 weeks after planting under different treatments

Treatments	PH (h_2O)	O.M %	N %	P Mg/kg soil	K	Ca	Mg Mmol/kg	Na
Control (no fertilizer)	5.40e	0.23g	0.03f	4.5j	0.03i	0.05i	0.04h	0.06g
NPK 15-15-15	5.10f	0.28g	0.32bc	34.2b	3.42bc	0.03i	0.02h	0.025g
Poultry manure	6.50c	2.30e	0.28cd	24.5g	2.49g	2.09g	1.32f	0.80d
Rabbit manure	6.45cd	2.26e	0.24d	26.5f	2.25h	1.97g	1.28f	0.69e
Turkey manure	6.60bc	2.35e	0.26d	22.7h	2.78de	2.07f	1.32f	0.74de
Oil palm bunch ash	6.90b	2.30e	0.23d	21.7hi	3.18c	1.89g	1.25f	0.64ef
Spent grain	6.20	1.76f	0.16e	20.5i	2.47g	1.04h	0.81g	0.62f
Spent grain + cocoa husk	6.48c	2.58d	0.29c	25.5f	2.48ef	2.74d	1.64e	0.88c
Spent grain + oil palm bunch ash	7.10a	3.31b	0.29c	33.2c	2.65e	2.63de	1.62e	0.85cd
Cocoa husk + turkey manure	6.53c	2.85c	0.30c	31.9d	2.91d	2.17f	2.46b	1.10b
Oil palm bunch ash + poultry	7.00ab	3.34b	0.35ab	35.2b	3.62b	3.89b	2.05c	1.09b
Oil palm bunch ash + rabbit manure	7.20a	3.80a	0.39a	37.2a	4.53a	4.29a	3.5a	1.25a
Spent grain + poultry manure	6.70b	2.93c	0.31bc	27.3ef	2.52f	3.62b	1.86d	1.20ab
Spent grain + rabbit manure	6.40cd	2.67d	0.28cd	28.6e	2.86d	3.40c	1.65c	0.92bc
Spent grain + turkey manure	6.80b	2.75cd	0.34b	26.3f	2.81de	2.60e	1.68e	0.93bc

Treatment means within each group followed by the same letters are not significantly different from each using Duncan Multiple Range Test at 5% level.

composition and growth parameters of budded rubber by the oil palm bunch ash and cocoa huks blended with turkey, rabbit and poultry manures compared with their sole forms could be explained in term of their better nutrient levels form organically-amended fertilizers than their unamended forms.

The effect of turkey and poultry manure on the growth, leaf and soil chemical composition of budded rubber compared to the spent grain and cocoa husk is consistent with the higher values of soil N, P,K,K, Ca, Mg and O.M of the former than that of the latter. The observation agreed with Folorunso (1999) who reported that the spent grain had lower C, N, Ca, Mg, P, K and Zn content and C/N ratio 1:14 which would make it more resistant to degradation and their nutrients might be made slowly available to plants compared to turkey, poultry and rabbit manures.

The fact that oil palm bunch ash and cococa husk pod increased the soil pH is consistent with the previous finding that the ash contained mainly K, Ca and Mg (Ojeniyi 1995). The NPK fertilizer also reduced the soil pH and this could be a result of acidication associated with continuous use of 300 kg NPK 15-15-15 fertilizer applied per hectare which was a standard practice used for budded rubber in the field. The above statement is consistent with the fact that application of high amount of NPK fertilizer would increase the NH_4^+ cation sorption on the soil surface leading to increased soil acidity (Barber 1962). The phenomenon is also responsible for the reduction in soil O.M. because the soil acidity reduced the activities of microbial organisms, especially aerobic bacteria (inotrosomonas and nitrobacter) which are N fixers cause poor organic matter build up.

CONCLUSION AND RECOMMENDATION

Oil palm bunch ash, cocoa pod husk, turkey, poultry manures, spent grain and rabbit manures are effective sources of nutrients because their additions to the soil have enhanced the leaf and soil N, P,K, Ca, Mg, soil pH and O.M. plant height, leaf area, leaf number and nodes number of budded rubber in the field.

Spent grain was the least effective in promoting budded rubber growth while the amended residues with turkey, poultry and rabbit manures performed well. Oil palm bunch ash + rabbit manure, oil palm bunch ash + poultry manure and cocoa husl + turkey applied at 6t/ha improved nutrient availability and would ensure sustainable cultivation of budded rubber on soils of low fertility in the humid tropics. Thus, they can be used in place of scarce and expensive inorganic fertilizers.

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