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Evaluation of Plant and Animal Tea Solution Fertilizers on the Soil Fertility and Growth of Locust Bean (*Parkia clappertonia*) Seedlings in the Nursery

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ABSTRAK

*Satu eksperimen bagi menentukan keberkesanan 'liquid plant' dan 'animal tea solutions' sebagai baja ke atas tumbesaran dua benih kacang lokus (*Parkia clappertonia*), telah dijalankan di Akure, sebuah zon hutan hujan Nigeria. Lapan jenis campuran anak-anak pokok telah digunakan; kopi, koko,* Cajanus-cajan *(Pigeon pea), gajus, daun plantain, baja najis kambing, ayam belanda dan itik, di mana 100 mL/10 kg tanah yang diisi dalam polibeg digunakan dengan NPK 15-12-12 pada 1g, NPK/10 kg tanah dan kawalan (tanpa najis binatang, baja). Tanah tersebut diterbalikkan sebanyak tiga kali dan disusun secara rawak dalam bentuk yang berbeza. Campuran tanah dan baja tersebut dianalisis secara kimia sebelum benih kacang lokus tersebut ditanam. Keputusan menunjukkan anak-anak pokok yang ditanam dengan tanah tersebut meningkat secara signifikan ($P<0.05$) dari segi ketinggian tumbuhan, lilitan batang, jumlah dedaun, jumlah dahan, berat tunas dan kepanjangan akar, komposisi kimia pada dedaun dan status khasiat tanah kacang lokus tersebut. Bagi komposisi kimia tanah, campuran daun kopi meningkatkan nilai pH tanah, O.M, N, P,K Ca dan Mg masing-masing pada kadar 4.2%, 10%, 13.6%, 58.3%, 22%, 91.3% dan 84% apabila dibandingkan dengan campuran daun cajanus. Manakala, campuran daun gajus telah meningkatkan nilai pH tanah, O.M, N,P,K, Ca dan Mg masing-masing pada kadar 2.8%, 11%, 48%, 57%, 8.3%, 38.5% dan 33% jika dibandingkan dengan campuran daun koko. Campuran daun kopi meningkatkan nilai pH tanah, O.M, N, P, K Ca dan Mg masing-masing pada kadar 24%, 74%, 82%, 89%, 96%, 98% dan 97% jika dibandingkan dengan setiap rawatan kawalan. Anak pokok kopi meningkatkan nilai pH tanah, O.M, K, Ca dan Mg masing-masing pada kadar 25%, 69%, 39%, 98.7% dan 99% berbanding rawatan baja NPK. Baja najis ayam belanda juga meningkatkan nilai pH tanah, O.M, N, P dan Mg masing-masing pada kadar 2%, 19%, 37%, 42% dan 82% berbanding baja daripada najis itik. Pemerhatian yang dibuat ke atas parameter tumbesaran benih kacang lokus, anak pokok gajus telah meningkat dari segi ketinggian, jumlah daun, jumlah dahan, lilitan batang, kepanjangan akar dan berat tunas pada kadar 33%, 41%, 33.3%, 12.2%, 36.4% dan 16% berbanding rawatan baja NPK. Sama seperti di atas, ia juga meningkatkan parameter tumbesaran masing-masing pada kadar 61%, 71%, 78%, 62%, 77% dan 71% berbanding rawatan kawalan. Di dalam komposisi kimia daun kacang lokus, N, P, K, Ca dan Mg anak pokok gajus telah meningkat dengan 42%, 45%, 41.6%, 8.5% dan 83% berbanding baja NPK. Anak pokok gajus dan baja dari najis ayam belanda adalah yang paling menunjukkan tumbesaran yang pesat, tumbesaran daun dan tanah bagi benih kacang lokus.*

ABSTRACT

An experiment was carried out at Akure in the rainforest zone of Nigeria to determine the effectiveness of liquid plant and animal tea solutions as fertilizers on the growth of two crops of locust bean (Parkia clappertonia) tree seedlings in the nursery. Eight manurial tea solutions were used namely; coffee, cocoa, Cajanus-cajan *(Pigeon pea), Cashew, plantain leaf tea fertilizers, goat dung, turkey and duckmanure tea fertilizers, applied at 100 mL/ 10 kg soil filled polybag with NPK 15-15-15 at 1 g NPK/10 kg soil and control (no manure, no fertilizer). They*

were replicated three times and arranged in a completely randomized design. The soil and manurial tea fertilizers were chemically analysed before planting locust bean seeds. The results showed that the manurial tea solutions increased the plant height, stem girth, number of leaves and number of branches, shoot weight and root length at harvest, leaf chemical composition of locust bean seedlings and the soil nutrient status significantly ($P < 0.05$). For soil chemical composition, coffee leaf solution increased the soil pH, O.M, N,P,K, Ca and Mg by 4.2%, 10%, 13.6%, 58.3%, 22%, 91.3% and 84% respectively when compared with cajanus leaf solution while the cashew leaf solution increased the soil pH, O.M, N, P,K, Ca and Mg by 2.8%, 11%, 48%, 57%, 8.3%, 38.5% and 33% when compared with cocoa leaf solution respectively. Coffee leaf tea solution increased the soil pH, O.M, N, P, K, Ca and Mg by 24%, 74%, 82%, 89%, 96%, 98% and 97% compared with the control treatment respectively. Coffee tea solution increased the soil pH, O.M, K, Ca and Mg by 25%, 69%, 39%, 98.7% and 99% compared to NPK fertilizer treatment respectively. Turkey manure tea solution also increased the soil pH, O.M, N, P and Mg by 2%, 19%, 37%, 42% and 82% respectively compared to the duck manure tea. Concerning the growth parameters of locust bean seedlings, Cashew leaf tea solution increased the plant height, number of leaves, number of branches, stem girth, root length and shoot weight by 33%, 41%, 33.3%, 12.2%, 36.4% and 16% compared to the NPK fertilizer treatment respectively. It also increased the same growth parameters by 61%, 71%, 78%, 62%, 77% and 71% respectively when compared to the control treatment. In the locust bean leaf chemical composition, the cashew leaf tea solution increased the leaf N, P, K, Ca and Mg by 42%, 45%, 4.16%, 85% and 83% when compared with NPK fertilizer respectively. Cashew leaf solution and turkey manure tea solutions increased the growth, leaf and soils of locust bean seedlings most.

INTRODUCTION

African locust bean (*Parkia clappertonia*) is a traditional tea grown for its seeds which were used as condiment or spices for food preparation in most homes in the tropical countries. Despite the above importance, the crop is going into extinction (less of biodiversity) and this is because people are not growing the crop due to difficulty in raising the seedlings and the poor soil fertility which tend to prolong its maturity in the nursery and on the field. Now, there is a renewed interest in the crop as an organic condiment as demonstrated by some food industries such as Lever brothers PLC and Cadbury Nigeria PLC to replace the chemically manufactured maggi cubes and other food seasonings.

Efforts must be made to produce the locust bean seedlings for planting in commercial production and the use of inorganic fertilizers to sustain the soil fertility for the optimum growth of the crop is accompanied by high cost, scarcity at farmers' level and degradation of soil properties on continuous use.

Several researchers (Agboola 1974; Bredero 1977; Adu-Daaph *et al.* 1994; Ojeniyi 1998; Folorunso 1999) have established the importance of the following solid organic manures such as cocoahusk pod, woodash, spentgrain, poultry, goat, pig and rabbit manures in improving soil fertility, crop quality and yield of crops. They also established that these materials were locally available, cheap and sustainable. However, the adoption and utilization of these solid manures by farmers were still not encouraging because the farmers complained of the bulkiness, mess and difficulty in the transportation of the solid organic wastes (Agboola 1982).

The quest to find research answers to the above problems led to the development and use of organic tea solutions to raise locust bean seedlings in the nursery (Folorunso 1999 pers. comm.). An organic tea solution fertilizer is the one derived from plant leaves and animal dung through immersion in water. The objectives of the research were, therefore, to determine the effect of different organic tea fertilizers on the growth, nutrients in the leaf, and chemical composition of soil at a harvest of African locust bean (*Parkia clappertonia*) seedlings in the nursery.

MATERIALS AND METHODS

The experiment was carried out at Akure (70^0N^1, 5^010^1E) in the rainforest zone of Nigeria. The rainfall is between 1,500 mm per annum and temperature is 24°C all year round.

Soil Sampling and Analysis

The soil samples (30 core) were collected from the 0-15 cm depth on the site, mixed thoroughly, curdried and sieved to pass through a 2 mm sieve for routine analysis. The soil pH (1:1 soil/water) was read on the pH meter. Organic matter was determined by the wet oxidation method using chronic acid digestion procedure (Walkley

and Black 1934).

Soil P was extracted by Bray P1 extractant and P solution was determined with molybdate blue method (Murphy and Riley 1962).

The soil K, Ca, Mg and Ma were extracted with 1M NH_4Oac pH 7 and the content was determined by using atomic absorption spectrophotometer.

Total N was determined by microkjedahl (Jackson 1964).

Collection and Preparation of the Manurial Tea Solution Fertilizer

Cocoa, cashew and coffee leaves were collected from their plantations while cajanus cajan and plantain leaves were obtained from the nearby farms. The goat, turkey and duck manures were collected from their pens. The leaves were cleaned to remove the dust while the manures were airdried, and ready for the tea preparation.

The plant leaves (5 kg each) were weighed and the leaves were chopped, immersed in 50 litre (L) containers filled with the 40 L of water. The immersed leaves were stirred at every three-day interval with a wooden ladle until 14 days after setting up the experiment. Thereafter, the 40 L tea solution was diluted with 40 L of water and the diluted solution was applied to the soils on which locust bean seeds were grown.

The animal manure (10 kg each) was weighed into a polysac or salt bag, tied at the mouth with a rope into a crossbar stick of 10m length which had been suspended on two sticks with edges erected at a distance of 8 m from each other. The bag containing the weighed manure was gradually suspended into a 50 L container filled with 40 L water. Stirring of the solution took place at every three-day interval until 2 weeks after the initial setting of the experiment.

The tea solution (40 L of tea fertilizer) was diluted with 200 L of water for poultry manure (1:5) while goat, turkey and duck manure solutions were diluted with 120 L of water (1:3). The diluted solutions of the animal manure tea fertilizer were added to the soil to be used for raising locust seedlings.

Chemical Composition of the Manurial Tea Fertilizer

An aliquot of each tea fertilizer (5 mL) was taken for the chemical analysis. The total N was determined by microkjedahl method. The P content was analysed using vanado-molybdate method (Aduayi and Gatitu 1973).

The K, Ca, Na were determined using flame photometer and Mg on atomic absorption spectrophotometer (AOAC 1970).

Nursery Experiment

Seeds of locust bean were collected and pre-germinated in the pre-nursery boxes. One hundred and fifty (150) polybags were filled with 10 kg soil each and arranged in five sets for the ten treatments using a completely randomized design and replicated three times. Each replicate had 50 polybags.

Two germinated seeds of locust bean were planted into each polybag and one week after planting, 100 mL of each manurial tea fertilizer was applied per polybag while 1 g of NPK 15-15-15 fertilizer per 10 kg soil (400 kg/ha) was added to the five polybags (reference treatment) and the control treatment did not receive either manure or fertilizer.

The eight manurial tea fertilizers were made up of *Cajanus-cajan* (Pigeon leaves), coffee leaves, cocoa leaves, plantain leaves, cashew leaves, goat dung, turkey manure and duck dung solutions.

Hand weeding was carried out three times at 3, 6 and 9 WAP to control weed infestation. At 2 weeks after planting, the plant height, number of leaves, number of branches and stem girth were measured using ruler, visual counts and vernier calipher. The measurement of the growth parameters continued at a 7-day interval until 24 WAP.

At 9 WAP, leaf samples were taken from the middle part of the seedling, dried and used for nutrient analysis, N, P, K, Ca, Mg and Ma as described earlier.

Statistical Analysis

The mean data collected from the effect of different manurial tea fertilizer solutions on growth parameters, leaf and chemical composition of locust bean seedlings were subjected to analysis of variance (ANOVA) techniques and their means were separated and compared using the Duncan multiple range test at 5% level.

RESULTS

Initial Soil Fertility Status

The physical and chemical properties for soil used for the raising of locust bean seedlings in the nursery are presented in Table 1. Using the established critical levels for soils in Southwest Nigeria, the soils are acidic and low in organic matter, if compared with the critical level of 3% of organic matter (Agboola and Corey 1973) as optimum for crops (Sobulo and Osiname 1981). The available P is less than 10 mg/kg soil considered as adequate for crop production (Agboola 1982). The exchangeable K values are very low and crop grown on the soils is expected to respond to K application using 0.2 mmol/Kg as the critical level. The available Ca, Mg and Na are also low indicating soils with poor fertility status. The soils are very sandy and low in % clay. The soil bulk density is high (1.60 g/cm3) and would adversely affect crop growth. The soil belongs to Akure series and is an Alfisol (USDA 7th approximation).

Analysis of the Manurial Tea Fertilizers

Among the manurial plant tea solution fertilizers used, the cashew and coffee solutions had the highest N, P, K, Ca and Mg content followed by Plantain leaf solution, Cocoa leaf solution and *Cajanus cajan* leaf solution respectively. The animal dung tea solutions, especially turkey manure tea fertilizers, had better N, P, K, Ca and Mg contents than the goat and duck manure solutions (Table 2).

The leaf analysis of the locust bean seedlings under different manual tea solutions is presented in Table 3. There were significant increases ($P<0.05$) in the leaf N, P, K, Ca, Mg and Na contents. Locust bean seedlings treated with cashew leaf tea solution had the highest N, P, K, Ca and Mg contents. Coffee and cashew leaf tea solution had the higher leaf N content than NPK and unfertilized soil (control). *Cajanus cajan* (Pigeon pea) tea solutions contained the least P content.

All the manurial tea solutions gave better nutrients values of K, Ca, Mg and Na than NPK fertilizer. The Ca content was better in turkey and cashew leaf tea solution than that of NPK fertilizer. All the manurial tea solutions had better locust bean leaf nutrient contents than the control.

Effect of Manurial Tea Fertilizer on the Growth Parameters of Locust Bean Seedlings

The plant height, number of leaves, stem girth, root length and shoot weight of locust bean seedlings under different manurial tea solutions

TABLE 1
Physical and chemical composition of soil before planting locust bean seedlings

Bulk density	Texture Sand	Silt	Clay	Soil pH 1.20.01M $Cacl_2$	Organic matter	N	P	Exchangeable Cations K	Ca	Mg	Na	Exch acidity H^t	Al^{3t}	ECEC
g/cm³	-	%	-	-	%	-	mg/kg	-	-	-	mm01/kg	-	-	-
1.60	81.00	15.00	4.00	5.30	0.51	0.03	4.60	0.08	0.15	1.03	0.12	3.85	0.08	5.10

TABLE 2
Manurial tea solution chemical composition

Manurial types	N	P	K	Ca	Mg
			%		
Coffee leaf tea solution	0.16	0.22	0.49	0.72	0.34
Cocoa leaf tea	0.08	0.019	0.51	0.26	0.36
Cajanus cajan leaf tea (Pigeon pea)	0.06	0.01	0.57	0.42	0.18
Cashew leaf tea	0.19	0.12	1.88	0.70	0.48
Plantain leaf tea	0.10	0.11	1.56	0.64	0.25
Goat dung tea solution	0.12	0.04	0.77	0.32	0.16
Turkey manure tea	0.15	0.10	1.57	0.45	0.29
Duck manure tea	0.14	0.02	0.88	0.39	0.15
N P K fertilizer	5.33	4.33	3.2	0.00	0.00

TABLE 3
Nutrient content of the leaf of local bean seedlings at 9 WAP

Manurial tea solutions treatment	N	P	K	Ca	Mg
			%		
Coffee leaf tea	4.60f	0.349f	0.90d	0.14d	0.04c
Cocoa leaf tea	3.61de	0.294bc	0.69c	0.17e	0.05d
Cajanus-cajan leaf (Pigeon pea) tea	2.85b	0.208a	0.49b	0.10b	0.03b
Cashew leaf tea	4.75f	0.380g	1.44gh	0.20g	0.06e
Plantain leaf tea	2.99bc	0.286b	0.89e	0.11bc	0.03b
Goat dung tea	2.94c	0.309c	0.76cd	0.18ef	0.047c
Turkey manure tea	3.27d	0.345e	1.27f	0.21gh	0.048c
Duck manure tea	3.23d	0.312d	1.00e	0.12c	0.03b
NPK 15-15-15	2.75b	0.21a	1.38g	0.03a	0.01a
Control (no fertilizer)	0.08a	0.21a	0.03a	0.025a	0.01a

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

are presented in Table 4. The manurial tea fertilizers increased significantly ($P<0.05$) the growth parameters of locust bean seedlings relative to the control.

Among the plant tea fertilizers, the cashew leaf tea solution increased the plant height of locust bean seedlings by 39% compared to pigeon pea (*Cajanus cajan*).

The coffee leaf tea solution gave the highest number of leaves of locust bean compared to others while the goat dung had the least. The cashew, coffee, plantain and cocoa leaves and turkey manure tea solutions increased the number of leaves compared to NPK fertilizer (Table 4). The number of locust bean leaves produced by cashew leaf tea solution increased by 30% over that produced by goat dung.

The NPK fertilizer gave the best value of stem girth (cm) compared to other manurial tea solutions. The NPK fertilizer increased the stem girth of locust bean seedlings by 73% over goat dung solution tea.

The plantain leaf tea solution had the best value of stem girth of locust bean among the organic tea solutions.

The cashew leaf tea solution produced the longest value of root length of locust bean seedlings compared to other tea fertilizers while the NPK fertilizers produced the least root length, for-instance, the cashew leaf tea solution increased the root length compared to NPK fertilizer. The number of branches of locust bean seedlings was highest in cashew leaf tea solution. There was an increase in the number of branches of locust bean seedlings by all tea solutions compared with that of NPK fertilizer.

The cashew leaf tea solution gave the highest compared to other tea solutions. The cashew

TABLE 4
Growth parameters of locust bean seedlings using the different manurial tea solution fertilizers

Manurial tea solution treatment	Plant height (cm)	Number of leaves	Number of branches	Stem girth	Root length	Shoot weight
Coffee leaf tea	40.10g	15.00e	14.00d	2.72d	37.00g	67.00f
Cocoa leaf tea	38.40f	11.00d	14.00d	2.22c	33.00e	60.00d
Cajanus-cajan (Pigeon pea)	32.90b	11.00d	13.00c	2.02b	29.60c	58.00c
Cashew leaf tea	56.00h	17.00	18.00e	3.12g	44.00h	110.00j
Plantain leaf tea	39.40f	10.00c	13.00c	2.46d	30.20c	53.00b
Goat dung tea	34.50c	8.80b	12.00b	1.80b	30.00c	61.00de
Turkey manure tea	38.50f	11.00d	14.00d	2.86f	35.00f	71.00h
Duck manure tea	35.64d	10.10c	12.00b	2.08c	32.00d	68.00fg
Control (no fertilizer)	15.60a	5.00a	4.00a	1.20a	10.00a	32.00a
NPK 15-15-15	37.70d	10.00c	12.00b	2.74de	28.00b	93.00i

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

leaf tea solution increased the shoot weight of locust bean seedlings by 47.27% compared to that produced by *Cajanus cajan* (Pigeon pea) leaf tea solution.

The manurial tea solutions and NPK fertilizer increased the soil N, P, K, pH, O.M, Ca, Mg and Na of locust bean seedlings significantly ($P<0.05$) relative to the control treatment (Table 5).

The cashew and coffee leaf tea solutions and turkey dung solutions gave the best values of soil pH, O.M, N, P, K, Ca, Mg and Na compared to other manurial tea solutions. The manurial tea fertilizers increased the soil pH, O.M, Ca, Mg and Na significantly compared to NPK fertilizer; however, the NPK fertilizer gave better soil N and P values than the manurial tea fertilizers.

DISCUSSION

The poor growth of locust bean seedlings in the nursery under the control treatment is consistent with the low nutrients in soil especially K, Ca, Mg and Na and low in) M and pH. This view is corroborated by Agboola (1982) who had identified poor soil fertility as the main factor retarding yield of crops, if not fertilized. The increase in the soil pH by the use of the manurial tea fertilizers could be responsible for the better growth of locust bean seedlings because it would favour nutrient release and this view was supported by Raymond (1990) who had reported the importance of neutral soil pH in effective release of nutrients for crops.

The increase in plant height, number of leaves, root length and plant shoot weight of locust bean seedlings by cashew leaf tea solution could be due to its high N, P, K and Ca contents. Calcium has been reported to encourage root growth while K is essential in the formation and transfer of carbohydrates during photosynthesis and N is responsible for vegetative growth and protein synthesis (Tisdale and Nelson 1966). The roots growth could encourage better uptake of nutrients and water from the soil for a fast vegetative growth.

Generally, the high nutrient status of the liquid tea fertilizer, especially the leaves tea solution might have been responsible for the possible influence on the growth parameters of locust bean seedlings. The increase in soil and leaf N, P, K, Ca, Mg and Na nutrient contents of locust bean seedlings was consistent with the nutrient composition of the manurial tea solution (Table 3). The higher soil and leaf K, Ca, Mg and Na nutrient contents of locust bean seedlings under the manurial tea fertilizers more than NPK fertilizer was consistent with the view of Swift and Anderson (1992) who had reported that organic manure supplied nutrients which NPK fertilizer could not supply to the crops. This showed the potential of the manurial tea fertilizers in increasing the yield of crops.

The availability of nutrients in solution form in the tea fertilizers could be responsible for the fast rate of growth parameters in locust bean seedlings.

TABLE 5
The soil chemical composition after planting under different manurial tea fertilizer treatments

Manurial tea Solution treatment	pH 0.01M $CaCl_2$	Organic matter	N	P	K	Ca	Mg
		%		mg/kg		mmol/Kg	
Coffee leaf tea	7.00g	1.58f	0.22	36.00g	1.80f	2.30h	1.00e
Cocoa leaf tea	6.90f	1.50e	0.15b	18.00c	2.20h	1.60fg	0.80d
Cajanus cajan leaf (Pigeon pea) tea	6.70d	1.42d	0.19d	15.00b	1.40e	0.20b	0.16b
Cashew leaf tea	7.10g	1.68g	0.29g	2.00i	2.40i	2.60i	1.20f
Plantain leaf tea	6.60c	1.35c	0.18c	26.00f	1.30d	0.80e	0.30c
Goat dung tea	6.70d	1.44d	0.16bc	22.00d	0.90b	0.50d	0.26c
Turkey manure tea	6.90f	1.56ef	0.26ef	38.00h	1.90g	0.50d	1.10f
Duck manure tea	6.80e	1.26b	0.20d	24.00e	1.10e	0.40g	0.20c
Control (no fertilizer)	5.30ab	0.41a	0.04a	4.00a	0.08a	0.05a	0.03a
NPK 15-15-15	5.25a	0.49a	0.32h	44.00j	1.10c	0.03a	0.01a

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

CONCLUSION AND RECOMMENDATION

The use of plant and animal manure tea solution fertilizers such as coffee, plantain, cashew, cocoa and plantain leaf solutions turkey, duck and turkey tea fertilizers increased the growth parameters, leaf and soil chemical composition of locust bean seedlings.

However, the coffee and cashew leaf solution fertilizers appeared to be most effective especially when applied at 100 mL per locust bean seedling while the turkey manure was the best among the animal manurial tea fertilizer.

The recommendation germanes with the fact that chemical fertilizers are very expensive, scarce and destroy soil properties and the need to revive the production of economic tree crops such as locust bean seedlings for income generation, industrial growth and export oriented economy in developing countries.

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