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Comparative effects of sole and combined application of organic and inorganic fertilizer on soil quality and rubber seedling performance at Edo State Iyanomo, Nigeria

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ABSTRACT

A field experiment was conducted at Rubber Research Institute of Nigeria, Edo state Iyanomo during the 2014 wet season to determine the comparative effects of sole and combined application of organic and inorganic fertilizer on soil, and Rubber seedling performance and the experiment consisted of six treatments. The treatments were laid in a Randomized Complete Block Design (RCBD) with three replications. The materials used were one strain of mycorrhizal (GC) applied at the rate of 5000kg/ha, NPK 15:15:15 at the rate of 112 kg/ha and poultry manure was also applied at the rate of 6000 kg/ha. Plant data; height, girth, leaf area and number of leaves were collected at monthly interval for seven (7) months. Soil samplings were obtained before, three months and seven months after application of soil treatment from 0-15cm depth and were subjected to laboratory analysis (chemical analysis). All data sets were subjected to analysis of variance (ANOVA) using Genstat (2008) statistical package. The significant means were separated using Duncan Multiple Range Test (DMRT) at 5% level of probability. Also the plant analysis was carried out at the end of the trial to determine the nutrient content which was used to calculate the nutrient uptake. The result show general increase in the chemical properties after application of treatments in organic matter, nitrogen, pH, calcium, potassium, Available phosphorus, ECEC and base saturation with values 6.74, 0.49, 6.53, 4.50, 1.50, 8.62, 10.68 and 99.85 respectively. Higher growth in plant height, (140.3, 133.0 cm) girth, (11.9, 10.5, respectively, were obtained after seven months of planting in the cropping seasons. The result of the nutrient uptake obtained showed that at 7 months after application of treatment. There was a general increase in the chemical properties of the soil through the addition of the different soil amendments (organic and inorganic fertilizer).

1.0. Introduction

Soil infertility is a common problem in the tropics where the forests are opened to continuous cultivation without adequate soil nutrient replenishment, thus resulting in steady decline in crop productivity. Lack of adequate soil nutrient replenishment is due to the poor soil fertility management methods among the farmers that make up the bulk of the farming populace in Nigeria. (Adejuwon, 1979). Based on Research findings, chemical fertilizer at appropriate recommendation may be applied in order to improve the soil fertility. However, negative consequences have been reported on wrong application of inorganic fertilizers as shown in many studies. (Ekanade, 1993 and Ekanade, 1997). Ayoola and Adeniyan (2006) had reported that the use of inorganic fertilizer has not been helpful under intensive agriculture because, it has often been associated with reduced yield as a result of nutrient imbalance, leaching and pollution of groundwater.

The fertilizer NPK plays a very important role in the area of improving soil fertility. Other critical nitrogenous plant compound includes the nucleic acids, in which hereditary control is vested in chlorophyll which is the heart of photosynthesis (Planters bulletin, 1971). Nitrogen is also essential in carbohydrates use in plant, a good supply of nitrogen stimulate growth and development as well as the uptake of other nutrient (Les, 1981).

In Nigeria, most rubber growing soils are predominantly sandy to sandy-loam in the surface area and are therefore, susceptible to leaching, erosion and nutrient loses. The fertility management of rubber at the young stage is critical to the productivity of rubber at maturity. The soils of the rubber belt of Nigeria with few exceptions have sub-optimal nutrient status. They are well known for their low available phosphorus (Uzu, 1973). Their nitrogen content is also low as a result of low organic matter content. The available potassium content is invariably low except in some soils in north of Calabar (Onuwaje and Uzu, 1980), hence, the need for soil improvement using fertilizer. Fertilizer if used properly enhances the productivity of rubber and their overuse can have deleterious effect on plant and soil quality. This necessitates the need for alternative sources of nutrient that are readily available, relatively cheap and environmentally friendly. One of these alternative sources of soil nutrient is the mycorrhizae.

Organic matter in poultry manure varies with temperature, drainage, rainfall and other environmental factors. Organic matter in soil improves moisture content and nutrient retention. Their use therefore, will go a long way to reduce the cost of raising *Hevea brasiliensis* saplings. In Nigeria, especially in areas with acid sandy soil, the nutrient concentration is usually low. It is therefore necessary to improve the soil for proper plant growth (Onuwaje and Uzu, 1980).

Thus, this research work focused on strategy that would generate higher and sustainable yield of *Hevea brasiliensis* seedlings as well as improving the soil fertility status. Consequently, the aim of this study was to evaluate the effectiveness of mycorrhizae as tools to increase the production of improved *Hevea brasiliensis* seedlings in the rootstock nursery.

Soil infertility has become a barrier to the production and availability of improved *Hevea brasiliensis* saplings and this study therefore will profer a lasting solution of improving the soil fertility and increasing the crop production through the use of bio- fertilizer.

Mineral fertilizers are very costly and inadequately available for farmers use. Therefore, there is the need to solve this problem by the use of bio fertilizer which is cheap, readily available and environmental friendly. The use of bio fertilizer will ensure 'friendly association' with *Hevea brasiliensis* saplings and soil environment thereby promoting crop yield and healthy environment. Therefore, there is the need to solve this problem by the use of bio fertilizer which is cheap, readily available and environmental friendly and can reduce the damaging effect of chemical fertilizer, if, not possibly replacing it.

The objective of the study is to examine the comparative effects of mycorrhizal, NPK 15;15:15 and poultry manure on some soil properties and growth of rubber (*Hevea brasillensis)* seedlings on some soil chemical properties , growth of rubber (*Hevea brasiliensis)* seedlings and nutrient uptake by rubber (*Hevea brasiliensis)* seedlings.

2.0. Materials and methods

The field experiment was carried out in 2014 wet cropping season at the experimental site of the Soil and Plant Nutrition Division of the Rubber Research Institute of Nigeria, main station Iyanomo, Benin City, Edo State. The study area occupies a land area of 2070 hectares about 29 kilometers away from Benin City, Edo State, Southern Nigeria. The main access road is through Obaretin Village situated at km 19, Benin- Sapele highway. The Area is located within the co-ordinates of 5º 34'E and 5º 38'E Longitudes; 6º 08'N and 6º 11'N Latitudes. The area lies within the humid rain forest agro-ecological zone. Mean annual rainfall goes above 2000 mm, distributed in a bi-modal pattern with peaks in the month of July and September. the soils of this humid forest belt are mainly ultisols with pH range between 4.0 and 5.5; the soil has been described as the acid sand derived from unconsolidated grits and sand stones containing clay peds of varying proportions, this area has deep, porous, non-mottled and non-concretionary red soils (sand and sandy clay), The detailed characteristics and classification of the soils in this area have been reported (Orimoloye, 2011; Orimoloye and Akinbola, 2013).

The experiment was a 2 x 3 factorial and arranged in a randomized complete block design (RCBD). The field was partitioning into plots with each measuring 1m x 1m and 1m apart between the plots giving rise to a total of 18 plots. Each plot was pulverized and prepared into beds. The materials used were one strain of mycorrhizal applied at the rate of 5000kg/ha, NPK 15:15:15 at the rate of 112 kg/ha and poultry manure was also applied at the rate of 6000 kg/ha which gave rise to 6 treatments which is as follows: control (0), *Glomus clarius* (GC), NPK 15:15:15 (GC0F1), poultry manure (GC0F2), *Glomus clarius* + NPK 15:15:15 (GCF1) and *Glomus clarius* + poultry manure (GCF2) respectively. Plant data; height, girth, leaf area and number of leaves were collected at monthly interval for seven (7) months. Soil samplings were obtained before, three months and seven months after application of soil treatment from 0-15cm depth and were subjected to laboratory analysis (chemical analysis). All data sets were subjected to analysis of variance (ANOVA) using Genstat (2008) statistical package. The significant means were separated using uncan Multiple Range Test (DMRT) at 5% level of probability. Also the plant analysis was carried out at the end of the trial to determine the nutrient content which was used to calculate the nutrient uptake.

3.0. Result

Table 2 shows the some of the physical and chemical characteristics of the soil before the application of treatments.

3.1. Comparative effect of mycorrhiza, NPK 15:15:15 and poultry manure on soil chemical properties in the cropping season at 3 months after planting

The effects of the various treatments on soil chemical properties in the field at three months after treatments application are shown in Table 3. There was a significant

Table 1: Mean annual rainfall and temperature of the study site

Months	Rainfall	Temperature
January	0.44	34.50
March	0.38	35.30
April	3.93	35.70
May	8.48	34.70
June	7.51	34.60
July	8.42	33.60
August	10.86	29.30
September	12.61	30.70
October	8.55	30.50
November	8.06	26.00
December	3.63	26.30
Mean	10.39	28.70
	6.94	31.66

difference (P<0.05) among the treatments with respect to soil pH, Organic C, Organic matter, Total N of the soil. However the highest pH value (4.77) was recorded in soil treated with control (GC0F0), for Organic carbon *Glomus*

Table 2: Pre cropping soil physical and chemical properties of the soil

Parameter	Values 0 – 15 cm
Sand (g/kg)	949.80
Silt (g/kg)	7.80
Clay (g/kg)	42.40
Textural class	Sand
pH	4.12
Organic carbon (g/kg)	3.45
Organic matter	5.95
Total N (g/kg)	0.21
Available P (mg/kg)	3.26
Exch. Acidity (Cmol/kg)	2.20
K (C mol/kg)	0.29
Na (C mol/kg)	0.04
Ca (C mol/kg)	1.60
Mg (C mol/kg)	0.08
ECEC (C mol/kg)	4.21
Base Saturation (%)	47.74

clarius (GCF2) had the highest value 3.43 g/kg also with Organic matter and in Total N three (3) of the . *Glomus clarius* and poultry manure (GCF2), *Glomus clarius* and NPK 15:15:15 (GCF1), did not differ significantly from one another but different significantly from the other treatments.

Similarly, K level varied across the treatments, the treatment poultry manure (GC0F2) which had the highest value of 0.96 Cmol/kg but differ from the treatment. As for Mg, there was a significant difference (P<0.0 5) among the treatments, *Glomus clarius* and NPK 15:15:15 (GCF1) recorded the highest value for magnesium (1.86 Cmol/kg), however it did not differ significant from other treatment. In case of Calcium, the result showed that the value ranged from 1.60 to 3.02 Cmol/kg, there was a significant variation among treatments for calcium. Many other elements in the soil in the field study after three months of *Hevea* saplings growth showed that there was a significant difference among the treatments for Sodium NPK 15:15:15 (GC0F1) had the highest value in the soil 2.28 Cmol/kg which did not differ from other treatments. As for EA, ECEC and % BS, the values were relatively similarly and showed no wide significant difference (P<0.05) variation among treatments. EA result showed that the treatments where similar to each other. Meanwhile, ECEC, *Glomus clarius* and poultry manure (GCF2) recorded the highest value 6.92 Cmol/kg significantly difference from other treatments. The result of % BS were relatively similar and show variation among the treatment control had the best % BS value 98.87 % in the soil.

3.2. Comparative effects of Mycorrihza, NPK 15:15:15 and Poultry Manure on soil Chemical Properties at 7 months after planting.

The result on table 4 shows the effects of the various soil treatments on soil chemical properties in the field at seven months after treatments application. There was no significant difference (P>0.05) among treatment in available P and percentage Base saturation after statistical analysis of data. However pH, Organic C, Organic matter, Nitrogen, potassium, Magnesium, calcium, Sodium, EA and ECEC recorded a significant difference (P<0.05) among the various treatments applied on the soil. The pH of the various treatment at seven months after planting which ranges from 4.68 to 5.10, were higher in *Glomus clarius* and poultry manure GCF2 (5.10) and lowest in the soil treated with *Glomus clarius* GCF0 (4.68), however there was no significant difference among the treatment for pH at seven months after planting. Organic carbon differ significantly among the treatments values ranged from 1.67 –3.20 g/kg with NPK 15:15:15 (GC0F1) having the highest (3.20 g/kg) and NPK 15:15:15 GC0F1 (1.67 g/kg) having the lowest though differ significantly from one another. Potassium value of the difference treatment shows a significant (P<0.05) ranged from 0.12 to 0.38 with NPK 15:15:15 (GC0F1) achieved the highest of value of 0.38 Cmol/kg (Table 4). Magnesium value of the difference treatment which differ significantly (P<0.05) ranged from 0.15 to 1.13 Cmol/kg with GC0F1 having the highest value of 1.13 Cmol/kg.

Similarly, Sodium, EA and ECEC were differed significantly (P<0.05) with *Glomus clarius* and poultry manure GCF2 having the highest value of 0.64 Cmol/kg, control GC0F0 (0.81 Cmol/kg) and NPK 15:15:15 GC0F1 (6.59 Cmol/kg).

The effect of mycorrhizae, NPK 15:15:15 and poultry at seven month after planting on soil also showed significant difference (P<0.05) for total N and Calcium across the treatment. For Calcium, six (6) of the treatments *Glomus clarius* and poultry manure and NPK 15:15:15 (GC0F1), poultry manure (GC0F2) and poultry (GC0F2) and poultry manure (GC0F2) did not differ significantly from one another but differed significantly from other treatments (Table 4). Similarly there was a significant difference (P<0.05) for total N though NPK 15; 15: 15 (F1) had the highest value. as for Organic matter accumulation across the treatment at seven months after planting in 2014 at the field, the result showed that poultry manure GC0F2 have the lowest value of 2.89 (Table). Generally, soil organic matter accumulation ranged between 2.89 and 5.53 at the seven months of *Hevea* seedlings growth on treated soil with mycorrhizae, NPK and poultry manure. The variation of the Organic matter among the treatments was significant different (P<0.05).

3.3. Comparative effect of Mycorrhizea, NPK 15:15:15 and poultry manure on the growth characteristics of Hevea brasiliensis seedlings

3.3.1. Plant height

Figure 1 shows generally, that the treatments had positive influence on the growth height of the Hevea seedlings across the period of growth (2 to 7 months after planting). However, from the first two months after planting, growth in height was recorded in *Glomus deserticola* and poultry manure (M3F2). Similar pattern was observed at three

Table 3: Comparative effects of mycorrhiza, NPK 15:15:15 and poultry manure on soil chemical properties at 3 months

TREATNT	pH (H_2O)	ORG C	Org M g/kg	N	AVP mg/kg	K	Mg	Ca Cmol/kg	Na	EA	ECEC	%BS
GC0F0	4.77	3.39	5.83	2.00	5.18	0.80	1.16	2.69	2.28	0.08	6.87	98.87
GCF0	4.72	2.39	4.11	1.60	5.00	0.32	0.80	1.60	0.64	0.07	3.45	95.32
GC0F1	4.67	2.81	4.83	1.80	6.40	0.88	0.46	2.33	1.60	0.08	5.21	98.47
GC0F2	4.68	3.18	5.48	1.90	8.28	0.96	0.93	3.02	1.60	0.08	6.55	98.77
GCF1	4.60	3.36	5.77	2.00	4.33	0.10	1.86	2.33	1.60	0.08	6.92	98.77
GCF2	4.41	3.43	5.89	2.00	1.03	0.10	0.49	1.63	1.60	0.08	5.54	98.47
LSD (0.05)	0.11	0.03	0.04	0.21	0.25	0.20	0.37	0.16	0.25	0.06	0.42	0.34

GC0F0-control, Gc--*Glomus clarius*, GC0F1 – NPK 15:15:15, GC0 F2 – poultry manure, GcF1 – *Glomus clarius*+NPK 15:`15:15, GcF2 – *Glomus clarius*+poultry manure.

Table 4: Comparative effects of mycorrhizal, NPK 15:15:15 and poultry manure on soil chemical properties at 7 months after planting

Treatnt	pH (H2O)	Org C	Org M g/kg	Total N	AVP mg/kg	K	Mg	Ca cmol/kg	Na	EA	ECEC	%BS
Gc0F0	4.82	2.59	4.48	1.67	3.33	0.18	0.45	1.11	0.55	0.81	3.13	74.44
GcF0	4.68	2.29	3.96	1.57	1.16	0.22	1.12	1.60	0.55	0.25	4.99	69.93
Gc0F1	5.10	2.86	4.94	1.77	4.60	0.38	0.80	1.27	0.23	0.69	6.59	78.75
Gc0F2	4.93	1.67	2.89	1.37	7.64	0.12	0.32	1.61	0.37	0.68	3.53	69.03
GcF1	4.99	2.41	4.16	1.57	5.42	0.15	0.17	1.60	0.56	0.12	3.58	67.21
GcF2	4.99	2.36	4.08	1.57	8.83	0.31	0.15	1.60	0.64	0.55	3.92	69.62
LSD (0.05)	0.38	0.38	0.43	0.09	Ns	0.02	0.29	0.03	0.02	0.55	0.57	ns

ns= not significant, Gc0F0-control, GCF02-*Glomus clarius*, GC 0F1 – NPK 15:15:15, GC0 F2 – poultry manure,

GCF1 – *Glomus clarius* + NPK 15:`15:15, GCF2 – *Glomus clarius* + poultry manure.

months of seedling growth for the treatment (M3F0). At 4th and 5th months of seedlings growth, the best growth in height was recorded in treatment *Glomus clariu* and NPK 15:15:15 (M2F1) and *Glomus clariu* and poultry manure (M2F2). The case was however different for the 6th and 7th months of sapling growth. The highest growth at both period was recorded in treatment control (M0F0). Observation, here reflects high influence of the treatments on the plant height growth across the growth periods with seven months after sapling planting showing the highest.

3.3.2. Plant girth

The result of treatment effects of the treatments on Hevea seedlings girth growth is shown in Figure 2. At two and three months after treatment application, seedlings treated with *Glomus desertlcola* and poultry manure (M3F2) and *Glomus mossesae* and NPK 15:15:15 (M1F1) had the

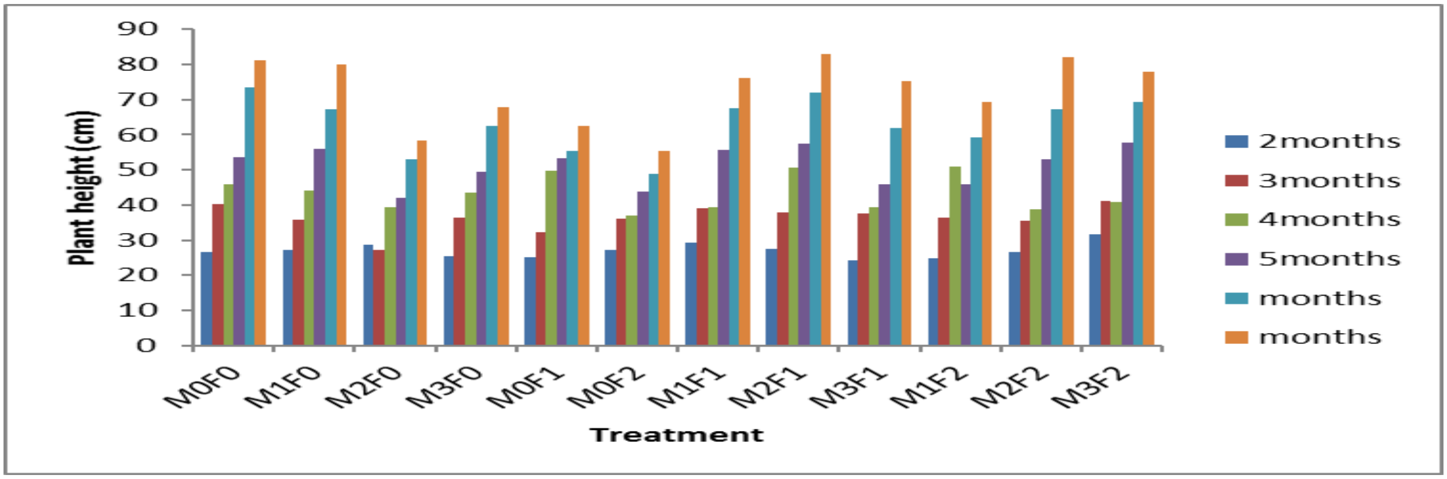

Fig 1: Effects of the treatments on Hevea seedlings plant height

GC0F0-control, Gc--Glomus clarius, GC0F1 – NPK 15:15:15, GC0 F2 – poultry manure, GcF1 – Glomus clarius+NPK 15:`15:15, GcF2 – Glomus clarius+poultry manure

highest girth development, while at four months after treatment application, the highest girth development was recorded in *Glomus clarius* and NPK 15:15:15 (M2F1), which was closely followed by *Glomus mosseae* (M1F2). Similarly, *Glomus clarius* and poultry manure (M2F2) had the highest girth at five months after treatment application. The seedlings treatment with *Glomus mosseae* (M1F0) and *Glomus clarius* and NPK 15:15:15 (M2F1) at six and seven months after treatment application had the highest seedlings girth in growth.

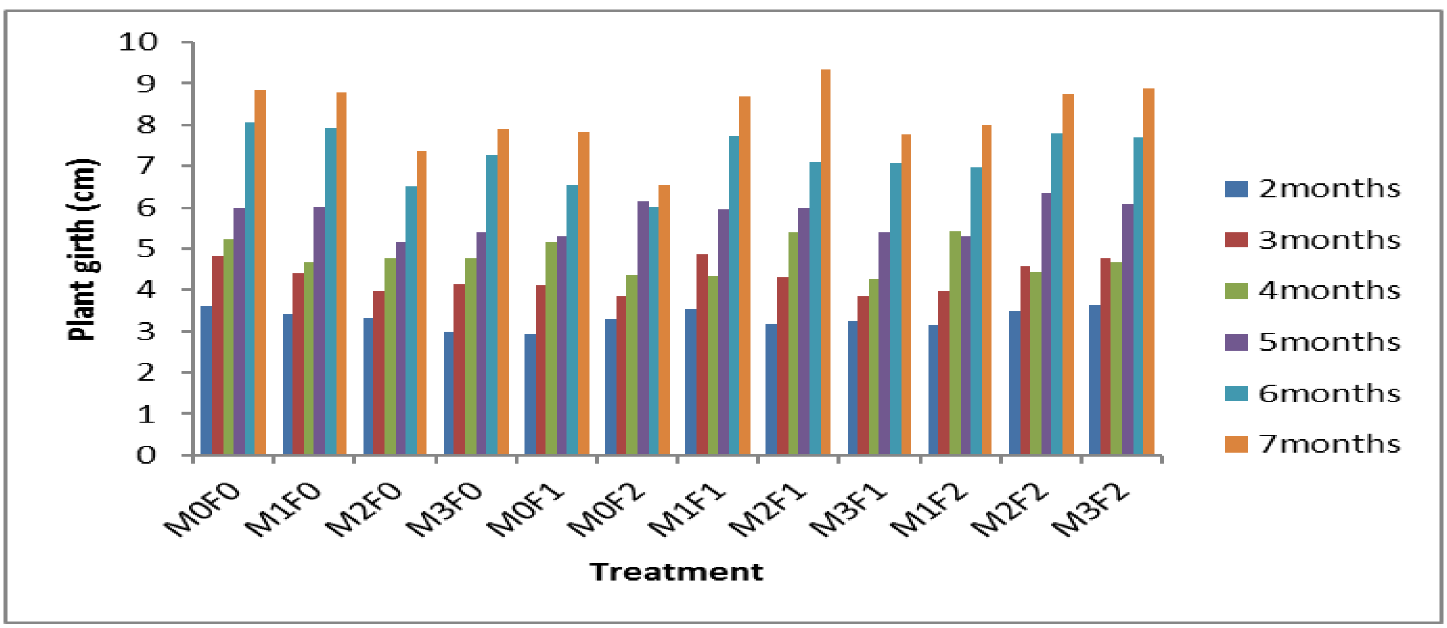

Fig 2: Effects of the treatments on Hevea seedlings plant girth

GC0F0-control, Gc--*Glomus clarius*, GC0F1 – NPK 15:15:15, GC0 F2 – poultry manure, GcF1 – *Glomus clarius* + NPK 15:`15:15, GcF2 – *Glomus clarius* + poultry manure

3.3.3. Leaf area

The result of the Hevea saplings leaf area is shown in Figure 3. At 2nd and 3rd months after treatment application, the highest leaf area was recorded on saplings treated with *Glomus deserticola* (M3F0) and *Glomus deserticola* and poultry manure (M3F2), respectively. While, *Glomus mosseae* and NPK 15:15:15 (M1F1) had the highest leaf area at four months of seedlings growth. Similarly, seedlings treated with *Glomus clarius* and NPK 15:15:15 (M2F1) had the highest leaf area at 5th months after treatment application. The seedlings treated with (M1F2) had the highest leaf area both at 6th and 7th months after treatment application, *Glomus clarius* and NPK 15:15:15 (M2F1) had the highest and in the same trend was followed closely by Glomus deserticola (M3F0).

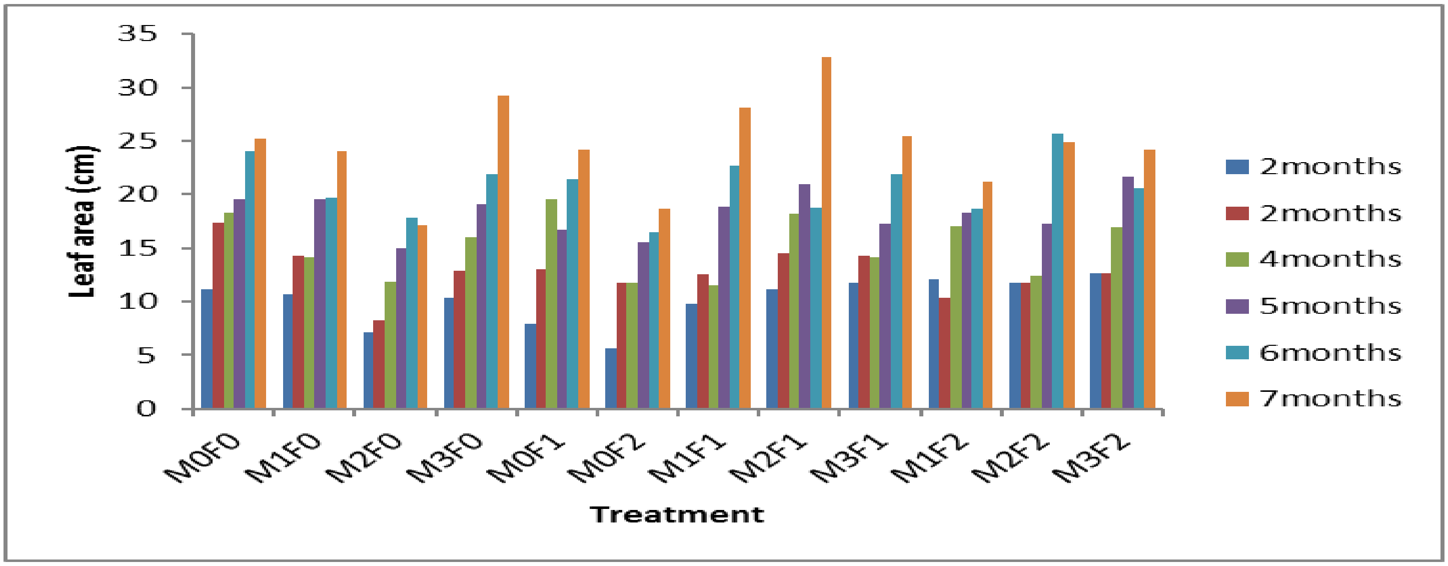

Fig 2: Effects of the treatments on Hevea seedlings leaf area

GC0F0-control, Gc--Glomus clarius, GC0F1 – NPK 15:15:15, GC0 F2 – poultry manure, GcF1 – Glomus clarius+NPK 15:`15:15, GcF2 – Glomus clarius+poultry manure

3.3.4. Number of leaves

Figure 4 shows the number of leaves of *Hevea brasiliensis* saplings at different period of growth. At 2nd months after treatment application, the highest leaves formation was observed in saplings treated with control (M0F0), *Glomus mossease* (M1F0), *Glomus clarius* (M2F0) and *Glomus deserticola* (M3F0) all not different from each other. while saplings treated with NPK 15:15:15 (M0F1) and *Glomus deserticola* and poultry manure (M3F2) had the highest leaves development at three months after treatment application. Also the highest number of leaves was recorded in *Glomus mosseae and NPK 15:15:15* (M1F1) similar to one another and *Glomus deserticola* and poultry manure (M3F2) at 4th and 5th months after treatment application,

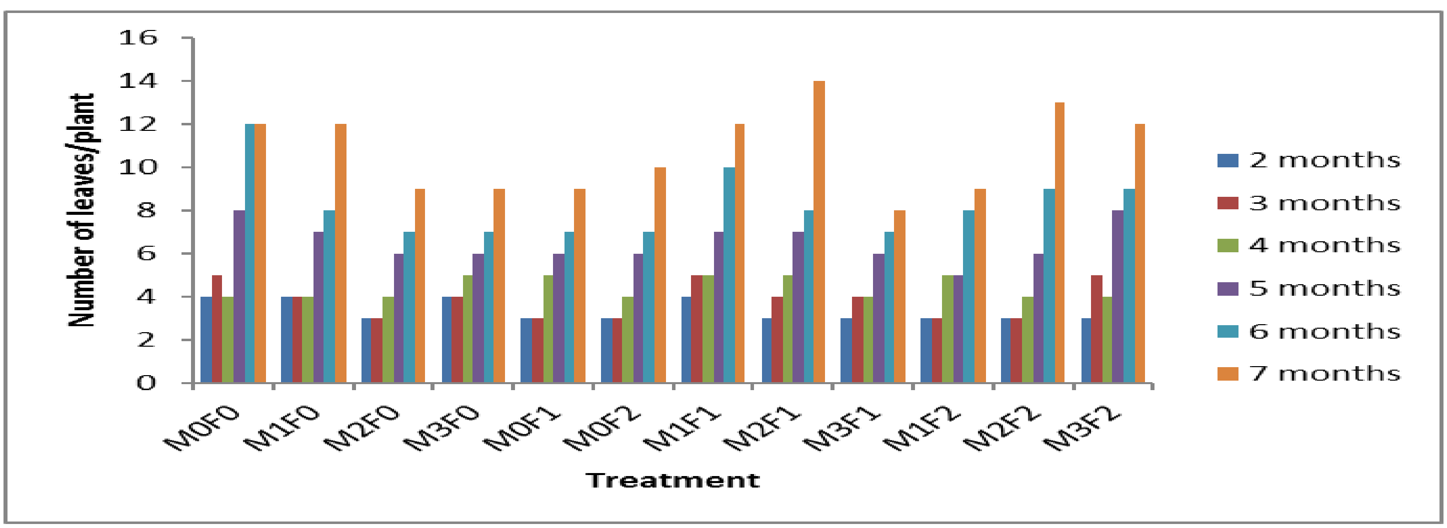

Fig 4: Effects of the treatments on Hevea seedlings number of leaves/plant

GC0F0-control, Gc--*Glomus clarius*, GC0F1 – NPK 15:15:15, GC0 F2 – poultry manure, GcF1 – *Glomus clarius*+NPK 15:`15:15, GcF2 – *Glomus clarius*+poultry manure respectively. However, at 6th and 7th months after treatment application, the highest number of leaves was recorded in saplings treated with control (M0F0) and *Glomus clarius* and NPK 15:15:15, (M2F1), *Glomus mosseae and NPK 15:15:15* (M1F1), *Glomus clarius* and poultry manure (M2F2), *Glomus mosseae* (M1F0) and *Glomus deserticola* and poultry manure (M3F2) close ly followed each other at 7th months after treatment application.

3.3.5. Comparative effect of mycorrhizae, NPK 15:15:15 and poultry manure on the nutrient uptake by Hevea brasiliensis saplings

The nutrient uptake by ***Hevea brasiliensis*** sapling as influenced by the soil treatment is presented in Table 5 There was a significant difference ($P<0.05$) among the various treatments in 2014 cropping season with respect, Nitrogen, available P, Potassium, Calcuim and Magnesium for the field studies. Poultry manure (GC0F2) had a significant higher Nitrogen uptake (1.58 kg/ha) relative to the treatments. In terms of available P, *Glomus clarius* (GCF0) also had the highest uptake value of 0. 29 kg/ha and significantly differed from the other treatments. The Hevea saplings grown on the soil treated with NPK 15:15:15 – GC0F1 recorded the highest potassium (0.13 kg/ha) and calcium uptake with values of 0.85 kg/ha with *Glomus clarius* and poultry manure (GCF2) respectively and significantly differed from the other treatment for both Calcium and Potassium. While Hevea saplings grown on soils treated with *Glomus clarius* (GCF0) significantly higher in magnesium uptake 0.29 kg/ha respectively than the other treatment including control.

Table 5:Comparative effect of mycorrhizae, NPK 15:15:15 and poultry manure on nutrient uptake in *Hevea brasiliensis* seedlings

Treatment	N	AVP Kg/ha	K	Ca	Mg
GC0F0	0.68	0.14	0.07	0.45	0.15
GCF0	0.39	0.29	0.05	0.41	0.29
GC0F1	0.62	0.16	0.13	0.44	0.28
GC0F2	0.49	0.27	0.05	0.56	0.11
GCF1	0.82	0.28	0.08	0.85	0.09
GCF2	0.37	0.21	0.07	0.38	0.03
LSD (0.05)	0.55	0.27	0.08	0.50	0.24

GC0F0-control, GCF0 Glomus clarius, GC0 F1 – NPK 15:15:15, GC0 F2 – poultry manure, GCF1 – Glomus clarius+NPK 15:`15:15, GCF2 – Glomus clarius+poultry manure .

4.0. Discussion

The textures of the soils in the study area were sandy. The soils were also characterised by low pH, low ECEC as observed by Juo, (1981), and Kang and Juo, (1986). The sandy surface soils with clayey subsoil typically characteristic of the study area are described as desirable for rubber growth under high rainfall condition by Asawalam and Ugwa (1993). The sandy nature may be due to excessive rainfall experienced in the region or influence of the parent material. This also explains why the soil have low nitrogen and the low total nitrogen may be as a result of excess leaching and low organic matter content of the soil prior to treatment. Exchangeable bases in the soil were also very low with calcium having the highest value of 1.6 cmol/k in the cropping seasons, which is less than 2.5 cmol/kg being the critical levels for fertile soils (Obigbesan and Akinrunde 2000). Other cations such as potassium (K) had values of 0.29, Magnesium (Mg) with values of 0.08, cmol/kg in the seasons were also low. They fell between the critical levels of 0.16 - 2.5 cmol/kg, potassium and 0.20 - 0.40 cmol/kg magnesium (Adeoye and Agboola, 1985). The percentage base saturation was expectedly low since the basic cations were low which is as a result of high precipitation leading to leaching condition of the area. The available P was slightly high value of 3.26 mg/kg in the season which also fall below the critical levels of 10-16 mg/kg as reported by Adeoye and Agboola (1985). This is further indicative of low fertility state of the study area. However, the acidic nature of the soil may be attributed to high rainfall experienced in the region. The high rainfall makes the soil fragile and susceptible to erosion and leaching. Similar observation was made by Donahue (1983).

In the result of the soil chemical properties after application of these treatment showed improvement in the soil chemical properties in the cropping seasons when compared with the value before application of treatments. This could be ascribed to the application of different mycorrhizae, NPK and poultry manure treatments. Brady and Weils (1999) reported that the addition of fertilizer increased the nutrient pool of the soil. In the screen house the pH of the soil in season which corroborate with the report of Yogaratnam and Silva (1987) that when NPK 15:15:15 is applied to acid soil, which are usually acidic, the initial hydrolysis of ammonium carbonate result in an increase in pH. The organic carbon in the *Glomus clarius* and poultry manure treated plants was higher in all the season which may be due to the higher activities of soil microorganisms which aided in the mineralization of poultry manure thereby increasing the soil organic matter status. The mycorrhizae and poultry manure treated plant responded better than the NPK treated plants in all the growth characteristics. This can be attributed to the loss of nitrogen either through volatilization and leaching of the NPK treated plant as reported by (Thorup, 1984) who stated that volatilization loss from NPK can occur in both acid and basic soils within 24hours after surface application and that the extent of loss can account for 50%. Keller and Mendel, (1986) also stated that NPK volatilization is almost three times higher in a sandy soil with a CEC of 7 cmol/kg than in a silt loam with a higher CEC. The *Glomus clarius* and poultry manure performed better due to the gradual mineralization of organic manure. The mineralized nutrients were not easily leached out thereby making nutrients readily available for crop uptake as reported by Brady and Weil, (1999). Brady and Weil (1999) also reported that organic colloids hold nutrient cations (K, Ca and Mg) in places where easily they can be used by plants. The ECEC and percentage base saturation increased in the screen house studies of the cropping season, this may be due to the effect of soil treatments. This agrees to the report of Knoeep and Swank (1994) which state that the compilation of nutrient shows that each base cation differently and each reacts distinctively.

Two months after application of the treatments, the mean plant height, plant girth, leaf area and number of leaves were almost the same in all the treatments. This may be attributed to the low inherent soil nutrient as the treatments applied were slow in releasing plant nutrient, especially the mycorrhizae and poultry manure. The increase in the mean plant height, plant girth, leaf area and number of leaves in the in the cropping season revealed that the plant treated with mycorrhizae and NPK 15:15:15 performed better in the early stage. This is loss of nitrogen through volatilization and leaching as reported by Yogaratnam (1980) who noted that there is a reduction of nitrogen loss by volatilization and leaching when NPK is applied to soil. The gradual mineralization of organic manure. was not easily leached out thereby making nutrients readily available for crop uptake as earlier reported by (Brady and Weils, 1999).

The nutrient uptake of *Hevea brasiliensis* seedlings were all significant in the cropping season This may be attributed to the nutrient uptake ability of the rubber seedling and soil nutrient interaction. There was generally a relationship between some of the major elements. The supply of one can increase, decrease or maintain their percentage dry matter in the leaf (Remison 1997). The effects are described as antagonist when the nutrient of an element is reduced by the application of another element and synergetic when application increased the leaf content of an element, the effect tends to influence nutrient uptake of plant.

5.0. Conclusion and Recommendation

There was a general increase in the chemical properties of the soil through the addition of the different soil amendments (organic and inorganic fertilizer).

The result also showed that seedlings height, girth, leaf area and number of leaves increased significantly with various treatments.

The use of organically sourced fertilizer materials shows better in the improvement of the soil plant height and girth than the leaf area and number of leaves when compared to other treatments.

The use of these treatments also increases the nutrient uptake of rubber (*Hevea brasilensis)* seedling.

There is therefore need to formulate and improve on the organic fertilizers to suit various soils, since Nigerian soils vary in their characteristics with respect to pH, organic matter, availability of plant nutrients, and erosion related problems.

It was also observed that mycorrhizae and poultry manure performed very well when compared to NPK. And also to enhance farmers knowledge on the use of mycorrhizae and poultry manure as a fertilizer and source in raising rubber seedlings in the nursery.

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