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COMBINE EFFECT OF POULTRY MANURE AND NPK FERTILIZER ON SOIL PLANT NUTRIENT COMPOSITION AND GROWTH OF RUBBER

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ABSTRACT

Because of cost and scarcity associated with the use of chemical fertilizers on rubber and acidic nature of rubber growing soils in Nigeria, a study was conducted into effect of poultry manure (PM) and its combination with NPK fertilizer (NPKF) on soil and plant nutrients and growth of rubber seedlings. Six treatments replicated three times on rubber seedlings were the control, NPK fertilizer (NPKF) at 111kg/ha, 83.3kg/ha NPKF + 0.5t/ha PM, 55.5kg/ha NPKF + 1.0t/ha PM and 27.8kg/ha NPKF + 1.5t/ha PM, and PM 2.0 t/ha. Soil samples were collected for chemical analysis at the two sites, Ilusin and Araromi in Southwest Nigeria before experiment and at 24 weeks after planting. Leaf samples were also taken and growth parameters measured. The soils were very acidic and low in N,P,K,Ca, Mg and organic matter. NPKF, PM and NPKF + PM increased soil N, P, K, Ca, Mg. The PM and its combined use with NPKF increased pH while NPKF reduced it. NPKF, PM and their combinations at reduced levels increased plant N, P, K, Ca and Mg. NPKF, PM and 83.3kg/ha NPKF + 0.5t/ha PM increased plant height, number of leaves and leaf area. The combination has significant effect on number of leaves and leaf area.

INTRODUCTION

Rubber tree *(Hevea brasiliensis)* is an industrial cash crop that serves as a major source of natural rubber. In Nigeria most rubber growing soils are predominantly sandy to sandy loam textured in the surface layer and are therefore susceptible to leaching, erosion and nutrient losses. An important basis for increased rubber production lies in proper soil fertility management. The soil fertility management of rubber at the juvenile stage is critical to the productivity of rubber at maturity. It is indicated that rubber production has suffered decline in Nigeria which is attributable to long immaturity period of rubber trees and low soil fertility and supply of nutrient (Esekhade *et al*, 1998). The lack of adequate crop and soil management in the cultivation of rubber on acid soils was recognized as limiting productivity of rubber trees (Esekhade *et al*, 1998).

Soils of the rubber belt of Nigeria with few exceptions have sub-optional nutrient status (Yakub *et al*, 2012). The soils are well known for their low available phosphorus. The nitrogen content is also low as a result of low organic matter. The potassium content is low except in some soils North of Calabar, hence the need for soil amendment using fertilizer (Yakub *et al*, 2012).

Fertilizers are essential to agriculture, their acquisition and distribution in Nigeria remain a challenge to government and farmers. Fertilizers are also highly expensive for farmers. Problems associated with the use of chemical fertilizers and the need for organic manures and integration of inorganic fertilizer and organic manures have been stressed (Ojeniyi, 2012; Odedina *et al*, 2012, Ojeniyi et al, 2012). Some studies have provided information on NPK, NPK Mg and P fertilizer requirements of rubber (Esekhade *et al*, 2005: Osodeke and Kamalu, 1992). Yakub *et al* (2012) reported the effect of poultry manure alone or combined with rock phosphate on rubber seedling in the nursery. The manure increased growth of seedlings and its application was recommended.

This work studed in the field the effect of sole poultry manure, NPK fertilizers and their combined application at reduced rates on soil and plant chemical composition and growth of rubber seedlings.

MATERIALS AND METHODS

Field experiments were conducted during the 2009 and 2010 cropping seasons at Ilusin and Araromi Obu Village adopted by Rubber Estate Nigeria Limited (RENL). Ilusin (Longitude $4^0$22′N, Latitude $6^0$31′N) and Araromi Obu (Longitude $4^0$30′E, Latitude $6^0$36′N) are in the rainforest zone of Southwest Nigeria. The dominant soil of the locations is a sandy loam, Skeletal Kaolinitic Oxic Paleustalf (alfisol) or Ferric Luvisol.

Budded polythene bag rubber stumps were acquired from nursery of Rubber Estate Nigeria Limited (RENL) Ilusin, Ogun State. The sites were cleared and planting lines for the rubber stumps were marked with pegs. Planting holes were 40cm deep and 30cm wide, and planting was done at 6 x 3m. There were 10 plants in each of 18 treatment plots. Air-dried poultry manure was first applied in ring form and lightly incorporated into soil, and the fertilizer was similarly applied. Weeding was done at 2 week interval till the 24th week.

Treatments:

There were six treatments applied to soil namely: NPK: 15:15:15 at 111kg/ha, NPK 15:15:15 at 83.25 kg/ha + 500 kg/ha poultry manure, NPK 15:15:15 at 27.75 kg/ha + 1.5t/ha manure, manure at 2t/ha, and control (no treatment). The treatments were replicated three times in a randomized block design, with 10 plants in each of six plots in a block.

Four weeks after treatment application in each site, measurements of plant height, number of leaves and leaf area were taken biweekly in situ to 24 weeks. Leaf area was estimated using the equation,

LA = 0.654 x LL x LB,

LA = leaf area, LL = leaf length, LB = leaf breadth (Lim and Narayanan 2008 cited by Odeyemi, 2012).

Leaf analysis:

Representative leaf samples were taken at 15-20 weeks after treatment application from each plot, and oven-dried at 70^0C for 48hours. Samples were dry ashed and later solubilized into solution. The P was determined by vanado-molybdate colorimetry on spectronic 20, while K and Ca were determined on flame photometer, and Mg on atomic absorption spectrophotpmeter. Total N was determined using micro-kjeldahl method (Faithful, 2002).

Soil Analysis:

Before planting in 2009, surface soil samples were collected at thirty points in each study site and bulked. Samples were also taken per treatment plot using soil auger at twenty four weeks after planting. Samples were air-dried and sieved using 2mm sieve for routine analysis as described by Carter (1993).

The soil pH in 1:2 soil – $CaCl_2$, organic matter by wet dichromate method, total N by micro-kjedahl method and available P by Bray - 1 extraction method were determined. The exchangeable K, Ca and Mg were extracted by ammonium acetate and determined as for leaf analysis. (Faithful, 2002).

RESULT AND DISCUSSION

The soils at both sites of study were very low in nutrients such as N, P, K, Ca, Mg and organic carbon (Table 1). The soils are also acidic due to low pH. This observation is consistent with the observation of Yakub et al

(2012), who recorded that rubber soils in Nigeria, have suboptimal nutrient status as indicated by low available P, N, OM, K, hence they require soil amendment with inorganic and organic fertilizers.

Analysis of poultry manure (PM) indicated very low N, hence high C:N ratio relative to the soil. This could be due to air – drying and seasoning of the manure which led to volatilization and leaching of N. However the manure is relatively high in Ca, Mg, K and less acidic. This may favourably affect the growth of the rubber seedling.

Table 1: Initial Chemical analysis of test soil

	Site 1	Site 2	Poultry Manure
pH ($CaCl_2$)	5.3	5.2	6.2
OC (%)	0.24	0.24	0.75
Total N (%)	0.07	0.08	0.06
Available P mg/kg	7.6	7.5	7.0
K cmol/kg	0.08	0.09	1.14
Ca cmol/kg	0.12	0.11	3.30
Mg cmol/kg	0.15	0.13	1.70
C:N ratio	3.4	3.4	12.5

Relative to the control, NPKF (NPK fertilizer), PM, combination of NPK and PM at reduced levels increased soil N, P, K, Ca and Mg at sites 2 and 3 (Table 2 and 3), The increases in N, P, Ca and Mg were significant. Treatments involving PM also increased soil exchangeable, Ca, Mg and K and pH. The organic resource reduced acidity.

Table 2: Effect of poultry manure (PM) and NPK fertilizer (NPKF) on soil chemical properties at Ilusin (Site 1)

Treatment	Ca	N (%)	P (mg/kg)	K (cmol/kg)	Ca (cmol/kg)	Mg (cmol/kg)
Control	5.1a	0.26e	7.20b	0.08c	1.26d	0.42d
NPK	4.2b	1.06b	8.60a	0.11bc	1.80b	0.73b
PM	5.6a	0.44c	9.29a	0.16a	1.50c	0.88a
83.3kg/ha NPKF + 500 kg/ha PM	5.40a	1.13a	8.80a	0.12abc	2.27a	0.60c
27.7 kg/ha NPKF + 1.5 t/ha PM	5.50a	0.26e	8.70a	0.4ab	1.81b	0.69b
55.5 kg/ha NPKF + 10 T/HA pm	5.20a	0.38d	8.41a	0.13abc	2.29a	0.87a

Treatment means within each group with different letters differ according to DMRT.

Table 3: Effect of poultry manure (PM) and NPK fertilizer (NPKF) on soil chemical properties at Araromi (Site 2)

Treatment	pH($CaCl_2$)	N (%)	P (mg/kg)	K (cmol/kg)	Ca (cmol/kg)	Mg (cmol/kg)
Control	4.8e	0.09a	4.26d	4.12e	0.87d	0.42d
NPK	3.50	0.52b	4.66f	0.14de	1.66a	0.50c
PM	5.5a	0.16e	9.10c	0.20a	1.28b	0.81a
83.3kg/ha NPKF + 500 kg/ha PM	5.1ab	0.35c	8.90b	0.15cd	1.32b	0.51c
27.7 kg/ha NPKF + 1.5 t/ha PM	5.6c	0.38c	8.57a	0.16bc	1.05c	0.52c
55.5 kg/ha NPKF + 10 t/ha PM	5.4c	0.23d	8.73e	0.18ab	1.63a	0.73b

Treatment means within each group with different letters differ according to DMRT.

Generally, NPKF, PM and their combinations at reduced levels increased plant (leaf) N, P, K, Ca and Mg at sites 1 (Table 4) and 2 (Table 5). The increases in N were significant relative to the control except incase of 83.3kg/ha NPKF + 500kg/ha PM at site 1. Combination 55.5kg/ha NPKF + 1.0 t/ha (50:50) mostly increased plant nutrients and tended to give the highest values.

Table 4: Effect of poultry manure (PM) and NPK fertilizer (NPKF) on leaf chemical composition at Ilusin (Site 1)

Treatment	N (%)	P (%)	K (%)	Ca (%)	Mg (%)
Control	3.82d	0.24b	0.19a	0.29d	0.25c
NPK 111kg/ha	4.53a	0.79a	0.61a	0.39bcd	0.29c
PM 2 t/ha	4.31b	0.52ab	0.33a	0.81a	0.38bc
83.3kg/ha NPKF + 500 kg/ha PM	3.85d	0.50ab	0.29a	0.34cd	0.68ab
27.7 kg/ha NPKF + 1.5 t/ha PM	3.94c	0.29b	0.54a	0.58abc	0.80a
55.5 kg/ha NPKF + 10 t/ha PM	4.53a	0.40b	0.63a	0.60ab	0.91a

Treatment means within each group with different letters differ significantly according to DMRT.

Table 5: Effect of poultry manure (PM) and NPK fertilizer (NPKF) on leaf chemical properties at Araromi (Site 2)

Treatment	N (%)	P (%)	K (%)	Ca (%)	Mg (%)
Control	3.92e	0.22c	0.17c	0.27d	0.26b
NPK 111kg/ha	4.33b	0.75a	0.34bc	0.59b	0.33ab
PM 2 t/ha	4.07d	0.40bc	0.38bc	0.69ab	0.33ab
83.3kg/ha NPKF + 500 kg/ha PM	4.17cd	0.60ab	0.32bc	0.29d	0.35ab
27.7 kg/ha NPKF + 1.5 t/ha PM	4.28bc	0.75a	0.51b	0.42c	0.49a
55.5 kg/ha NPKF + 10 t/ha PM	4.47a	0.64a	0.74a	0.79a	0.43ab

Treatment means within each group with different letters differ according to DMRT.

The growth parameters such as plant height and number of levels were increased by NPK, PM and combination of the materials at 83.3 kg/ha NPK + 0.5 t/ha PM. Generally the leaf area was increased at site 1 by NPK, PM and their combinations relative to the control, and also at site 2 except in case of sole PM. Unlike other treatment combinations 83.3 kg/ha NPKF + 0.5 t/ha PM gave significant increases in number of leaves and leaf area, and gave highest values for plant height.

Table 6: Effect of Poultry Manure (PM) and NPK Fertilizer (NPKF) on growth of rubber seedlings at 24 weeks after planting Site 1 (24 WAP)

	Height	No of leaves per plant	Plant leaf area
Control	87.92ab	75.60b	99.76c
NPK (111kg/ha)	9348ab	79.60ab	99.76c
PM (2 t/ha)	91.18ab	82.26ab	103.52bc
NPK (83.25kg/ha) + PM (0.5+t/ha)	95.18a	88.23a	118.27a
NPK (55.5kg/ha) + PM t/ha	86.92ab	74.80b	107.04b
NPK (27.75kg/ha) + PM (1.5 t/ha)	83.08b	74.57b	107.40b
Site 2 (24 WAP)			
	Height	**No of leaves per plant**	**Plant leaf area**
Control	86.71a	74.77ab	99.02c
NPK (111kg/ha)	92.65a	78.47ab	108.87b
PM (2 t/ha)	90.39a	81.26ab	98.12bc
NPK (83.25kg/ha) + PM (0.5+t/ha)	94.87a	86.57a	118.06a
NPK (55.5kg/ha) + PM t/ha	85.86a	74.09b	106.86b
NPK (27.75kg/ha) + PM (1.5 t/ha)	82.25a	74.26b	107.09b

Since the test soils were acidic, low in N,P,K, Ca and Mg and organic matter rubber crop expectedly responded positively to application of the NPKF and PM. These materials expectedly increased availability of nutrients in soil and their uptake by rubber seedlings. The reduction in soil pH due to addition of NPKF is attributable to enhanced soil acidity due to the NP components of the fertilizer. Treatments involving PM increased soil pH due to enhanced availability of K, Ca and Mg. (Moyin Jesu, 2009).

Although separate application of PM and NPKF increased growth of rubber, it was the combined use of the materials that most enhanced growth parameters. This can be adduced to release of nutrients to synchronize with the growth of the seedlings. The PM slowly releases nutrients as opposed to quick release and leaching of nutrients from the NPKF in the sandy, soils of the rainforest zone. There is also synergistic relationship between NPKF and PM since the fertilizer will stimulate microbia activity and mineralization of nutrients from the manure. The two reactions stated above are expected to improve uptake of nutrients by rubber seedlings. It can be seen that combined application of NPKF and PM at 50:50 and 25:25 ratios most enhanced plant nutrients especially at site 2.

The need for either organic and inorganic fertilizer can be reduced in rubber cultivation by combined use of poultry manure and NPK fertilizer at reduced rates while increasing the crop nutrient uptake and growth.

The integrated application of the materials will reduce the problem of soil acidity which reduces availability of macronutrients especially P which is the most important single element in the growth of juvenile rubber (Onuwaje and Uzu, 1982). Organic manure such as the poultry manure has being proved to have a liming effect on soil by supplying Ca, Mg and K; thus reducing soil acidity and increasing availability of P (Ojeniyi and Adeniyan, 1999). Soil reactions that reduce availability of P can be very pronounced at pH less than 5.5 as recorded for the test soils in this work.

The increased availability of N, P, K, Ca and Mg due to integrated application of PM and NPKF and enhanced growth of rubber explains the importance of N,P,K, and Mg in rubber industry. The Ca is a liming material which is needed to control acidity of rubber soil. The N, P, K and Mg is recommended for optimum growth of rubber in acidic ultisol of Nigeria (Ugwa et al, 2000). Apart from the direct role of these nutrients, K performs a remedial role for water stress in rubber as a result of sandy nature and low water holding capacity of soils supporting rubber. (Samarappuli et al, 1993). The Mg is known to prevent the physiological disorder that brings about tapping panel dryness (Ugwa et al, 2000). The P is the most important single element in the growth of juvenile rubber (Onuwaje and Uzu, 1982).

CONCLUSION

Combined use of poultry manure and NPK fertilizer at reduced levels is recommended for reducing soil acidity and increasing nutrients availability and growth of rubber plant.

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