SJIF IMPACT FACTOR (2015): 5.79 CRDEEP Journals
International Journal of Life Sciences Eseimuede. U et. al., Vol. 6 No. 2 ISSN: 2277-193x
International Journal of Life Sciences. Vol. 6 No. 2. 2017. Pp. 60-64

Full Length Research Paper

Influence of Rubber Effluent and NPK (15:15:15) Fertilizer on some Soil Physico-chemical properties and the growth of Maize (*Zea mays)* in a Humid area of Nigeria.

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Article history
Received: 04-04-2017
Revised: 24-04-2017
Accepted: 04-05-2017

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Abstract
A field experiment was conducted at the research site of Rubber Research Institute of Nigeria, Iyanomo, Benin City, Edo State, Nigeria at the 2014 cropping season to assess the effects of rubber effluent and $NPK_{15:15:15}$ fertilizer on the soil physio-chemical properties, and the growth of maize, (Zea mays L.). It was a 3x4 factorial experiment fitted into a randomized complete block design and replicated three times. The treatments were rubber effluent with four levels (0, 80, 160 and 320L/ha) and NPK (15:15:15) with three levels (0, 50 and 100kg/ha). Plots were separated by furrows (1m) apart within replicate and (1m) between replicate with 12 plots/ rep and 36 plots/experiment and at a plant spacing of 75 x 25 cm making a plant population of 66667stands/ha respectively. Plant data which consisted of plant height, leaf area and numbers of leaves were collected at 3 weeks interval till the 9th week. Pre- planting analysis of the soil showed that the soil was acidic with pH that varied from 4.5 to 5.5, loamy sand texture, with low organic carbon and Nitrogen. The exchangeable bases of the soil were low, ECEC was 4.33cmol/kg, percentage base saturation was 69.10% and with moderate macronutrient concentrations. The effluent analysis showed that the rubber effluent was slightly acidic with pH of 6.9 and was observed to contain some essential nutrients required for plant growth. The application of rubber effluent and $NPK_{15:15:15}$ fertilizer to the soil did not alter the soil texture, but there was an increase in the soil organic carbon, Total N, Exchangeable acidity, exchangeable bases, the percentage base saturation when compared to the control but showed no significant difference ($P<0.05$) among the treatment levels. The vegetative traits of maize such as plant height was significantly increased by rubber effluent and compared favorably with $NPK_{15:15:15}$ fertilizer.

Keywords: *Rubber effluent, $NPK_{15:15:15}$, Maize, Iyanomo*

Introduction
The soils of the southern parts of Nigeria with few exceptions have sub – optional nutrient status, they are well known for their low available phosphorus (P), their Nitrogen (N) content is also low as a result of low organic matter content and the available potassium (K) content is invariably low except in some soils of North Calabar (Onuwaje and Uzu, 1980), hence, the need for soil amendment using fertilizer. The principal method of overcoming the problems posed by inadequate nutrient in the soil is the judicious use of fertilizers. Inorganic fertilizers, which are one of the important inputs for increased food production, are expensive and farmers in developing countries can hardly afford them. Furthermore, there is a growing concern on health hazards caused by the consumption of food crops produced by frequent application of chemical fertilizers. Consequently, there is now a concerted effort to review the use of chemical fertilizers and to place more emphasis on the use of organic fertilizers such as green manure, compost manure, and farm yard manure and rubber effluent among others (Kihanda, 1996 and Ahmad, 2001). Rubber effluent is a liquid leftover which arises during Natural Rubber latex processing. The effluents which are improperly disposed continuously into soils, rivers and streams in developing countries especially Nigeria causing serious environmental pollution, the most important effect is caused by factory effluents which contains large amount of non-rubber substances in addition to traces of various processing chemicals (Seneviratne, 1997). However, these effluents contain various plant growth substances including a number of elements such as N, K, P, Ca, Mg (Peries and Fernando, 1983). Mohd and Abu (1989) reported that rubber effluent contains substantial amount of plant nutrients particularly N and K. These have potential as organic fertilizer for crops such as oil palm (*Elaeis guineensis*) and rubber (*Hevea brasilliensis*). Consequently, the use of effluent from rubber factory as an organic fertilizer for cultivating economic crops could give a

match between the pollution control purpose at virtually no additional cost and the need of farmers for beneficial utilization of the available nutrients contained in the effluent. Hence, the goal of this study was to evaluate the effects of rubber effluent and NPK 15:15:15 on the soil physicochemical properties and the growth of maize as a test crop (because of its short life span, a food crop with high demand and its vegetative qualities.) in a humid area of Nigeria.

Materials and Methods

Study area

This study was conducted in the research field of the Rubber Research Institute of Nigeria (RRIN) Iyanomo, near Benin City, EdoState. The study area falls between latitude $6^{0}00'$ and $7^{0}00'$ North and longitude $5^{0}00'$ and $6^{0}00'$ East of the equator. The rainfall pattern is bimodal with the peaks in the month of July and September but the highest in July and a short dry spell August. The soils of this humid forest belt are mainly utisols with the pH ranging between 4.0 and 5.5; the soils have been described as the acid sand derived from unconsolidated grits and sand stones containing clay peds of varying proportions (Vine, 1956).

Methodology

The experiment was conducted for a period of 3 months and consisted of 12 treatments: 3 levels of NPK15:15:15 (0, 50 and 100kg/ha) and 4 levels of rubber effluent (0, 80, 160 and 320L/ha), this formed a 3x4 factorial experiment fitted into randomized complete block design (RCBD) replicated thrice. The plot size was 3m x1.5m. Plots were separated by furrows (1m) apart within replicate and (1m) between replicate with 12 plots/ rep and 36 plots/experiment with a plant spacing of 75cmx 25cm giving a plant population of 66,667 plants stand per hectare. Rubber effluent was applied on plots by Hand Sprayer two weeks before planting the test crop (maize) while the NPK fertilizer was applied by side dressing method after planting. Seedlings were allowed to grow, maintained and data were collected on them from the third week after plant. Table 1 and 2 shows the chemical properties of the Rubber effluent and the physic-chemical properties of the soil before treatment application.

Growth data (plant height, number of leaves and leaf area) of the maize crop was taken at a three weekly interval till the ninth week from two tagged randomly selected plants in each experimental plot. Soil chemical characteristics were generated from samples collected three times: before treatment application, at six (6) and twelve (12) weeks after treatment using standard soil analytical procedures. All data collected were subjected to statistical analysis.

Table 1: Chemical Properties of Rubber Effluent used.

Property	Value
PH (H_2O)	6.90
Org.c (mg/l)	1.08
Total N (mg/l)	2.18
Org.matter (mg/l)	1.86
Al (mg/l)	0.83
H^+ (mg/l)	1.06
Ca (mg/l)	0.77
Mg (mg/l)	1.00
Avail P (mg/l)	23.00
Na (mg/l)	0.19
K (mg/l)	0.33
Fe (mg/l)	11.37
Cu (mg/l)	4.17
Mn (mg/l)	1.04
Zn (mg/l)	2.34

Table 2: Physico-chemical properties of Soil before Treatment Application

Properties	Value
pH (H_20)	5.40
Org.carbon (g/kg)	0.84
Total Nitrogen (g/kg)	0.25
Org.matter (g/kg)	1.45
Available Phosphorus (mg/kg)	8.75
Hydrogen (Cmol/kg)	0.90
calcium (Cmol/kg)	0.73
Magnesium (Cmol/kg)	1.10

Aluminium (Cmol/kg)	0.55
Sodium (Cmol/kg)	0.50
Potassium (Cmol/kg)	1.00
ECEC (Cmol/kg)	4.33
Base Saturation (%)	67.00
C/N (%)	3.36
Iron (mg/kg)	35.40
Copper (mg/kg)	4.23
Manganese (mg/kg)	8.40
Zinc (mg/kg)	2.34
Sand gkg^{-1}	853.20
Silt gkg^{-1}	34.50
Clay gkg^{-1}	112.30
Textural class	Loamy sand

Results and Discussion

Effect of Rubber Effluent and $NPK_{15:15:15}$ Fertilizer on the Height of Maize

The result of the experiment on maize height is presented in graph 1 and 2. The result showed a positive response of maize growth in terms of height to the application of both soil amendment (rubber effluent and NPK fertilizer). The higher application rate of 320l/ha rubber effluent and 100kg/ha NPK fertilizer showed the higher response of maize height when compared with the control. The result demonstrates that rubber effluent is an effective nutrient source to maize as NPK fertilizer, which agrees with Olaniyi and Akanbi (2007) who noted that the use organic manure would be sufficient to produce vigorous, healthy and high yielding plant that are comparable with those plants treated with synthetic or inorganic fertilizer. Similar observation was made by Peris and Farnado (1983) and concluded that rubber effluent is a good source of nutrients for maize growth.

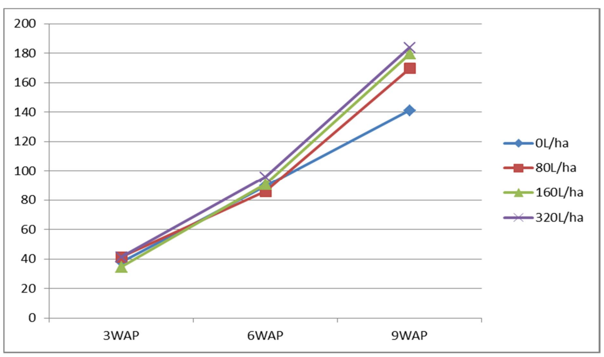

Fig 1: Effect of Rubber Effluent on the Height of maize

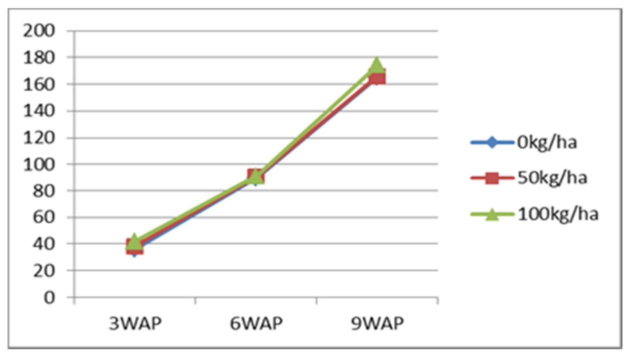

Fig. 2: Effect of $NPK_{15:15:15}$ on the Height of Maize.

(WAP- weeks after planting)

Effect of Rubber effluent and $NPK_{15:15:15}$ on some soil chemical properties after cropping

Table 3 and 4 shows the effect of both soil amendments on some soil chemical properties after cropping of maize. The result shows no significant difference ($P<0.05$) in pH at 6WAP but showed a significant difference ($P<0.05$) at 12WAP in the rubber effluent plot and this trend was also seen in the $NPK_{15:15:15}$ treated plots. Also, there was a general decline in soil pH from the pre-cropping of 5.4 to between 4.21- 4.97 in both 6WAP and 12 WAP for soils treated with rubber effluent and between 4.44 – 4.90 in the 6WAP and 12WAP for plots treated with $NPK_{15:15:15}$ respectively. The decrease maybe attributed to the effect of the soil amendment used which is in line with the finding of Brady and Weils (1999) who noted that when both inorganic and organic fertilizers are applied in soils, they are oxidized in the soil by microbes to produce strong inorganic acids by reactions and these strong acids provide H^+ ions that result in lower pH values. The fluctuations can also be traceable to soil erosion and leaching due to high rainfall in the area which conform to Donahue (1983), who noted that highly mobile basic cations are washed away by the effect of soil erosion and leaching leaving the sesquioxides to occupy the exchange sites of the soil colloids. There was no significant difference ($P<0.05$) in organic matter content and nitrogen in the rubber effluent treated plots in both the 6 and 12WAP, this same trend was noticed also in the $NPK_{15:15:15}$ fertilizer treated plot. There was an increase in the organic matter content from 1.45 g/kg in the pre-cropping to 2.70 and 1.65 g/kg at 6 and 12 WAP in the rubber effluent treated plot of 320 l/ha while $NPK_{15:15:15}$ fertilizer treated plot of 50 kg/ha also had an increase of 1.96 and 1.61 g/kg at 6 and 12 WAP respectively. The increase could be attributed to the activities of soil microbes acting on the organic fertilizer applied, which conforms with the study of David *et al* (2010) who revealed that land use practices such as fertilizer application influences several soil properties such as soil organic matter concentration and subsequently soil fertility, also higher vegetation and organic residues generated by the maximum plant growth will increase the amount of organic matter added to soil from crop residue. The fluctuation of the soil nutrients in the 6 and 12WAP may be due to soil erosion and leaching which is due to the high rainfall in the area. Vine, (1956).

Table 3: Effect of rubber effluent on soil pH,Org.C, Total N and Exchangeable bases.

	pH (H_20)		**Org.M**		**Total N**		**Avail. P**		**K**		**Na**		**Mg**		**Ca**	
Treatments l/ha			**……g/kg......**				**mg/kg**		**…………………………………Cmol/kg……………………………..**							
Effluent	**6WAP**	**12WAP**	**6WAP**	**12WAP**	**6WAP**	**12WAP**	**6WAP**	**12WAP**	**6WAP**	**12WAP**	**6WAP**	**12WAP**	**6WAP**	**12WAP**	**6WAP**	**12WAP**
0	4.90	4.87^{ab}	0.48	0.58	0.39	0.28	4.88^{a}	8.76	2.06	0.93	0.70	0.54	0.46	1.09	0.52	1.31
80	4.90	4.47^{ab}	1.81	1.10	1.55	0.91	4.63^{ab}	3.80	2.36	3.76	0.44	0.40	0.42	2.07	0.54	1.07
160	4.90	4.21^{b}	1.48	1.54	0.66	1.44	4.17^{ab}	5.90	2.64	0.83	0.70	0.39	0.36	1.33	0.61	1.31
320	4.70	4.97^{a}	2.7	1.65	1.74	0.93	3.81^{b}	3.30	2.51	1.09	0.57	0.20	0.59	1.64	0.61	1.20
Means	**4.85**	**4.63**	**1.62**	**1.23**	**0.26**	**1.17**	**4.37**	**5.44**	**2.39**	**1.65**	**0.60**	**0.38**	**0.46**	**1.53**	**0.57**	**1.22**
$LSD_{0.05}$	**NS**	**0.51**	**NS**	**NS**	**NS**	**NS**	**0.87**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Means followed by the same letters in vertical columns are not significantly different at 5% level. WAP: Week after planting.

Table 4: Effect of $NPK_{15:15:15}$ on soil pH,Org.C, Total N and Exchangeable bases

Treatment	**pH(H_2O)**		**Org.M**		**Total N**		**Avail P**		**K**		**Na**		**Mg**		**Ca**	
			……g/kg......				mg/kg		……………. …………………….Cmol/kg…………………….							
TRT NPK kg/ha	6WAP	12WAP	6WAP	12WAP	6WAP	12WAP	6WAP	12WAP	6WAP	12WAP	6WAP	12WAP	6WAP	12WAP	6WAP	12WAP
0	4.9	4.89^{a}	0.87	0.2	0.62	0.31	3.92^{b}	5.32	2.51	1.85	0.87	0.4	0.63	1.57	0.6	1.27
50	4.8	4.57^{ab}	1.96	1.61	1.74	1.13	4.44^{ab}	3.88	2.27	2.19	0.57	0.5	0.31	1.38	0.58	1.18
100	4.9	4.44^{b}	1.78	1.6	1.96	1.62	4.77^{a}	7.11	2.39	0.92	0.18	0.1	0.43	1.65	0.54	1.22
Means	**4.86**	**4.63**	**1.54**	**1.14**	**0.66**	**1.17**	**4.37**	**5.44**	**2.39**	**1.65**	**0.54**	**0.33**	**0.46**	**1.53**	**0.57**	**1.22**
$LSD_{0.05}$	**NS**	**0.44**	**NS**	**NS**	**NS**	**NS**	**0.75**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Means followed by the same letters in vertical columns are not significantly different at 5% level. WAP: Week after planting.

The total Nitrogen in the soil showed a higher rate both in 320 l/ha rubber effluent with values of 1.74 and 0.93 g/kg at 6 and 12 WAP and also $NPK_{15:15:15}$ fertilizer treated plot of 100 kg/ha showing values of 1.96 and 1.62 kg/ha at 6 and 12 WAP. This could be attributed to nitrification which may be stimulated by the presence of essential elements in adequate levels that is supplied by the inorganic and the organic fertilizers as noted by Orue *et al*, (2005). There was a significant difference ($P<0.05$) in the Available P at 6 WAP but at 12 WAP its shows there was no significant difference ($P<0.05$) in both the rubber effluent plot and the $NPK_{15:15:15}$ fertilizer. There was a decrease in Available P in both the soil amendment when compared with the control which may be attributed to the fact that under low pH (pH<5.0) and below, substantial amount of Available P is fixed by Fe and Al oxides contents of the soils Osenwota *et al*,(2010). Consequently because of the decrease in soil pH recorded, this led to the decrease in Available P respectively. There was no significant difference ($P<0.05$) in the exchangeable bases within the levels of rubber treated plot when compared with the control and the same trend was recorded for $NPK_{15:15:15}$ fertilizer. However, there was an increase in the exchangeable bases of the treated and cropped soils when compared to the pre-cropping soils values. This increase is attributed to the nutrient properties of the rubber effluent as well as the $NPK_{15:15:15}$ applied. Similar results have earlier been reported by Poon, (1982), Lim *et al,* (1983).

Conclusion

The result of this trial showed that rubber effluent compared favorably with $NPK_{15:15:15}$ fertilizer in improving the growth performance of maize. Application of rubber effluent and NPK fertilizer generally increased the nutrient pool of the soil. Hence, rubber effluent effect is seen as a promising material for soil amendment in food crop production. The fluctuations of soil nutrients between the sixth and twelfth weeks after planting was due to either nutrient uptake by plants or nutrient loss through leaching and soil erosion due to the high rainfall impact. Hence, further investigation into the impact of rubber effluent on the nutrient uptake of maize and other food crops should be carried out.

References

Ahmad, F. (2001). Sustainable Agriculture in Malaysia. Paper presented at Regional workshop on integrated Plant Nutrition System (IPNS) Development in Rural Poverty Alleviation, 18-20. Sept 2001 United Nations Conference complex Bangkok Thailand.

Brady, N.C and Weils, R.R. (1999). The nature and properties of soils 12th ed. 1999, 1996 by Practice Hall.Inc.Simon and Schuster.A Viacom company upper saddle river. New Jersey. Pp 326-328

David, S., Powlson, P., Penny, R. H and Phillip, C.B. (2010). Nutrient cycling in agro- ecosystems, Earth and Environment Science 61 (1-2): 41-51

Donahue, R.L., Milmer, R.W. and Schickluna,J.C. (1983): Soils: An Introduction to Soil and Plant growth. 5th edition Prentice Hall Inc. Eaglewood, New York. Pp 154- 160

Kihanda, F.M. (1996). The role of Farmyard Manure in Improving Maize production in the Sub-humid highlands of central Kenya. Ph.D Thesis University of Reading, U.K. pp 7-19

Lim, K.H., Wood, B.J. and Lal, A.L. (1983). POME on oil palm through flat-bad systems. Proceedings of the seminar on land application of oil palm and rubber factory effluent. Serdan, October 1983.

Mohd, Z.K.; and Abu, T.B. (1989). Comparative study of rubber effluent and inorganic fertilizer as source of plant nutrient for *Hevea* and their effect on soil properties. Journal of National Rubber Research 4:260-272

Olaniyi, J.O. and Akabi, W.B. (2007). Effect of organic mineral fertilizer application on growth yield and nutrient uptake of maize. *International Journal of Applied Agriculture Research 2(1)10-19*

Onuwaje, O.U and Uzu,F.O. (1980). Growth response of rubber seedlings to NPK fertilizer. Paper presented at the 3rd natural rubber symposium. Manaus Am Brazil.June 23 -29, 1980. Fertilizer Res. 3:167-175

Orhue, E.R., Osaigbovo, A.U. and Osahon, O. (2005). Rubber effluent effects on some chemical properties and growth of *Dialium guineense* seedlings: *Journal of sustainable Agricultural Environment 7:69-82*

Osemwota, I.O. (2010). Effect of abattoir effluent on the physical and chemical properties of Soils. Environmental Monitoring and Assessment 167:399-404

Peries, O.S. and Fernando, D.M. (1983). A Handbook of Rubber Culture and Processing. Rubber Research Institute of Sri lanka. Pp 341-345

Poon, Y.C. (1982) Recycling of Palm Oil Mill effluent in the field. Proceedings of rubber Research Institute of Malaysia, Kuala Lumpur October. 1982

Senevirane, W.M.G. (1997). Waste water from raw rubber processing industry in Sri Lanka and related environmental aspects. Bull. Rubber Research institute of Sri lanka 35:42-48.

Vine, H (1956). Studies of soil profile at the WAIFOR Main Station and some other sites of oil palm experiment*. J. West Afr. Inst. Oil palm Res., 4: 8-59*