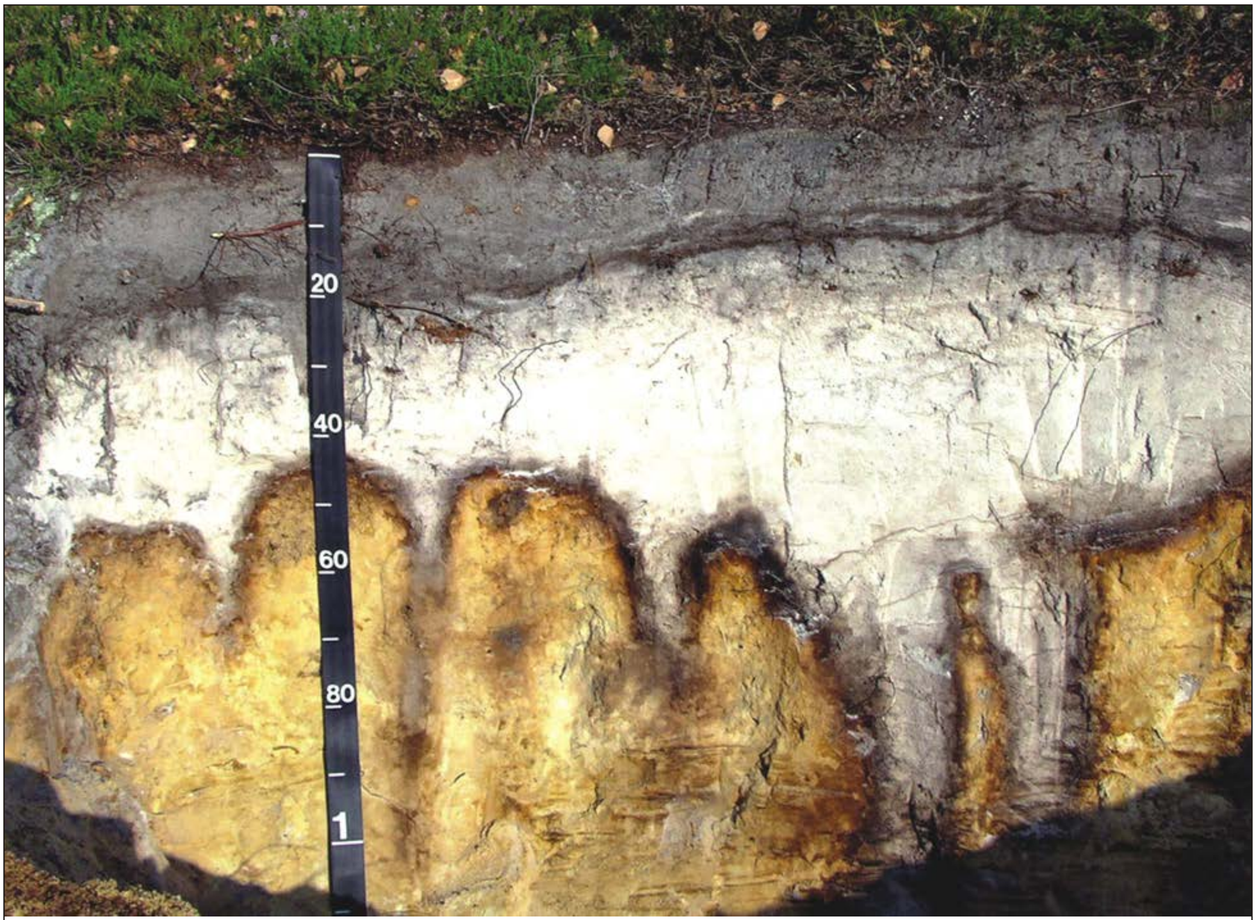

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Effect of Combining Rubber Effluent with Rock Phosphate on Some Soil Chemical Properties and Early Growth of Maize (*Zea mays.* L)

[1]Orhue Ehi Robert, [1]Uzu Ogbonnaya Frank and [2]Osaigbovo Agbonsalo Ulamen
[1]Department of Soil Science, [2]Department of Crop Science,
Faculty of Agriculture, University of Benin, Benin City, Nigeria

Abstract: Studies were conducted at the University of Benin, Benin City, Nigeria to examine the influence of combining rubber effluent with rock phosphate on some soil chemical properties as well as some agronomic characters of maize. The analysis of rubber effluent showed that it contains N, P, K, Ca Mg, Fe Mn, Zn and slightly acidic. It was also observed that the effluent had a pungent odour and colourless. In the first cropping, soil pH, N, Ca, Mg, K Na, Na, Fe, Mn, ECEC and Exchangeable acidity increased while the P and % carbon were reduced compared with control. In the second cropping, all the nutrient elements were reduced further. In the nutrient content of Maize, N, P increased up to 200,000l/(30 kg ha^{-1}) while Ca, Na, Mg, K increased up to 200000l (60 kg ha^{-1}). The trace elements content were not consistent. Similar trends were also recorded in the second cropping but the nutrient contents were reduced further. The N, P, K, Ca, Na, Al, Fe, Zn and Mn uptake were higher at 150,000l (30 kg ha^{-1}) while the Mg uptake was higher at 250,000l (120 kg ha^{-1}) At final harvest, 150,000l (30 kg ha^{-1}) was significantly ($p<0.05$) better than other treatments including control in plant height, collar girth and leaf area. The number of leaves was not significantly different from one another in all the treatments. In the residual effect, all the agronomic characters measured were almost closing up with the first cropping.

Key words: Effluent, rock phosphate, soil, maize, nutrient, uptake

INTRODUCTION

Rock phosphate is considered organic fertilizer and about 90% of the P is usually stable, insoluble in water and largely unavailable. It works best on acid soils high in organic matter (Leonard, 1986). Effectiveness of rock phosphate as a direct application fertilizer is determined by its chemical reactivity which in turn depends on the degree of carbonate substitution for phosphate in the appatite structure (Tisdale *et al.*, 1984). The utilization of phosphate as a source of plant nutrient is influenced by many factors such as fertilizer, soil environment and management. The soil environmental factors that affect phosphorus release and consequently utilization of phosphate when applied to soils are proton buffer, exchangeable calcium, phosphate buffer power, organic matter, soil pH and soil moisture holding capacity (Amapu *et al.*, 2000). Obigbesan and Akirinde (2000) and Gerner and Baanante (1995) have earlier advocated direct application of phosphate sources with a significant content of less soluble phosphorus such as rock phosphate to recapitalize the soils. Direct application of rock phosphate have been reported by Nehikhare (1987) and Chien (1990) to be beneficial. Natarajan *et al.* (1983) reported increased yield of millet especially when rock phosphate was combined with farmyard manure. Chalwade and Ghousika (1983) also observed that mixing manure with rock phosphate extended the period of phosphate availability to plants.

Corresponding Author: Orhue Ehi Robert, Department of Soil Science, Faculty of Agriculture, University of Benin, Benin City, Nigeria

Rubber effluent on the other hand is known to contain a large amount of non-rubber substances in addition to traces of various processing chemicals. The controlled applications of rubber effluent on land have been reported to cause changes in soil properties. Yeow and Zin (1981) reported improved water retention of soil whereas Poon (1982), Lim and P'ng (1983) and Lim *et al.* (1983) reported increased pH and soil K, Ca, Mg as well as organic matter when rubber effluent was applied on the soil. Orhue *et al.* (2005) reported an improved growth and nutrient uptake when rubber effluent was used on *Dialium guineense* and maize plants. Information on combining rubber effluent with rock phosphate in an ultisol is rare or scanty. Rubber effluent being an excellent soil conditioner (Seneravitne, 1997) could be use to complement organic fertilizer such as rock phosphate. The objective of this study was to evaluate the effectiveness of rock phosphate in soil amended with rubber effluent using maize as test crop.

MATERIALS AND METHODS

The experiment was conducted in both the greenhouse and laboratory at the University of Benin, Benin City, Nigeria. The topsoil obtained at a depth of 0-15 cm was bulked, mixed thoroughly and a composite sample collected, air dried and then sieved to remove debris. Thereafter, 2 kg of the composite was weighed and put in each of the 180 polythene bags measuring 24×28 cm in size. The experiment was a 6×5 factorial design laid out in a Completely Randomized Design with 3 replicates. Each replicate had 60 polythene bags with 2 polythene bags per treatment. Five levels of Ogun rock phosphate -0, 30, 60, 90 and 120 kg ha^{-1} were used while rubber effluent was applied at the following rates of 0, 50, 100, 150, 200 and 250 mL/2 kg soil equivalent to 0, 50000, 100000, 150000 200000 and 2500001 ha^{-1}. Prior to the application of the rock phosphate, analysis revealed that it contained 9% available P.

Rubber effluent and rock phosphate were applied to the soil in the polythene bags, mixed thoroughly and moistened with deionised water and left for 2 weeks for proper mineralization to enable the phosphate reacts with rubber effluent and the soil The soils were moistened before the seeds were sown. Ten seeds were initially sown and later thinned to one plant per pot. Subsequent moistening to 70% field capacity was carried out every 4 day interval with deionised water. Data collection on plant height, number of leaves, collar girth and leaf area were taken at 8 weeks after planting. Thereafter, the crops were harvested, oven dried to constant weight at 70°C for 48 h. Nutrient uptake was computed as product of dry weight and the nutrient content (%) (Pal, 1991).

The second cropping was conducted to investigate the residual effects of the rock phosphate and rubber effluent. The soils of 180 polythene bags were allowed to be air-dried for 2 weeks after the first harvest and then sieved to remove crop residue. Thereafter, each polythene bag was moistened and then sown again with ten seeds and thinned to one plant per pot 2 weeks after sowing. Watering carried out as previously described in experiment one. Data collections on plant height, collar girth leaf area as well as number of leaves were carried out 8 weeks after sowing. Mode of data collections and measurements of parameters were similar to those of experiment one.

Soil analyses were carried out before and after harvesting of maize. The rubber effluent was analyzed before using it to pollute the soil while the plant anlysis was done at the end of each experiment. Particle size analysis was determined by using hydrometer method of Bouyoucos (1951) while the soil pH was determined at a soil to water ratio of 1:1 using a glass electrode pH meter. The pH of rubber effluent was read directly with the pH meter. The electrical conductively of the effluent was read directly from the CIBA- CORNING conductivity meter. The organic carbon content of both soil and rubber effluent was determined by using the chronic acid wet oxidation procedure as described by Jackson (1962). The total nitrogen, available phosphorus, exchangeable bases as well as exchangeable acidity were determined using methods of Jackson (1962), Bray and Kurtz (1945) and

Mclean (1965), respectively. The effective cation exchange capacity was calculated as the sum of exchangeable bases and exchangeable acidity. The aluminum, iron and manganese were determined by methods described by Chanery (1955), Mehra and Jackson (1960) and Bradfield (1957), respectively.

RESULTS

Properties of Rubber Effluent

The physico-chemical properties of rubber effluent (Table 1) indicated that the effluent was slightly acidic, colorless and contained N, P, K, Ca, Na, Mg, Fe, Mn, Zn and organic Carbon.

Table 1: Analysis of the rubber effluent used in the experiment

Effluent property	Mean value
pH	5.00
Conductivity (S cm^{-1})	58.00
Total nitrogen (%)	2.10
Phosphorus (ppm)	5.26
Organic carbon (%)	0.14
Potassium (mg L^{-1})	12.25
Calcium (mg L^{-1})	8.82
Sodium (mg L^{-1})	1.54
Magnesium (mg L^{-1})	2.92
Iron (mg L^{-1})	0.04
Manganese (mg L^{-1})	0.02
Zinc (mg L^{-1})	0.91

Table 2: Physico-chemical analysis of polluted and unpolluted soil after harvest of maize plant in first cropping as influence by rubber effluent and phosphorus

Rubber effluent (L ha^{-1})	Rock Phosphate (kg ha^{-1})	pH (1:1 H_2O)	C (%)	N (%)	P (ppm)	K	Ca	Mg	Na
						---------------- (Cmol kg^{-1}) --------------			
Before pollution									
		5.10	1.32	0.05	4.71	0.04	0.01	1.39	0.08
After harvesting									
0	0	6.12	1.15	0.65	1.34	0.61	2.01	2.94	2.21
	30	6.14	1.13	0.68	2.35	4.61	4.01	2.45	2.22
	60	6.07	1.13	0.54	2.22	4.61	3.24	1.57	1.98
	90	6.99	1.12	0.54	2.19	4.07	3.24	2.45	2.06
	120	6.24	1.15	0.77	2.38	4.23	4.08	2.94	2.13
50,000	0	6.15	1.13	0.70	1.02	7.69	4.01	2.45	2.64
	30	6.16	1.13	0.72	1.32	9.23	4.01	2.45	2.72
	60	6.22	1.11	0.79	1.36	10.77	4.08	2.94	2.39
	90	6.17	1.14	0.72	1.38	11.92	4.01	2.94	2.30
	120	6.40	1.15	0.83	1.92	7.69	4.86	3.43	1.98
100,000	0	6.34	1.16	0.82	1.76	6.15	4.86	3.92	2.06
	30	6.21	1.14	0.74	2.36	7.69	4.08	2.45	1.98
	60	6.24	1.15	0.77	2.40	9.23	4.08	1.96	3.06
	90	6.43	1.18	0.85	2.95	7.69	5.61	3.92	3.30
	120	6.38	1.15	0.81	2.80	10.00	4.86	3.43	3.39
150,000	0	6.13	1.12	0.69	1.29	6.15	3.24	1.96	2.97
	30	6.17	1.11	0.71	1.34	7.69	4.01	3.43	2.31
	60	6.24	1.11	0.74	1.37	7.69	4.01	2.94	1.73
	90	6.33	1.16	0.81	1.70	4.61	4.09	3.43	2.06
	120	6.29	1.13	0.75	1.45	9.63	4.01	1.96	2.89
200,000	0	6.23	1.14	0.72	1.35	3.08	4.08	2.94	1.90
	30	6.25	1.13	0.76	1.38	7.69	4.08	1.57	1.81
	60	6.26	1.17	0.78	1.38	7.69	4.08	2.45	2.06
	90	6.23	1.16	0.73	1.32	4.61	4.08	2.45	1.90
	120	0.26	1.13	0.77	1.40	4.61	4.08	1.96	1.90
250,000	0	6.36	1.15	0.81	1.80	3.08	5.61	3.43	1.73
	30	6.31	1.12	0.80	1.72	4.61	4.86	2.94	1.90
	60	6.25	1.13	0.74	1.36	6.00	4.08	1.96	2.89
	90	6.54	1.16	0.88	1.98	6.15	5.61	3.89	2.15
	120	0.48	1.17	0.84	1.95	7.23	5.00	3.86	2.23

Table 2: Continued

Rubber effluent (L ha^{-1})	Rock phosphate (kg ha^{-1})	Exch. Acidity	ECEC	Zn	Fe	Mn	Sand	Silt	Clay
		---- (Cmol kg^{-1}) -------		----------- (ppm) -----------------			----------- (g kg^{-1}) ------------		
Before pollution		0.08	1.60	0.65	0.01	0.05	740	140	20
After harvesting									
0	0	2.00	9.77	0.65	0.31	0.28	752	112	136
	30	2.00	15.29	0.59	0.31	0.28	750	105	145
	60	2.20	13.60	0.58	0.36	0.29	731	125	144
	90	2.20	14.02	0.58	0.40	0.30	760	104	136
	120	1.80	15.18	0.58	0.29	0.32	740	120	140
50,000	0	2.20	18.99	0.80	0.31	0.26	755	101	144
	30	2.20	20.69	0.70	0.27	0.26	745	112	142
	60	1.80	21.98	0.71	0.26	0.22	744	103	153
	90	2.00	23.17	0.71	0.27	0.26	770	100	130
	120	1.00	18.96	0.72	0.18	0.19	754	121	125
100,000	0	1.60	18.59	0.86	0.23	0.21	760	120	120
	30	1.80	19.86	0.88	0.26	0.23	754	105	141
	60	1.80	20.13	0.88	0.26	0.23	750	114	136
	90	1.00	21.52	0.89	0.18	0.18	730	131	139
	120	1.60	23.28	0.89	0.21	0.21	751	116	133
150,000	0	2.40	15.72	0.86	0.34	0.28	730	119	141
	30	2.20	19.64	0.87	0.33	0.26	746	103	157
	60	2.00	18.37	0.87	0.22	0.21	735	103	162
	90	1.60	15.78	0.87	0.20	0.20	750	120	130
	120	2.00	20.49	0.86	0.22	0.21	752	95	153
200,000	0	1.80	13.80	0.84	0.25	0.24	747	110	143
	30	1.80	16.95	0.83	0.24	0.21	742	116	142
	60	1.80	18.68	0.83	0.24	0.21	736	122	142
	90	2.00	15.04	0.82	0.26	0.23	728	140	132
	120	1.80	14.35	0.82	0.23	0.19	745	123	132
250,000	0	1.60	15.45	0.70	0.20	0.16	750	102	148
	30	1.60	15.91	0.71	0.23	0.16	750	110	140
	60	1.80	16.73	0.21	0.26	0.22	761	103	134
	90	1.00	18.80	0.72	0.15	0.12	758	101	141
	120	1.00	19.63	0.71	0.16	0.13	743	123	134

Properties of Soil Used

The properties of soil used in the entire trial are shown in Table 2. The soil is moderately acidic. It is classified as Ultisol, Dystric Nitosol, Benin Fasc, grey in colour and texturally sandy (Enwezor, 1990). The soil contained organic carbon, N, P exchangeable cations, exchangeable acidity, Effective Cation Exchange Capacity (ECEC) as well as trace elements such as iron, manganese and zinc.

The Physico-chemical Properties of Soil After Harvesting

The soil pH increased from 5.10 to a mean between 6.07 in 60 and 6.99 90 kg ha^{-1} in first cropping (Table 2) while in the second cropping (Table 3) the soil pH was raised from 5.10 to a mean of between 5.15 in control and 6.70 in 100,000l (90 kg ha^{-1}). The application of effluent-rock phosphate combination in first cropping reduced the 1.32% carbon in control to a mean of between 1.11 and 1.18% (Table 2). The total nitrogen was increased from 0.05% in control to a mean of between 0.54% in 60 and 90 kg ha^{-1} and 0.88% in 200000l (90 kg ha^{-1}) (Table 2). In the second cropping (Table 3) the carbon was reduced further to a mean of between 0.90% in 250,000l (60 kg ha^{-1}) and 1.10% 50,000l (90 and 120 kg ha^{-1}) (Table 3). The nitrogen was reduced further to a mean value of between 0.50 and 0.72% in n100,000l (90 kg ha^{-1}). The phosphorus level was reduced from 4.71 ppm to a mean of between 1.02 in control and 2.95 ppm in 100000l (90 kg ha^{-1}) (Table 2) in first cropping and to a mean of between 0.96 ppm in 150,000l ha^{-1}, 200,000l ha^{-1} and 200,000l (30 kg ha^{-1}) and 2.20 ppm in 120 kg ha^{-1} in the second cropping (Table 3).

In the first cropping mono-valent cations such as K and Na were raised from 0.04 and 0.08 in control to a mean value of between 0.61 cmol kg^{-1} in control and 11.92 cmol kg^{-1} in 50,000l (90 kg ha^{-1}) and 1.73 cmol kg^{-1} in 150,000l (60 kg ha^{-1}) and 3.39 cmol kg^{-1} in 100,000l (120 kg ha^{-1}), respectively whereas the divalent cations such as Ca and Mg were increased from 0.01 and 1.39 cmol kg^{-1} in control to a mean value of between 2.01 cmol kg^{-1} in control and 5.61 cmol kg^{-1} in 100,000l (90 kg ha^{-1}) and 1.57 cmol kg^{-1} in 60 kg ha^{-1} and 3.92 cmol kg^{-1} in 250,000l (90 kg ha^{-1}), respectively (Table 2). The exchangeable acidity and Effective cation exchange capacity rose from 0.08 and 1.60 cmol kg^{-1} in control to a mean value of between 1.00 cmol kg^{-1} in 50,000l (120 kg ha^{-1}) 100,000/ (90 kg ha^{-1}), 250,000l (90, 120 kg) and 2.40 cmol kg^{-1} in 150,000l ha^{-1} and 9.77 Cmol kg^{-1} in control and 23.28 cmol kg^{-1} in 100,000l (120 kg ha^{-1}), respectively (Table 2). The K and Na monovalent cations and Ca and Mg divalent cations were further reduced in the second cropping (Table 4) to a mean value of between 0.50 cmol kg^{-1}in control and 9.51 cmol kg^{-1} in 50,000l (90 kg), 0.92 in 200,000l ha^{-1} and 1,99 cmol kg^{-1} in 100,000l (120 kg ha^{-1}), 1.70 in control and 6.07 cmol kg^{-1} in 100,000l (120 kg ha^{-1}) and 0.96 in 60 kg ha^{-1} and 2.58 Cmol kg^{-1} in 250,000l (90 kg ha^{-1}), respectively. The exchangeable acidity and effective cation exchange capacity were reduced further to mean value of between 1.08 in 250,000l (90 kg ha^{-1}) and 2.40 cmol kg^{-1} in 150,000l ha^{-1} and 8.01 cmol kg^{-1} in control and 20.56 cmol kg^{-1} in 50,000l (90 kg ha^{-1}), respectively (Table 3). In the first cropping (Table 2), trace elements such as zinc, iron and manganese were raised from 0.65, 0.01 and 0.05 ppm, in control to a mean value between 0.58 ppm in 60, 90 and

Table 3: Physico-chemical analysis of polluted and unpolluted soil after harvesting of maize in second cropping as influenced by residual effect of rubber effluent and phosphorus

Rubber effluent (L ha^{-1})	Rock phosphate (kg ha^{-1})	Characteristics							
		pH (1:1 H_2O)	C (%)	N (%)	P (ppm)	K	Ca	Mg	Na
						(Cmol kg^{-1})			
0	0	5.15	1.00	0.60	1.12	0.50	1.70	1.84	1.96
	30	6.09	1.04	0.64	2.00	3.64	2.73	1.85	1.87
	60	6.06	0.98	0.51	2.18	3.68	2.81	0.96	1.01
	90	6.00	0.99	0.51	2.12	3.25	2.84	1.95	1.87
	120	6.16	1.10	0.63	2.20	3.51	2.41	1.96	1.86
50,000	0	6.25	1.02	0.60	0.96	6.53	2.78	1.98	1.98
	30	6.20	1.06	0.63	1.20	7.93	3.80	1.97	1.97
	60	6.21	1.06	0.64	1.19	8.40	3.63	1.95	1.41
	90	6.19	1.10	0.62	1.18	9.51	3.54	1.54	1.98
	120	6.28	1.10	0.64	1.18	6.84	3.48	2.41	1.43
100,000	0	6.20	0.97	0.70	1.00	4.67	4.00	1.06	1.00
	30	6.31	0.98	0.68	1.20	5.69	4.50	2.53	1.07
	60	6.26	0.98	0.68	1.21	7.25	5.42	1.87	1.98
	90	6.70	0.99	0.72	1.21	5.95	4.48	2.53	1.87
	120	6.50	0.99	0.70	1.26	7.82	6.07	0.98	1.99
150,000	0	6.24	0.93	0.50	0.96	4.22	2.89	1.09	1.56
	30	6.27	0.94	0.51	0.98	4.53	3.00	2.51	1.72
	60	6.29	0.94	0.51	0.98	4.54	3.12	1.97	1.01
	90	6.38	0.94	0.52	0.98	2.87	3.07	2.48	1.22
	120	6.40	0.94	0.53	0.99	5.48	3.06	1.13	1.22
200,000	0	6.40	1.00	0.62	0.96	2.52	3.00	1.54	0.92
	30	6.30	1.01	0.63	0.96	4.15	3.01	1.07	0.93
	60	6.35	0.96	0.64	0.97	4.13	3.01	1.36	0.97
	90	6.26	0.95	0.65	0.98	3.17	3.11	1.38	1.01
	120	6.34	0.95	0.62	0.98	3.20	3.11	1.27	1.00
250,000	0	6.38	0.91	0.62	0.96	2.46	3.53	2.31	1.01
	30	6.36	0.91	0.62	0.98	3.83	3.24	2.02	1.02
	60	6.27	0.90	0.59	0.99	4.78	3.25	1.01	1.12
	90	6.52	0.92	0.58	0.99	4.75	3.56	2.58	0.98
	120	6.53	0.92	0.60	0.99	4.56	3.54	2.21	0.99

Table 3: Continued

		Characteristics							
Rubber effluent (L ha^{-1})	Rock phosphate (kg ha^{-1})	Exch. Acidity	ECEC	Zn	Fe	Mn	Sand	Silt	Clay
		---- (Cmol kg^{-1}) --------		------------ (ppm) -----------------			---------- (g kg^{-1}) -----------		
0	0	2.01	8.01	0.41	0.26	0.23	750	113	137
	30	2.00	12.09	0.41	0.30	0.24	752	107	141
	60	2.01	10.47	0.41	0.35	0.24	734	122	144
	90	2.10	12.01	0.40	0.34	0.27	751	113	136
	120	2.00	11.74	0.41	0.24	0.19	748	124	128
50,000	0	2.00	15.27	0.51	0.26	0.21	754	112	134
	30	2.00	15.67	0.52	0.23	0.23	748	114	138
	60	2.00	17.39	0.52	0.23	0.19	750	112	136
	90	2.01	20.56	0.52	0.24	0.22	753	113	134
	120	1.68	15.84	0.53	0.14	0.15	754	115	131
100,000	0	1.61	12.34	0.50	0.20	0.24	751	119	130
	30	1.90	15.69	0.50	0.23	0.23	753	121	126
	60	1.85	18.37	0.50	0.24	0.19	751	122	127
	90	1.23	16.06	0.50	0.16	0.17	742	120	138
	120	1.66	18.52	0.51	0.19	0.17	756	123	121
150,000	0	2.40	12.16	0.57	0.29	0.20	742	121	137
	30	2.13	13.99	0.56	0.29	0.17	751	115	134
	60	2.10	12.74	0.56	0.19	0.18	752	116	132
	90	1.63	11.27	0.57	0.17	0.18	753	118	129
	120	2.00	12.89	0.57	0.18	0.15	750	114	136
200,000	0	1.80	9.78	0.44	0.21	0.18	751	118	131
	30	1.80	10.96	0.45	0.22	0.17	754	118	128
	60	1.87	11.28	0.46	0.23	0.16	757	121	122
	90	2.10	10.77	0.46	0.23	0.18	760	126	114
	120	1.83	10.41	0.46	0.21	0.16	755	119	126
250,000	0	1.80	11.11	0.40	0.16	0.13	752	114	134
	30	1.62	11.73	0.41	0.17	0.12	754	115	131
	60	1.60	11.76	0.42	0.19	0.17	758	116	126
	90	1.08	12.95	0.40	0.13	0.11	757	117	126
	120	1.10	12.40	0.40	0.13	0.11	754	120	126

120 kg ha^{-1} and 0.89 ppm in 100,000l (90, 120 kg ha^{-1}), 0.15 in 250,000l (90 kg ha^{-1}) and 0.40 ppm in 90 kg ha^{-1}, 0.12 ppm in 250,000l (90 kg ha^{-1}) and 0.32 ppm in 120 kg ha^{-1}, respectively whereas in the second cropping (Table 3), zinc was further decreased to a mean value between 0.40 ppm in 90 kg ha^{-1}, 200,000l (90 and 120 kg ha^{-1}), 250,000 (90 and 120 kg ha^{-1}) and 0.57 ppm in 150,000l and 150,000l (90 and 120 kg ha^{-1}) Iron was reduced to a mean value of between 0.13 ppm in 50,000l (90 and 120 kg ha^{-1}) and 0.35 ppm in 60 kg ha^{-1} while manganese had a mean of between 0.11 ppm in 250,000l (90 and 120 kg ha^{-1}) and 0.27 ppm in 90 kg ha^{-1}. In both first and second cropping, it was however observed that soil texture was not affected by the various rubber effluent-phosphorus combinations as well as control (Table 2 and 3).

Nutrients Content of Maize Plants

The nutrient content of the maize plant in first and second cropping are shown in Table 4 and 5. In the first cropping (Table 4) that N, P, Na, Ca, Mg, K, Al, Fe, Mn and Zn had mean value of between 1.5% in control and 2.29%, in 100,000l, 0.086% in 30 kg ha^{-1} and 0.118% in 150000l and 150,000l (120 kg ha^{-1}), 0.032% in 250000l (90, 120 kg ha^{-1}) and 0.039% in 100,000l (30 kg ha^{-1}), 150000l (30, 60 90, 120 kg ha^{-1}), 0.059% in 30 kg ha^{-1} and 0.113% in 200000l (30, 60 kg ha^{-1}), 0.063% in 150,000l ha^{-1} and 0.621% in 250,000l (30, 90, 120 kg ha^{-1}), 1.030 in 200,000l ha^{-1} and 1.570% in 150,000l ha^{-1}, 120 mg kg^{-1} in 200,000l (30, 60, 90, 120 kg ha^{-1}) and 206 mg kg^{-1} in 250,000l ha^{-1}, 51 mg kg^{-1}` in 150,000 (60, 120 kg ha^{-1}) and 70 mg kg^{-1} in 50,000 (0, 60 kg ha^{-1}), 49 mg kg^{-1} in 60 kg ha^{-1} and 54 mg kg^{-1} in 250,000l (30 kg ha^{-1}), 39 mg kg^{-1} in 200,000l ha^{-1} and

Table 4: Effect of rubber effluent and phosphorus on nutrient content of maize plant in first cropping

		Characteristics									
Rubber effluent	Rock phosphate	N	P	Ca	Na	Mg	K	Al	Fe	Mn	Zn
(L ha^{-1})	(kg ha^{-1})	(%)	(%)	(%)	(%)	(%)	(%)	(mg kg^{-1})			
0	0	1.50	0.098	0.036	0.060	0.190	1.406	152	65	51	40
	30	1.56	0.086	0.037	0.059	0.191	1.408	152	64	50	41
	60	1.55	0.087	0.037	0.060	0.190	1.409	151	63	49	41
	90	1.54	0.090	0.037	0.061	0.191	1.411	150	63	50	41
	120	1.57	0.091	0.037	0.062	0.189	1.411	151	64	50	42
50,000	0	2.00	0.101	0.036	0.082	0.252	1.271	150	70	50	42
	30	1.99	0.095	0.038	0.081	0.250	1.270	149	69	50	43
	60	1.98	0.093	0.037	0.082	0.249	1.269	148	70	51	44
	90	1.97	0.092	0.037	0.083	0.248	1.269	148	68	50	44
	120	2.01	0.087	0.038	0.083	0.248	1.269	148	68	50	43
100,000	0	2.29	0.098	0.038	0.073	0.142	1.521	138	67	51	40
	30	2.07	0.098	0.039	0.073	0.139	1.520	139	66	51	41
	60	2.21	0.097	0.038	0.075	0.139	1.521	139	66	52	41
	90	2.20	0.098	0.038	0.073	0.138	1.522	138	67	50	42
	120	2.20	0.097	0.038	0.072	0.138	1.521	139	67	50	42
150,000	0	2.25	0.118	0.038	0.106	0.063	1.570	123	53	50	42
	30	2.26	0.115	0.039	0.105	0.066	1.560	122	52	50	42
	60	2.24	0.116	0.039	0.105	0.069	1.561	122	51	51	41
	90	2.25	0.117	0.039	0.106	0.068	1.562	123	52	52	42
	120	2.26	0.118	0.039	0.105	0.068	1.566	123	51	51	42
200,000	0	2.04	0.112	0.035	0.112	0.102	1.030	122	56	50	39
	30	2.00	0.113	0.035	0.113	0.101	1.233	120	55	50	40
	60	1.98	0.112	0.034	0.113	0.100	1.232	120	56	50	40
	90	1.92	0.112	0.034	0.112	0.101	1.233	120	56	50	40
	120	1.92	0.112	0.034	0.112	0.101	1.233	120	56	50	40
250,000	0	1.78	0.102	0.033	0.075	0.620	1.044	206	67	53	40
	30	1.79	0.101	0.033	0.076	0.621	1.032	205	66	54	40
	60	1.78	0.100	0.033	0.077	0.620	1.034	202	66	53	40
	90	1.77	0.101	0.032	0.075	0.621	1.034	200	65	53	41
	120	1.75	0.102	0.032	0.075	0.621	1.033	200	66	53	41

Table 5: Effect of rubber effluent and phosphorus on nutrient content of maize plant in second cropping

		Characteristics									
Rubber effluent	Rock phosphate	N	P	Na	Ca	Mg	K	Al	Fe	Mn	Zn
(L ha^{-1})	(kg ha^{-1})	(%)						(mg kg^{-1})			
0	0	1.44	0.075	0.030	0.052	0.180	1.207	141	60	43	35
	30	1.43	0.076	0.031	0.056	0.181	1.228	142	61	46	36
	60	1.41	0.076	0.031	0.054	0.180	1.296	139	62	45	36
	90	1.40	0.077	0.031	0.053	0.181	1.295	140	60	46	37
	120	1.43	0.079	0.031	0.052	0.183	1.298	141	59	45	37
50000	0	2.01	0.077	0.031	0.060	0.230	1.206	142	60	45	36
	30	2.11	0.078	0.032	0.079	0.232	1.251	143	64	43	37
	60	2.14	0.080	0.032	0.081	0.230	1.251	140	64	42	37
	90	2.16	0.081	0.033	0.083	0.231	1.260	140	62	46	38
	120	2.18	0.082	0.033	0.081	0.231	1.262	140	61	43	38
100000	0	2.13	0.079	0.031	0.073	0.098	1.200	108	50	44	35
	30	2.15	0.080	0.033	0.074	0.112	1.221	115	52	41	37
	60	2.18	0.081	0.033	0.072	0.112	1.220	116	51	44	38
	90	2.19	0.081	0.034	0.074	0.111	1.210	115	50	43	38
	120	2.20	0.081	0.034	0.076	0.119	1.210	114	53	43	38
150,000	0	2.19	0.080	0.031	0.096	0.060	1.292	119	40	42	37
	30	2.25	0.090	0.032	0.105	0.090	1.296	120	41	42	39
	60	2.20	0.097	0.032	0.103	0.86	1.291	121	40	43	39
	90	2.21	0.098	0.032	0.104	0.086	1.291	122	42	44	39
	120	2.22	0.097	0.032	0.102	0.088	1.292	120	40	42	39

Tabel 5: Continued

Rubber effluent (L ha^{-1})	Rock phosphate (kg ha^{-1})	Characteristics N	 P	 Na	 Ca	 Mg	 K	 Al	 Fe	 Mn	 Zn
		(%)						(mg kg^{-1})			
200,000	0	2.00	0.083	0.031	0.098	0.096	1.090	111	40	40	34
	30	2.04	0.087	0.031	0.099	0.097	1.096	111	40	42	35
	60	2.05	0.086	0.031	0.099	0.096	1.096	116	41	43	35
	90	1.92	0.087	0.031	0.097	0.095	1.097	117	42	43	36
	120	1.94	0.087	0.031	0.099	0.093	1.098	116	42	43	36
250,000	0	1.56	0.080	0.030	0.070	0.200	0.98	102	42	43	35
	30	1.62	0.081	0.030	0.075	0.201	0.98	101	43	44	34
	60	1.64	0.082	0.031	0.075	0.230	0.99	101	42	43	34
	90	1.64	0.082	0.031	0.072	0.221	0.98	102	45	43	34
	120	1.65	0.082	0.031	0.073	0.221	0.98	102	45	44	34

Table 6: Effect of rubber effluent and phosphorus on nutrient uptake by maize plant in the first cropping

Rubber effluent (L ha^{-1})	Rock phosphate (kg ha^{-1})	Characteristics N	 P	 Ca	 Na	 Mg	 K	 Al	 Fe	 Mn	 Zn
		(mg kg^{-1})									
0	0	364.40	17.33	12.88	7.79	43.32	312.63	0.33	0.146	0.111	0.088
	30	364.14	21.55	14.07	8.48	43.78	318.79	0.34	0.149	0.113	0.091
	60	395.50	21.77	14.86	9.10	46.98	342.29	0.36	0.162	0.119	0.100
	90	404.37	21.77	15.34	9.50	47.98	347.86	0.37	0.163	0.121	0.102
	120	417.98	22.22	15.92	9.70	49.26	355.53	0.38	0.169	0.126	0.104
50000	0	527.96	23.87	21.02	8.83	60.44	303.88	0.35	0.169	0.124	0.102
	30	538.12	24.75	21.76	9.29	62.37	312.59	0.36	0.176	0.127	0.107
	60	545.89	27.37	22.13	9.34	62.45	314.50	0.36	0.172	0.125	0.105
	90	575.56	27.37	22.97	10.06	65.81	330.10	0.38	0.183	0.136	0.113
	120	570.40	28.00	22.71	10.06	66.07	329.85	0.38	0.183	0.134	0.113
100000	0	606.15	27.50	20.74	10.23	38.25	438.85	0.36	0.185	0.134	0.110
	30	611.99	27.87	21.02	10.51	38.82	439.44	0.36	0.183	0.140	0.110
	60	649.34	29.87	22.21	11.10	41.29	464.50	0.39	0.197	0.148	0.119
	90	686.58	31.87	24.00	11.48	44.05	495.19	0.41	0.209	0.159	0.127
	120	607.50	28.62	21.00	10.53	39.15	440.37	0.37	0.183	0.140	0.113
150000	0	587.60	29.87	27.30	9.88	17.94	408.72	0.32	0.143	0.132	0.109
	30	1105.93	61.87	51.91	18.05	44.68	712.30	0.56	0.243	0.234	0.189
	60	761.65	43.37	35.78	13.13	31.84	518.38	0.40	0.180	0.170	0.137
	90	771.95	44.12	36.06	13.14	32.69	531.60	0.41	0.188	0.168	0.144
	120	741.06	42.25	34.47	12.56	30.93	507.78	0.40	0.173	0.67	0.135
200000	0	548.55	29.37	30.21	9.27	27.82	275.33	0.32	0.153	0.132	0.081
	30	505.44	27.86	27.94	8.74	24.78	301.32	0.29	0.140	0.119	0.086
	60	517.27	28.37	28.46	8.89	26.23	307.39	0.29	0.146	0.123	0.094
	90	506.88	30.00	29.69	9.21	27.39	319.23	0.31	0.145	0.130	0.102
	120	450.60	30.12	29.24	8.90	27.21	316.85	0.30	0.144	0.129	0.101
250000	0	453.94	26.62	19.27	8.62	159.50	265.01	0.52	0.174	0.136	0.103
	30	454.43	27.12	19.91	8.61	160.58	267.80	0.51	0.171	0.135	0.102
	60	457.38	27.87	19.31	8.63	161.60	266.55	0.51	0.165	0.132	0.102
	90	445.50	25.87	19.30	8.41	155.92	259.38	0.50	0.160	0.128	0.099
	120	464.80	27.25	20.03	8.73	162.04	269.38	0.52	0.169	0.136	0.102

44 mg kg^{-1} in 50,000l (60, 90 kg ha^{-1}), respectively. In the second cropping (Table 5) the mean nutrient content were between 1.40% in 90 kg ha^{-1} and 2.25% in 100,000 (30 kg ha^{-1}) for N, 0.075% in control and 0.098% in 150,000l (90 kg ha^{-1}) for P, 0.030% in control and 150,000l (0. 30 kg ha^{-1}) and 0.034% in 100,000l (90, 120 kg ha^{-1}) for Na, 0.052% in control and 120 kg ha^{-1} and 0.105% in 150,000l (30 kg ha^{-1}) for Ca, 0.060% in 150 kg ha^{-1} and 0.232% in 50,000l (30 kg ha^{-1}) for Mg, 0.98% in 250,000l (0, 60, 90, 120 kg ha^{-1}) and 1.298% in 120 kg ha^{-1} for P, 101 mg kg^{-1} in 250,000l (30, 60 kg ha^{-1}) and 143 mg kg^{-1} in 50,000l (30 kg) for Al, 40 mg kg^{+} in 150,000l (0, 60, 120 kg ha^{+}), 200,000l (0, 30 kg ha^{-1}) and 64 mg kg^{-1} in 50,000l (0, 30 kg ha^{-1}) for Fe, 40 mg kg^{-1} in 200,000l ha^{-1}

and 46 mg kg^{-1} in 50,000l (30, 90 kg ha^{-1}) and 90 kg ha^{-1} for Mn, 34 mg kg^{-1} in 200,000l ha^{-1}, 250,000l (30, 60, 90, 120 kg ha^{-1}) and 50,000l (30, 60 kg ha^{-1}) and 39 mg kg^{-1} in 150,000l (30, 60, 90, 120 kg ha^{-1}) for Zn. The N and P increased up to 200,000l (30 kg ha^{-1}) while Ca, Na, Mg and K increased up to 200,000l (60 kg ha^{-1}). The trace elements nutrient content was not consistent.

Nutrient Uptake by Maize Plant

The N and P uptake in first cropping (Table 6) indicated that there were progressive increase from control-phosphorus combinations up to 150,000l (30 kg ha^{-1}) and declined gradually. The N mean value was between 364.44 mg/plant in 30 kg ha^{-1} and 1,105.93 mg/plant in 150,000l (30 kg ha^{-1}) whereas P mean value was between 17.33 mg/plant in control and 61.87 mg/plant in 150,000l (30 kg ha^{-1}). There was no consistency in the Ca, Na P, Al, Mn and Zn uptake in various effluent-phosphorus combinations in first cropping (Table 6). The Ca uptake however had a mean value of between 12.88 mg/plant in control and 51.91 mg/plant in 150,000l (30 kg ha^{-1}), Na had between 7.79 mg/plant in control and 18.05 mg/plant in 150,000l (30 kg ha^{-1}) while Mg was between 17.94 mg/plant in 150,000l ha^{-1} and 162.60 mg/plant in 250,000 (120 kg ha^{-1}). K, Al, Fe Mn and Zn mean value were between 259.38 mg/plant in 250,000l (90 kg ha^{-1}) and 712.30 mg/plant in 150,000l (30 kg ha^{-1}), 0.29 mg/plant in 200,000l (30, 60 kg ha^{-1}) and 0.56 mg/plant 150,000l (30 kg ha^{-1}), 0.140 mg/plant in 200,000l (30 kg ha^{-1}) and 0.243 mg/plant in 150,000l (30 kg ha^{-1}), 0.111 mg/plant in control and 0.234 mg/plant in 150,000l (30 kg ha^{-1}), 0.081 mg/plant in 200,000l ha^{-1} and 0.189 mg/plant in 150,000l (30 kg ha^{-1}), respectively in the first cropping (Table 6). In the second cropping (Table 7) similar trends in various nutrient uptakes as shown in first cropping were also recorded.

Table 7: Effect of rubber effluent and phosphorus on nutrient uptake by maize plant in the second cropping

		Characteristics									
Rubber effluent (L ha^{-1})	Rock phosphate (kg ha^{-1})	N	P	Na	Ca	Mg	K	Al	Fe	Mn	Zn
		(mg kg^{-1})									
0	0	233.56	12.16	4.86	8.43	29.19	195.77	0.228	0.097	0.069	0.056
	30	247.96	13.17	5.37	9.71	31.38	212.93	0.246	0.105	0.079	0.062
	60	253.37	13.65	5.57	9.70	32.34	232.89	0.249	0.111	0.080	0.064
	90	243.04	13.36	5.38	9.20	31.42	224.81	0.243	0.104	0.078	0.064
	120	250.96	13.86	5.44	9.12	32.11	227.79	0.247	0.103	0.078	0.064
50000	0	412.25	15.79	6.35	12.30	47.17	247.35	0.291	0.123	0.092	0.077
	30	435.29	16.09	6.60	16.29	47.86	258.08	0.295	0.132	0.088	0.076
	60	437.84	16.36	6.54	16.57	47.05	255.95	0.286	0.130	0.085	0.077
	90	435.88	16.34	6.65	16.74	46.61	254.26	0.282	0.125	0.092	0.076
	120	457.36	17.20	6.92	16.99	48.46	264.76	0.293	0.127	0.090	0.079
5100000	0	436.22	16.17	6.34	14.95	20.07	245.76	0.221	0.102	0.090	0.071
	30	458.16	17.04	7.03	15.76	23.86	260.19	0.245	0.110	0.087	0.078
	60	489.84	18.20	4.41	16.14	25.16	274.13	0.260	0.114	0.098	0.085
	90	536.33	19.83	8.32	18.12	27.18	296.32	0.281	0.122	0.102	0.093
	120	516.12	19.00	7.97	17.82	27.91	283.86	0.267	0.124	0.100	0.089
150000	0	463.84	16.94	6.56	20.33	12.70	273.64	0.252	0.084	0.088	0.078
	30	683.32	30.06	9.71	31.88	27.33	393.59	0.364	0.124	0.127	0.118
	60	658.68	29.04	9.58	30.83	25.74	386.52	0.362	0.119	0.128	0.116
	90	640.01	28.38	9.26	30.11	24.90	373.87	0.353	0.121	0.127	0.112
	120	660.22	28.84	9.51	30.33	25.73	384.24	0.356	0.118	0.124	0.115
1200000	0	417.20	17.31	6.46	20.44	20.02	227.37	0.231	0.083	0.083	0.070
	30	454.71	19.39	6.90	22.06	21.62	244.29	0.247	0.089	0.093	0.078
	60	464.94	22.45	7.03	22.45	21.77	248.57	0.263	0.092	0.097	0.079
	90	435.07	21.98	7.02	21.98	21.52	248.58	0.265	0.095	0.097	0.081
	120	442.12	19.82	7.06	22.65	21.19	250.23	0.264	0.095	0.097	0.082
250000	0	331.50	17.00	6.37	14.87	42.50	208.25	0.216	0.089	0.091	0.074
	30	343.76	17.18	6.36	15.91	42.65	207.95	0.214	0.091	0.093	0.072
	60	338.66	16.93	6.40	15.48	45.43	204.43	0.208	0.086	0.088	0.070
	90	359.16	17.95	6.78	15.76	48.39	214.62	0.223	0.098	0.094	0.074
	120	369.43	18.35	6.94	16.34	49.48	219.42	0.228	0.100	0.098	0.076

Table 8: Effect of rubber effluent and phosphorus application on the leaf area, collar girth (cm), number of leaves, plant height (cm) of maize plant in first and second cropping

		Leaf area (cm^{2})		Collar girth (cm)		Number of leaves		Plant height (cm)	
Rubber effluent (L ha^{-1})	Rock phosphate (kg ha^{-1})	First cropping	Second cropping	First cropping	Second cropping	First cropping	Second cropping	First cropping	Second cropping
0	0	87.88^{d}	61.52^{c}	1.67^{c}	1.21^{d}	8.00^{a}	7.00^{a}	51.62^{c}	39.36^{c}
	30	88.63^{d}	72.66^{c}	1.82^{c}	1.24^{d}	7.66^{a}	7.00^{a}	54.03^{c}	40.79^{b}
	60	89.80^{d}	72.58^{c}	1.81^{c}	1.26^{d}	7.00^{a}	7.00^{a}	51.66^{c}	43.81^{b}
	90	89.10^{d}	73.67^{c}	1.81^{c}	1.27^{d}	7.00^{a}	7.00^{a}	52.53^{c}	43.31^{b}
	120	91.45^{d}	73.51^{c}	1.82^{c}	1r.27^{d}	7.00^{a}	7.33^{a}	53.53^{c}	46.66^{b}
50,000	0	90.35^{d}	70.84^{c}	1.88^{c}	1.27^{d}	8.33^{a}	7.66^{a}	54.06^{c}	39.89^{c}
	30	95.76^{d}	77.11^{c}	1.89^{c}	1.28^{d}	8.33^{a}	8.00^{a}	57.41^{b}	42.68^{b}
	60	99.10^{d}	77.12^{c}	1.92^{c}	1.29^{d}	8.33^{a}	8.00^{a}	56.80^{b}	44.71^{b}
	90	99.04^{d}	81.39^{ce}	1.92^{c}	1.30^{d}	8.00^{a}	8.33^{a}	57.53^{b}	45.39^{b}
	120	100.6c^{e}	83.14^{ce}	1.93^{c}	1.32^{d}	8.00^{a}	8.66^{a}	58.78^{b}	46.40^{b}
100,000	0	99.72^{c}	74.38^{c}	2.11^{c}	1.57^{d}	9.00^{a}	8.33^{a}	60.66^{b}	44.14^{b}
	30	111.08^{c}	90.69^{c}	2.07^{c}	1.70^{c}	9.33^{a}	8.66^{a}	61.83^{b}	46.55^{b}
	60	111.83^{c}	93.60^{c}	2.20^{c}	1.70^{c}	9.33^{a}	8.66^{a}	60.60^{b}	47.55^{b}
	90	114.20^{c}	95.00^{c}	2.23^{c}	1.71^{c}	9.33^{a}	8.66^{a}	60.50^{b}	48.47^{b}
	120	114.69^{c}	95.37^{c}	2.28^{c}	1.72^{c}	9.00^{a}	8.66^{a}	61.50^{b}	49.49^{b}
150,000	0	145.20^{b}	87.29^{c}	2.96^{a}	2.68^{a}	9.00^{a}	8.66^{a}	73.13^{a}	51.36^{a}
	30	154.16^{a}	140.09^{a}	2.77^{a}	2.70^{a}	10.00^{a}	10.00^{a}	81.56^{a}	59.54^{a}
	60	153.6^{a}	139.58^{a}	2.69^{a}	2.70^{a}	10.00^{a}	10.00^{a}	75.50^{a}	59.57^{a}
	90	161.34^{a}	139.47^{a}	2.62^{a}	2.71^{a}	10.00^{a}	10.00^{a}	76.56^{a}	61.43^{a}
	120	165.49^{a}	139.75^{a}	2.74^{a}	2.73^{a}	10.00^{a}	10.00^{a}	82.66^{a}	64.64^{a}
200,000	0	145.76^{b}	87.89^{c}	2.48^{b}	1.60^{c}	9.33^{a}	9.00^{a}	65.65^{b}	51.61^{a}
	30	146.85^{b}	115.66^{b}	2.42^{b}	1.98^{b}	9.00^{a}	9.00^{a}	69.36^{b}	55.45^{a}
	60	147.18^{b}	111.52^{b}	2.45^{b}	1.98^{b}	9.00^{a}	9.00^{a}	68.58^{b}	56.41^{a}
	90	147.52^{b}	111.36^{b}	2.51^{b}	1.97^{b}	9.00^{a}	9.00^{a}	68.59^{b}	56.00^{a}
	120	148.83^{b}	111.71^{b}	2.51^{b}	1.99^{b}	9.00^{a}	9.00^{a}	68.58^{b}	58.66^{a}
250,000	0	145.53^{b}	87.15^{b}	2.41^{b}	1.50^{c}	9.33^{a}	9.00^{a}	61.57^{b}	50.64^{a}
	30	146.57^{b}	111.58^{b}	2.43^{b}	1.87^{b}	9.66^{a}	9.00^{a}	67.90^{b}	53.70^{a}
	60	147.91^{b}	111.69^{b}	2.43^{b}	1.87^{b}	9.00^{a}	9.00^{a}	67.77^{b}	53.37^{a}
	90	149.49^{b}	111.06^{b}	2.46^{b}	1.87^{b}	9.33^{a}	9.00^{a}	67.80^{b}	55.02^{a}
	120	149.62^{b}	111.69^{b}	2.45^{b}	1.98^{b}	9.00^{a}	9.00^{a}	67.73^{b}	56.04^{a}

Means followed by the same letter in the column are not significantly different from one another at 5% level of probability

Vegetative Growth

The vegetative growth parameters measured in first and second cropping are depicted in Table 8. In the number of leaves, there were no significant differences among the treatments in both first and second cropping. However, the highest number of leaves were recorded in first and second cropping at 150,000l (30, 60, 90, 120 kg ha^{-1}). Also in plant height, treatment combination of 150,000l (0, 30, 60, 90, 120 kg ha^{-1}) were not significantly different from one another but better than other treatments in first cropping whereas in the second cropping treatments 150,000l (0, 30, 60, 90, 120 kg ha^{-1}), 200,000l (0, 30, 60, 90, 120 kg ha^{-1}) and 250,000l (0, 30, 60, 90, 120 kg ha^{-1}) were not significantly different from one another but better than other treatments including control. The treatment combinations of 150,000l (0, 30, 60, 90, 120 kg ha^{-1}) were not significantly different from one another but better than other treatments in both first and second cropping in collar girth. The leaf area were also not significantly different from each other at 150,000l (90, 120 kg ha^{-1}) in the first cropping and at 150,000l (30, 60, 90, 120 kg ha^{-1}) in the second cropping but they were better than other treatments including control.

DISCUSSION

The soil used is a typical Ultisol low in fertility as shown by its properties. This result is similar to the findings of Agboola and Ogunkule (1993). The properties of the effluent showed that it contains some both micro and macro nutrients that can be utilized by crops. Similar results have also been recorded by Seneviratne (1997) and Orhue *et al.* (2005). The basic facts according to Orhue *et al.* (2005) is that most of the effluents whether obtained from processing of crepe, crumb, concentrate latex contain the basic plant nutrients.

The increase in the soil pH, N, K, Ca, Mg, Na is attributed to the nutrient properties (Serum) of the effluent as well as the phosphorus applied. Similar results have earlier been reported by Poon (1982) Lim and P'ng (1983) and Lim *et al.* (1983). The increase in above nutrients further confirms that applying effluent alone or combining it with phosphorus is not problematic especially when the rate of application is geared to supply nutrients at levels corresponding to those in inorganic fertilizer normally applied to promote satisfactory crop performance and that controlled application of effluent causes no detrimental changes in the soil. Rather it improves soil fertility and has no apparent adverse effect on the environment. Also the gains or beneficial properties of rubber effluent as an excellent soil conditioner makes it a good source of fertilizer. The decrease in P with increase in effluent-phosphorus combination may be due to overlapping of sphere of soil serving as a sink for the dissolution products of adjacent P fertilizer particles which could have influenced dissolution (Elraside and Larson, 1978). The practical consequence of this would be a progressive decline in the agronomic effectiveness of a given quantity of P fertilizer as rate of application increases (Amapu *et al.*, 2000) and this is primarily due to the build-up of products of dissolution on the surface of the fertilizer particles. This result suggests that it is not advisable to rapidly raise the soil P status by the application of large doses of P fertilizer.

The utilization of rock phosphate is influenced by some soil factors which affect the dissolution and consequently its release of P. Some of the factors according to Amapu *et al.* (2000) include soil pH, proton buffer power, exchangeable Ca, phosphate buffer power, organic matter, soil moisture holding capacity. The decrease percentage carbon is however contrary to the finding of Lim *et al.* (1983) and Seneviratne (1997). Although there were no definite pattern of exchangeable acidity, ECEC, Fe, Mn, Zn, there were slight increase compared with control. The soil texture was never influenced or changed by the effluent-phosphorus combinations. The increases in nutrient content of the maize plants except N and P in the trials were not definite. This may be attributed to the nutrient uptake ability of the maize plant, soil nutrient interaction as well as an indication that the effluent – phosphorus combination should be at the rates corresponding to crop requirements..

There is generally a relationship between some of the major elements especially N, P and K, Mg (Remison and Snaydon, 1981; Remison and Okpala-Jose, 1992). The supply of one element can increase, decrease or maintain their percentage in dry matter in the leaves (Remison, 1997). The effects are described as antagonistic when the leaf nutrient of an element is reduced by the application of another element and synergetic when application increases the leaf content of element concentrated (Remison, 1997). These effects tend to influence nutrient uptake and subsequent nutrient content of plant. The increase in N, P, K, Ca, Mn uptake up to 200,000 (90 kg ha^{-1}) showed that the effluent-phosphorus combinations should be applied at the rate corresponding to the plant requirement. The uptake of Mg, Na, Al, Zn, Mn were however not definite. This variation in nutrient uptake may have been influenced by certain factors such as temperature, aeration, plant age, concentration of competing ions as well as nutrient interaction in the soil. All these may have differential effects upon nutrient uptake rate and subsequent different nutrient composition (Clinton and William, 1981; Drewes and Blume, 1997; O'Conner and Anderson, 1997). Loos *et al.* (1979) asserted that reduce nutrient uptake in the presence of effluent could occur due to strong adsorption or degradation in the soil and that the extent of absorption or degradation does not only depend on the properties of the effluent but also on the properties of the site, soil types, kind of soil organisms and climatic conditions.

The increase in the plant height, leaf area and collar girth up to 150,0001 (120 kg/ha) combination indicated that both effluent and rock phosphate can compliment each other and that the optimum growth at 150,000l (30 kg ha^{-1}) is a matter of crop preference and the depression in height, girth and leaf area as from 200,000l ha^{-1} effluent with various rock phosphate combinations could be due to effluent and phosphorus interactions with other elements in the soil. The residual effect on the vegetative growth was also glaring such that the effluent-rock phosphate combination was almost closing up with first cropping indicating that rock phosphate availability to plant is slow and dependent on soil factors such as soil pH. This result confirms that, in slightly acid soils the performance of rock phosphate is often inferior. Obigbesan and Mengel (1981), Chien *et al*. (1989) and Chien (1990) showed that a finely ground rock phosphate can be as effective as water soluble P-fertilizer particularly in strongly acidic soils. The improvement effect of the rock phosphate over the control and better performance in the second cropping is a clear indication of the rock phosphate efficacy as viable alternative P-source for direct use in the long run. Strongly acid soil can bring about favorable residual effects by releasing much of the P gradually for plant use. The presence of anthocyanin purple colorations in the maize plants treated with rock phosphate is an indication of P-deficiency at the early growth of the plant. This confirms that rock phosphate availability to plant is slow. Similar results have earlier been obtained by Mengel and Kirkby (1987) and Obigbesan and Akinrinde (2000).

CONCLUSIONS

The study revealed that application of effluent-phosphorus combination had an effect on the uptake, synthesis and translocation of vital mineral elements in maize plants. The vegetative growths as well as soil nutrient elements were enhanced greatly. However, maize plant that received higher rate effluent-phosphorus combination greater than 150,000l ha^{-1}(120 kg ha^{-1}) had a declined vegetative growth as well as reduced nutrient elements levels in the soil showing the existence of interaction between effluent and phosphorus with other nutrient elements in soil.

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