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AGRONOMY

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

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Abstract: The green house trials were carried out at the Faculty of Agriculture, University of Benin, Benin City, Nigeria to determine the effect of rubber effluent and Single Super Phosphate (SSP) combination on some soil chemical properties, growth and nutrient uptake of maize in an Ultisol. The SSP used was 0-18-0. Five level-0, 30, 60, 90 and 120 kg ha^{-1} SSP were combined with 6 levels of rubber effluent (0, 50,000, 100,000, 150,000, 200,000 and 250,000 L ha^{-1}) in 6×1×5 factorial arrangement in a completely randomized design. Results of the effluent analysis showed that the effluent contains both micro and macro nutrients, slightly acidic pungent in odour and colourless. In the first cropping, soil pH, N, Ca, Mg, K, Na, Fe, Mn, ECEC as well as exchangeable acidity increased when compared with control. The available P and %C were however, reduced when compared with control. In the second cropping, all the nutrient elements declined further after harvesting. The content of N and P increased up to 150,000 L ha^{-1} treatment with phosphorus combination. The N, P, K, Ca, Na, Al, Fe, Zn and Mn uptake were also higher at 150,000 L ha^{-1} effluent treatment with phosphorus combination Mg uptake was however higher or greater at 150,000 L ha^{-1} effluent treatment with phosphorus combinations. The textural status of the soil was not changed throughout the trials. All the treatments were not significantly different from one another in all the growth parameters 2 Weeks after Sowing (WAS). At final harvest, 150,000 L ha^{-1} effluent concentration/30 kg ha^{-1} of SSP was significantly ($p<0.05$) better than other treatments including control in plant height, collar girth and leaf area. However, the number of leaves was not significantly different from one another throughout the period of the trials.

Key words: Rubber effluent, single super phosphate, ultisol, maize

INTRODUCTION

Improving the fertility of the soil has consistently been pinpointed as one of the most critical factors among numerous others in a bid to promote the sustainability of agriculture in Nigeria. The very crucial aspect of improving and maintaining soil fertility is the application of deficient nutrients of which phosphorus is one of the most important. Phosphorus plays a vital role in crop production and so much so that it is considered an amendment because it improves current input like fertilizer, water and labour more efficient (Amapu *et al.*, 2000).

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 influence phosphorus release and consequently utilization of phosphate when applied to soil are proton buffer, exchangeable calcium, phosphate buffer power, organic matter, soil pH and soil moisture holding capacity (Amapu *et al.*, 2000). Soil pH is known to influence the availability of phosphorus. In most soils phosphorus availability is at a maximum in the pH range of 5.5-7.0 decreasing as the pH drops and also as it goes above 7.0. The ions of calcium and magnesium as well as the presence of carbonates of these metals in the soil cause precipitation of the added phosphorus and its availability again decreases. At low pH values the P retention results largely from the reaction with iron and aluminum and their hydroxides. The controlled application of rubber effluent on soil have been reported to cause changes in soil properties. Yeow and Zin (1981) reported an improved water retention of soil when rubber effluent was applied on the soil. Poon (1982), Lim and P'ng (1983), Lim *et al.* (1983), Seneviratne (1997) and Orhue *et al.* (2005) have reported an increased soil pH and soil K, Ca, Mg and organic matter content when rubber effluent was used. The properties of rubber effluent make it an

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excellent soil conditioner and it could be use to complement synthetic fertilizers. This study therefore seek to evaluate the effect effect of combining rubber effluent with single super-phosphate on some soil chemical properties and growth of maize (*Zea mays* L.).

MATERIALS AND METHODS

First cropping: This first cropping experiment was carried out in a greenhouse at the Faculty of Agriculture, University of Benin, Benin City Nigeria. The top soil collected from the floor of *Gmelina arborea* plantation at a depth of 0-15 cm was composited, air dried and sieved. Two killogram soil samples were weighed into each 180 polythene bags. The experiment was a $6 \times 1 \times 5$ factorial design laid out in a completely Randomized Design with 3 replicates. Each replicate had 60 polythene bags with 2 polythene bags for a treatment. Single super-phosphate 0-18-0 was used. Five levels-0, 30, 60, 90 and 120 kg ha^{-1} of the single super phosphate were used.

The soil in the polythene bags were polluted with rubber effluent at the rate of 0, 50, 100, 150, 200 and 250 mL (equivalent to 0, 50,000, 100,000, 150,000, 200,000 and 250,000 L ha^{-1} effluent treatment), respectively mixed thoroughly and then left for 2 weeks for proper mixing with soil while the phosphate was applied 2 weeks after the rubber effluent application. The soils were moistened with deionized water and then allowed to incubate for another 2 weeks to enable the phosphates react with the rubber effluent and soil. Before the seeds were sown, the soils were also moistened. Four seeds were initially sown and later thinned to one plant per polythene bag. Subsequent watering was carried out every 4 day interval with deionized water. Visual observation and crop performance and data collection on plant height, number of leaves, collar girth and leaf area were measured every 14 day interval for 8 weeks. At 8 weeks the plants were harvested oven dried to constant weight at 70°C for 48 h. Nutrient uptake was also computed using the dry weight and nutrient content (%) (Pal, 1991).

Second cropping: The second cropping was carried out in order to investigate the residual effect of both the phosphate fertilizer and rubber effluent For this second cropping soils of the 180 polythene bags were left 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 re-sown with four seeds. They were thinned to one plant per pot 2 weeks after sowing. Watering carried out as described earlier. Data collections were carried out every 14 day till 8 weeks.

Soil, effluent and maize plant analysis: Soil analysis was carried out before, after pollution and after harvesting of

maize plant. The rubber effluent was analyzed before using it to pollute the soil. While the plant analysis was done at the end of the 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 Chenery (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 colourless and contained N, P, organic carbon, K, Ca, Na, Mg, Fe, Mn and Zn.

Properties of soil used: The property of soil used in the entire trial is 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 *et al.*, 1990). The soil contained organic carbon, N, available P, exchangeable cations, exchangeable acidity, Effective Cation Exchange Capacity (ECEC) as well as trace elements such as Fe, Mn and Zn.

Physio-chemical properties of soil after harvest as influenced by effluent phosphorus combinations in first and second cropping: The physico-chemical properties of

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
Phosphoms (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

Rubber effluent (L ha⁻¹)	SSP kg ha⁻¹	pH (1:1H₂o)	C (%)	N (%)	P (ppm)	K	Ca	Mg	Na	Exch acidity	ECEC	Zn	Fe	Mn	Sand	Silt	Clay
						(cmol kg⁻¹)						(ppm)			(g kg⁻¹)		
Before pollution																	
		5.10	1.32	0.05	4.71	0.04	0.01	1.39	0.08	0.08	1.60	0.65	0.01	0.05	740	140	120
After harvesting																	
0	0	5.16	1.13	0.74	1.25	0.61	2.78	2.91	1.15	1.60	9.05	0.66	0.26	0.17	720	137	143
	30	5.71	1.13	0.66	3.07	4.61	6.41	4.91	2.06	2.00	19.99	0.62	0.41	0.21	725	173	102
	60	5.58	1.14	0.62	3.98	4.61	5.61	3.43	2.06	2.00	17.71	0.60	0.44	0.23	760	112	128
	90	5.38	1.13	0.59	3.92	4.61	4.86	2.94	2.15	2.20	16.76	0.60	0.51	0.24	720	120	160
	120	5.33	1.15	0.57	3.94	4.61	4.82	2.94	2.56	2.20	17.13	0.60	0.51	0.23	740	90	170
50,000	0	5.20	1.11	0.79	2.10	4.61	5.61	3.92	2.31	1.80	18.25	0.80	0.33	0.18	770	106	124
	30	5.66	1.14	0.72	2.98	4.61	4.80	2.94	4.05	2.00	18.40	0.82	0.42	0.21	711	110	180
	60	5.61	1.14	0.72	2.95	3.08	4.82	2.94	2.23	2.00	15.07	0.81	0.42	0.21	756	102	142
	90	5.43	1.11	0.55	2.88	4.61	3.08	2.45	2.23	2.20	13.04	0.81	0.45	0.23	747	120	120
	120	5.60	1.15	0.55	2.81	4.61	3.08	2.45	2.48	2.00	15.22	0.80	0.52	0.28	760	105	105
100,000	0	5.80	1.13	0.61	1.01	4.61	4.86	3.43	1.57	2.00	16.47	0.82	0.38	0.22	750	102	148
	30	5.28	1.12	0.53	3.92	6.13	4.82	2.94	1.81	2.40	18.10	0.98	0.51	0.27	730	120	150
	60	5.13	1.12	0.49	3.86	4.61	4.82	2.45	1.90	2.40	16.18	0.99	0.54	0.28	780	110	110
	90	5.04	1.16	0.47	3.81	4.61	4.08	2.45	1.81	2.80	15.75	1.00	0.54	0.33	723	127	150
	120	5.94	1.14	0.41	3.75	6.15	3.01	1.96	2.30	3.20	16.62	1.00	0.59	0.36	742	136	122
150,000	0	5.62	1.16	0.59	0.96	4.61	4.86	3.92	1.48	1.60	16.47	0.86	0.43	0.20	745	102	153
	30	5.83	1.14	0.53	1.92	6.15	4.82	3.43	2.06	1.80	18.26	1.00	0.50	0.22	700	150	150
	60	5.76	1.16	0.44	1.89	6.15	4.01	2.45	3.97	2.40	18.98	1.01	0.53	0.26	730	130	140
	90	5.56	1.16	0.50	1.94	6.15	4.04	2.94	3.06	1.80	17.99	1.03	0.48	0.21	748	120	132
	120	5.70	1.12	0.42	1.86	7.69	4.01	2.45	2.39	2.40	18.94	0.88	0.54	0.25	696	34	170
200,000	0	6.18	1.13	0.83	1.26	3.08	5.61	3.92	2.48	1.60	16.69	0.85	0.30	0.14	750	120	130
	30	6.60	1.15	0.83	0.96	4.61	4.82	2.94	1.98	1.80	16.15	0.84	0.44	0.24	735	134	131
	60	6.29	1.13	0.54	0.91	7.69	4.08	2.45	2.48	2.00	18.70	0.84	0.51	0.25	768	120	160
	90	6.19	1.12	0.51	0.89	6.15	4.08	1.96	2.46	2.20	10.85	0.84	0.53	0.26	700	125	175
	120	6.10	1.18	0.45	0.89	4.61	4.08	1.96	1.81	2.20	14.66	0.84	0.53	0.31	765	113	142
250,000	0	6.24	1.15	0.72	1.15	4.61	4.86	3.56	2.05	1.80	16.88	0.76	0.37	0.21	722	134	144
	30	6.27	1.15	0.55	0.94	4.61	4.82	3.40	2.10	2.40	17.33	0.75	0.55	0.27	667	132	201
	60	6.33	1.13	0.52	0.94	6.15	4.08	3.40	2.39	2.20	18.22	0.76	0.51	0.23	734	125	141
	90	6.40	1.16	0.52	0.97	4.61	4.82	3.40	2.15	2.20	17.18	0.76	0.49	0.22	750	109	141
	120	6.33	1.17	0.47	0.81	7.70	4.01	2.94	2.48	2.60	19.73	0.74	0.56	0.35	755	143	102

soil at harvest in both first and second cropping are shown in Table 2 and 3. The soil pH increased from 5.10 in control to a mean of between 5.13-6.60 in first cropping (Table 2) with various effluent-phosphorus combinations while in the second cropping (Table 3) the soil pH was raised from 5.10 to a mean of between 5.11 and 6.78. The application of effluent-phosphorus combinations in first cropping reduced the 1.32% carbon in control to a mean of between 1.11 and 1.18% (Table 2). The total N was increased from 0.05% in control to a mean of between 0.41 and 0.83% (Table 2). In the second cropping (Table 3) the carbon was reduced further to a mean of between 0.91 and 1.10% (Table 3). The total nitrogen was reduced to a mean value of between 0.38 and 0.71%. The P level was reduced from 4.71 ppm to a mean of between 0.81 and 3.98 ppm (Table 2) in the first cropping and to a mean of between 0.78 and 3.07 ppm in the second cropping (Table 3).

In the first of cropping, monovalent cations such as K and Na were raised from 0.04 and 0.08 in control to a mean value of between 0.61 and 7.70 Cmol kg⁻¹ 1.15 and 4.05 cmol kg⁻¹, respectively whereas the divalent cations such as Ca and Mg were increased from 0.01 and 1.39 cmol kg⁻¹ to a mean value of between 3.01 and 6.41 cmol kg⁻¹ and 1.96 and 4.91 cmol kg⁻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 1.60 and 3.20 cmol kg⁻¹ and 9.05 and 23.17 cmol kg⁻¹, respectively (Table 2). The K and Na monovalent cations and Ca and Mg divalent cations were further reduced in the second cropping (Table 3) to a mean value of between 0.48 and 5.12 cmol kg⁻¹, 0.84 and 1.98 cmol kg⁻¹, 2.19 and 4.72 cmol kg⁻¹ and 0.96 and 2.58 cmol kg⁻¹, respectively. The exchangeable acidity and effective cation exchange capacity were reduced to mean value of between 0.08 and 2.91 cmol kg⁻¹ and 6.94 and 20.59 cmol kg⁻¹, respectively (Table 3). In the first cropping (Table 2), trace elements such as zinc, iron and manganese were raised from 0.65 and 0.01, 0.05 ppm, in control to a mean of between 0.58, 1.03 ppm and 0.16 and 0.59 ppm, 0.12 and 0.36 ppm respectively whereas in the second cropping (Table 3), zinc was further decreased to

Table 3: Physico-chemical analysis of polluted and unpolluted soil after harvesting of maize in second cropping

Rubber effluent (L ha^{-1})	SSP (kg ha^{-1})	pH (1:1H$_2$o)	C (%)	N (%)	P (ppm)	K (cmol kg^{-1})	Ca	Mg	Na	Exch acidity	ECEC	Zn (ppm)	Fe	Mn	Sand (g kg^{-1})	Silt	Clay
0	0	5.11	1.01	0.63	1.18	0.48	2.19	1.84	0.84	1.59	6.94	0.40	0.22	0.14	723	136	141
	30	5.42	1.02	0.55	2.98	3.73	4.72	2.58	0.96	1.98	13.97	0.41	0.34	0.17	724	174	102
	60	5.39	1.03	0.60	3.05	3.68	3.97	2.64	1.85	2.00	14.14	0.41	0.37	0.17	764	113	123
	90	5.30	0.96	0.53	3.07	3.82	3.00	2.01	1.76	2.19	12.78	0.42	0.43	0.19	718	121	161
	120	5.30	1.10	0.53	3.10	3.84	2.72	1.96	1.84	2.18	12.54	0.42	0.45	0.19	743	97	160
50,000	0	5.19	1.01	0.70	1.92	3.64	4.00	2.48	1.98	1.98	14.61	0.52	0.29	0.15	752	112	136
	30	5.64	1.05	0.68	1.94	3.65	3.97	1.96	1.87	1.99	13.44	0.53	0.36	0.17	741	115	144
	60	5.78	1.06	0.67	1.83	2.50	3.41	1.93	1.85	2.10	11.79	0.54	0.37	0.17	757	111	132
	90	5.52	1.10	0.50	1.83	2.46	2.68	1.97	1.92	2.21	11.24	0.54	0.39	0.18	750	117	133
	120	5.27	1.07	0.50	1.89	3.67	2.74	1.98	1.97	2.01	12.37	0.54	0.43	0.21	751	120	129
100,000	0	5.82	0.96	0.50	0.90	3.22	3.18	2.48	1.01	1.99	11.88	0.50	0.34	0.17	751	113	136
	30	5.38	0.98	0.49	2.90	4.59	4.59	2.51	1.21	2.41	15.31	0.51	0.41	0.18	742	119	139
	60	5.19	1.07	0.45	2.82	3.20	3.00	1.56	1.21	2.41	11.29	0.51	0.46	0.21	762	121	117
	90	5.16	1.03	0.43	2.76	3.18	3.01	1.52	1.00	2.81	11.52	0.51	0.47	0.18	738	130	132
	120	5.03	1.07	0.42	2.80	4.63	4.54	1.86	1.17	2.91	15.11	0.52	0.49	0.21	750	124	126
150,000	0	6.78	0.96	0.56	0.85	3.78	3.00	2.31	0.98	1.61	11.68	0.56	0.36	0.11	755	112	133
	30	6.39	0.94	0.49	0.96	5.00	3.11	1.11	1.20	1.80	12.22	0.60	0.41	0.14	751	120	129
	60	6.26	0.95	0.39	0.95	5.10	3.12	1.09	1.85	2.42	13.58	0.61	0.45	0.14	751	117	132
	90	6.64	0.95	0.38	0.96	5.12	3.00	1.10	1.86	1.90	12.98	0.61	0.41	0.15	753	119	128
	120	6.22	0.95	0.38	0.96	5.08	3.12	1.08	1.56	2.38	13.22	0.60	0.44	0.26	758	121	121
200,000	0	6.25	0.91	0.71	0.96	2.64	3.48	2.54	1.86	1.61	12.13	0.47	0.26	0.18	753	121	126
	30	6.00	0.92	0.50	0.95	2.81	3.13	2.08	1.01	1.92	10.95	0.47	0.37	0.22	760	131	109
	60	6.01	0.91	0.46	0.80	4.30	3.00	2.09	1.22	2.10	12.71	0.48	0.42	0.19	767	130	113
	90	6.02	0.91	0.44	0.80	3.19	3.07	1.08	1.22	2.20	10.76	0.48	0.43	0.19	758	132	110
	120	6.10	0.92	0.40	0.80	2.99	3.00	1.11	0.98	2.19	10.27	0.48	0.44	0.31	766	131	103
250,000	0	6.31	0.92	0.63	0.96	2.43	3.51	2.15	1.87	1.80	11.76	0.41	0.29	0.17	748	129	123
	30	6.37	0.92	0.46	0.90	2.51	3.42	2.32	1.87	2.41	12.53	0.41	0.45	0.21	758	128	114
	60	6.40	0.92	0.46	0.87	3.62	3.40	2.30	1.88	2.21	13.41	0.42	0.41	0.18	756	124	120
	90	6.44	0.93	0.46	0.85	2.35	3.21	2.41	1.89	2.23	12.09	0.42	0.40	0.18	755	119	126
	120	6.41	0.94	0.40	0.78	4.00	3.26	2.10	1.91	2.61	13.88	0.42	0.45	0.17	757	126	117

a mean value of between 0.40 and 0.16 ppm. Iron was reduced to a mean value of between 0.13 and 0.40 ppm while manganese had a mean of between 0.11 and 0.31 ppm. In both first and second cropping, it was however observed that soil texture was not affected by the various rubber effluents phosphorus combination as well as control (Table 2 and 3).

Nutrients content of maize plants treated in first and second cropping: The nutrient content of the maize plant in first and second cropping are shown in Table 4 and 5. The analyses revealed in the first cropping (Table 4) that N, P, Na, Ca, Mg, K, Al, Fe, Mn and Zn had mean value of between 1.64 and 2.45%, 0.078 and 0.136%, 0.032 and 0.040%, 0.058 and 0.116%, 0.069 and 0.631%, 1.039 and 1.631%, 121 and 207 mg kg^{-1}, 54 and 72 mg kg^{-1}, 49 and 57 mg kg^{-1}, 38 and 44 mg kg^{-1}, respectively whereas in the second cropping (Table 5) the mean nutrient content were between 1.40 and 2.25% for N, 0.075 and 0.098% for P, 0.030 and 0.034% for Na, 0.052 and 0.105% for Ca, 0.060 and 0.232% for Mg, 0.98 and 1.298% for K, 101 and 143 mg kg^{-1} for Al, 40 and 64 mg kg^{-1} for Fe, 40 and 46 mg kg^{-1} for Mn, 34 and 39 mg kg^{-1} for Zn.

The N and P content however increased from control up to 150,000 L ha^{-1} for various SSP combinations and then declined at 200,000 L ha^{-1}-phosphorus combinations at first cropping (Table 4) and second cropping (Table 5). In the case of Ca, Mg, K, Na, Mn, Zn, Al and Fe, there were no consistency in the mean values of the nutrient content in both first (Table 4) and second (Table 5) cropping. Generally, the mean values of nutrient content obtained in the first cropping (Table 4) were higher than those of second cropping (Table 5) in the various levels of effluent-SSP combinations.

Nutrient uptake by maize plant in first and second cropping: The nutrient uptake by maize in both first and second cropping as influenced by effluent and phosphorus combination are presented in Table 6 and 7. The data for N and P uptake in first cropping (Table 6) indicated that there were progressive increase from control concentration-phosphorus combinations up to 150,000 L ha^{-1}-SSP combination and decline gradually. The N mean value was between 364.14 and 1,105.93 mg/plant whereas P mean value was between 17.33 and 61.87 mg/plant. There was no consistency in the

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

Rubber effluent (L ha⁻¹)	SSP (kg h⁻¹)	N	P	Ca	Na	Mg	K	Al	Fe	Mn	Zn
		(%)						(mg kg⁻¹)			
0	0	1.64	0.078	0.036	0.058	0.195	1.407	153	66	50	40
	30	1.63	0.097	0.038	0.063	0.196	1.427	154	67	51	41
	60	1.65	0.098	0.038	0.062	0.196	1.428	153	68	50	42
	90	1.66	0.098	0.039	0.063	0.197	1.428	154	67	50	42
	120	1.68	0.100	0.039	0.064	0.198	1.429	154	68	51	42
50,000	0	2.21	0.100	0.037	0.088	0.253	1.272	149	71	52	43
	30	2.20	0.101	0.038	0.089	0.255	1.278	149	72	52	44
	60	2.22	0.105	0.038	0.090	0.254	1.279	148	70	51	43
	90	2.23	0.106	0.039	0.089	0.255	1.279	148	71	53	44
	120	2.21	0.108	0.039	0.088	0.256	1.278	150	71	52	44
100,000	0	2.25	0.102	0.038	0.077	0.142	1.629	137	69	50	41
	30	2.27	0.103	0.039	0.078	0.144	1.630	137	68	52	41
	60	2.28	0.104	0.039	0.078	0.145	1.631	138	68	52	42
	90	2.26	0.105	0.039	0.079	0.145	1.630	137	69	52	42
	120	2.25	0.106	0.039	0.080	0.145	1.631	138	68	52	42
150,000	0	2.26	0.115	0.038	0.105	0.069	1.572	124	55	51	42
	30	2.45	0.136	0.040	0.115	0.099	1.578	125	54	52	42
	60	2.32	0.132	0.040	0.109	0.097	1.579	125	55	52	42
	90	2.29	0.131	0.039	0.107	0.097	1.577	124	56	50	43
	120	2.30	0.131	0.039	0.107	0.096	1.576	125	54	52	42
200,000	0	2.07	0.111	0.035	0.114	0.105	1.039	122	58	50	39
	30	2.08	0.115	0.036	0.115	0.102	0.240	122	58	49	39
	60	2.09	0.115	0.036	0.115	0.106	1.242	121	59	50	38
	90	1.98	0.117	0.036	0.116	0.107	1.247	122	57	57	40
	120	1.99	0.118	0.035	0.115	0.107	1.246	121	57	51	40
250,000	0	1.79	0.105	0.034	0.076	0.629	1.045	207	69	54	41
	30	1.78	0.106	0.034	0.078	0.629	1.049	203	67	53	40
	60	1.80	0.106	0.034	0.079	0.630	1.049	203	65	52	40
	90	1.80	0.105	0.034	0.078	0.630	1.048	204	65	52	40
	120	1.81	0.106	0.034	0.078	0.631	1.049	205	66	53	40

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

Rubber effluent (L ha⁻¹)	SSP (kg ha⁻¹)	N	P	Ca	Na	Mg	K	Al	Fe	Mn	Zn
		(%)						(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
50,000	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
10,0000	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
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})	SSP (kg ha^{-1})	N (mg plant)	P	Ca	Na	Mg	K	Al	Fe	Mn	Zn
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

Ca, Na K, Al, Mn and Zn uptake in various effluents-SSP combinations in first cropping (Table 6). Ca uptake however had a mean value of between 12.88 and 51.91 mg/plant, Na had between 7.79 and 18.05 mg/plant, Fe had a mean value between 0.132 and 0.243 mg/plant, Mn had a mean value between 0.111 and 0.234 mg/plant and Zn had a mean value between 0.081 and 0.189 mg/plant, Mg had a mean value between 17.94 and 162.04 mg/plant, K had a mean value between 25.38 and 712.30 mg/plant and Al had a mean value between 0.29 and 0.56 mg/plant in the first cropping (Table 6).

In the second cropping (Table 7), N, P uptake also increased from 0 L ha^{-1} effluent-SSP combination up to 150,000 L ha^{-1} (30, 60, 90, 120 kg ha^{-1} SSP) combination. The mean values of N and P uptake were between 233.56 and 683 mg/plant and 12.16 and 30.06 mg/plant respectively. The Na uptake by maize plant exhibited an increase as from 0 L ha^{-1}. Effluent-SSP combination up to 150,000 L ha^{-1}-SSP combination then declined at 200,000 L ha^{-1}-SSP combinations. The Na mean uptake by maize plant was between 4.86 and 9.71 mg/plant. In the case of Ca, there was an increase in uptake as from 0 L ha^{-1} effluent -SSP combination up to 50,000 L ha^{-1} effluent-SSP combinations. Thereafter, an increase at 150,000 L ha^{-1} effluent-SSP combination was recorded

and then decreased again as from 200,000 L ha^{-1}-SSP combinations. The mean value of Ca uptake was between 8.00 and 31.88 mg/plant. The Mg uptake exhibited a progressive increase from 0 L ha^{-1} effluent-SSP combination up to 50,000 L ha^{-1} effluent-SSP combinations and then declined inconsistently up to 100,000 L ha^{-1} effluent-SSP combination and was raised again at 250,000 L ha^{-1} effluent-SSP combination. In the second cropping (Table 7), the N,P,K uptake increased up to 150,00 L ha^{-1}-various SSP combinations and then decreased at 200,000 L ha^{-1}-various SSP combination whereas Na, Ca, Mg, Al, Fe Mn and Zn uptake were generally not consistent with various effluent-SSP combination.

Vegetative growth: The vegetative growth parameters measured in first and second cropping were plant height, leaf area, collar girth and number of leaves are shown in Table 8-11, respectively. The results revealed that at 2 WAS the various effluent-SSP combinations including the control were not significantly different from one another in the first and second cropping. As from 4 WAS till 8 WAS the plant height (Table 8), leaf area (Table 9) and collar girth (Table 10) increased progressively from control up to 150,000 L ha^{-1}(30 kg ha^{-1} SSP) combination

but declined at treatment combination of 150,000 L ha^{-1} (60 kg ha^{-1} SSP) in both the first and second cropping. The decline however was not a sharp one but gradual. The treatment combination of 150,000 L ha^{-1} (30 kg ha^{-1} SSP) was significantly (p<0.05) better than other treatments in plant height (Table 8) from 4 WAS till 8 WAS in first cropping. At 4 WAS in the second cropping treatment 150,000 L ha^{-1} (30 kg ha^{-1} SSP) was not significantly different from treatment combinations of 150,000 L ha^{-1} (60, 90 kg ha^{-1} SSP), 200,000 L ha^{-1} (120 kg ha^{-1} SSP), 250,000 L ha^{-1}(30, 60, 90 kg ha^{-1} SSP) for plant heights.

Also at 6 WAS in the second cropping, plant height (Table 8) was not significantly different from one another at the following treatment combinations of 150,000 L ha^{-1}(30, 60, 90, 120 kg ha^{-1} SSP). Also plant height at 8 WAS in the second cropping (Table 8), the following effluent-SSP combination of 150,000L ha^{-1} (30, 60, 90, 120 kg ha^{-1} SSP)were not significantly different from one another. The leaf area (Table 9) at 4 and 6 WAS in both first and second cropping as well as 8 WAS in the first cropping, the treatment combination 150,000L ha^{-1} (30 kg ha^{-1} SSP) was significantly (p<0.05) better than other treatment combination including control. At 8 WAS the treatment combination of 150,000 L ha^{-1} (30, 60, 90, 120 kg ha^{-1} SSP) were not significantly different from one another (Table 9) in the second cropping. The collar girth (Table 10) was also significantly greater at

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

Rubber effluent (L ha^{-1})	SSP (kg ha^{-1})	N (mg plant)	P	Na	Ca	Mg	K	Al	Fe	Mn	n
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
100,000	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
150,000	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
200,000	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
250,000	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 plant height (cm) of maize plant in first and second cropping of experiment 2

Rubber effluent (L ha^{-1})	SSP (kg ha^{-1})	2 Wap 1st cropping	2 Wap 2nd cropping	4 Wap 1st cropping	4 Wap 2nd cropping	6 Wap 1st cropping	6 Wap 2nd cropping	8 Wap 1st cropping	8 Wap 2nd cropping
0	0	11.24[a]	8.74[a]	21.53[c]	13.16[c]	38.53[e]	23.38[c]	52.78[d]	39.70[d]
	30	13.01[a]	9.43[a]	22.50[c]	15.13[c]	39.60[e]	23.88[c]	55.77[d]	42.94[c]
	60	12.86[a]	9.33[a]	21.75[c]	13.77[c]	38.73[e]	23.56[c]	54.18[d]	44.05[c]
	90	12.00[a]	9.31[a]	25.65[c]	14.56[c]	39.50[e]	24.51[c]	54.82[d]	44.73[c]
	120	12.00[a]	9.30[a]	23.63[c]	15.93[c]	40.00[e]	24.21[c]	55.05[d]	45.70[c]
50,000	0	11.46[a]	8.80[a]	23.48[c]	15.40[c]	37.85[e]	24.41[c]	53.83[d]	40.96[d]
	30	12.33[a]	10.10[a]	25.45[c]	18.26[b]	46.63[d]	26.01[c]	59.59[d]	43.37[c]
	60	12.63[a]	10.03[a]	25.25[c]	18.23[b]	41.94[de]	26.35[c]	59.23[d]	44.27[c]

Table 8: Continued

Rubber effluent (L ha⁻¹)	SSP (kg ha⁻¹)	2 Wap		4 Wap		6 Wap		8 Wap	
		1st cropping	2nd cropping	1st cropping	2nd cropping	1st cropping	2nd cropping	1st cropping	2nd cropping
	90	12.00ᵃ	10.58ᵃ	27.78ᶜ	18.90ᵇ	44.41ᵈ	27.10ᶜ	61.15ᵈ	45.11ᶜ
	120	12.57ᵃ	10.00ᵃ	27.06ᶜ	19.20ᵇ	44.03ᵈ	27.52ᶜ	60.74ᵈ	46.34ᶜ
100,000	0	12.93ᵃ	9.23ᵃ	25.07ᶜ	20.13ᵇ	45.53ᵈ	24.92ᶜ	61.73ᵈ	44.34ᶜ
	30	12.50ᵃ	9.40ᵃ	26.72ᶜ	20.20ᵇ	47.35ᵈ	26.73ᶜ	65.76ᶜ	47.08ᶜ
	60	12.50ᵃ	9.66ᵃ	26.54ᶜ	21.26ᵇ	46.93ᵈ	28.03ᶜ	64.70ᶜ	47.40ᶜ
	90	12.13ᵃ	9.66ᵃ	26.6ᶜ	20.96ᵇ	46.51ᵈ	27.73ᶜ	65.66ᶜ	48.00ᶜ
	120	12.11ᵃ	9.56ᵃ	26.65ᶜ	21.00ᵇ	46.49ᵈ	27.38ᶜ	64.80ᶜ	48.71ᶜ
150,000	0	12.00ᵃ	9.08ᵃ	30.73ᵇ	22.20ᵇ	58.38ᶜ	27.01ᶜ	72.76ᶜ	51.07ᵇᶜ
	30	12.66ᵃ	9.00ᵃ	47.58ᵃᵇ	29.30ᵃ	78.88ᵃ	43.02ᵃ	96.93ᵃ	64.81ᵃ
	60	12.13ᵃ	9.36ᵃ	34.67ᵇ	25.66ᵃ	67.16ᵇ	41.70ᵃ	83.76ᵇ	59.33ᵃ
	90	12.56ᵃ	9.60ᵃ	35.10ᵇ	24.36ᵃ	65.18ᵇ	41.74ᵃ	85.30ᵇ	59.72ᵃ
	120	12.93ᵃ	9.30ᵃ	35.64ᵇ	25.66ᵃ	66.48ᵇ	42.40ᵃ	85.88ᵇ	59.71ᵃ
200,000	0	12.97ᵃ	9.53ᵃ	34.68ᵇ	22.44ᵇ	55.47ᶜ	27.20ᶜ	65.36ᵈ	52.18ᵇᶜ
	30	12.06ᵃ	9.30ᵃ	36.09ᵇ	23.33ᵇ	60.76ᶜ	31.33ᶜ	72.78ᶜ	53.82ᵇᶜ
	60	12.00ᵃ	9.43ᵃ	34.78ᵇ	23.26ᵇ	58.55ᶜ	34.27ᶜ	70.73ᶜ	54.17ᵇᶜ
	90	12.00ᵃ	9.53ᵃ	34.26ᵇ	23.56ᵇ	58.70ᶜ	35.40ᶜ	70.78ᶜ	54.25ᵇᶜ
	120	12.00ᵃ	9.70ᵃ	33.88ᵇ	24.00ᵇ	58.77ᶜ	35.26ᶜ	70.80ᶜ	54.59ᵇᶜ
250,000	0	12.47ᵃ	9.70ᵃ	34.28ᵇ	25.40ᵃ	51.93ᶜ	28.63ᶜ	61.56ᵈ	49.67ᶜ
	30	12.23ᵃ	9.56ᵃ	33.50ᵇ	26.06ᵃ	57.33ᶜ	30.03ᶜ	68.63ᶜ	54.33ᵇᶜ
	60	12.40ᵃ	9.50ᵃ	32.33ᵇ	25.40ᵃ	57.82ᶜ	30.70ᶜ	68.86ᶜ	53.01ᵇᶜ
	90	12.33ᵃ	9.78ᵃ	32.33ᵇ	24.74ᵃ	57.59ᶜ	31.80ᶜ	69.48ᶜ	53.45ᵇᶜ
	120	12.10ᵃ	9.72 ᵃ	33.23ᵇ	25.41ᵃ	57.76ᶜ	32.41ᶜ	68.75ᶜ	54.74

[b-e]Means followed by the same letter(s) in the column are not significantly different from one another at 5% level of probability. WAP =Weeks After Planting. SSP = Single Super Phosphate

Table 9: Effect of Rubber effluent and phosphorus on the leaf area (cm²) of the maize plant in first and second cropping

Rubber effluent (L ha⁻¹)	SSP (kg ha⁻¹)	2 Wap		4 Wap		6 Wap		8 Wap	
		1st cropping	2nd cropping	1st cropping	2nd cropping	1st cropping	2nd cropping	1st cropping	2nd cropping
0	0	11.06ᵃ	8.45ᵃ	43.27ᵍ	45.07ᵈ	56.45ᵍ	53.32ᵍ	88.57ᶠ	61.15ᶠ
	30	11.00ᵃ	8.54ᵃ	63.93ᶠ	45.68ᵈ	71.97ᶠ	55.32ᵍ	90.88ᶠ	71.52ᵉ
	60	11.10ᵃ	8.53ᵃ	63.01ᶠ	46.60ᵈ	71.26ᶠ	56.00ᵍ	92.21ᶠ	72.54ᵉ
	90	10.70ᵃ	8.52ᵃ	63.46ᶠ	45.96ᵈ.	71.50ᶠ	56.16ᵍ	92.25ᶠ	72.17ᵉ
	120	10.42ᵃ	8.52ᵃ	64.86ᶠ	46.46ᵈ	72.45ᶠ	56.15ᵍ	92.98ᶠ	72.48ᵉ
50,000	0	11.43ᵃ	8.43ᵃ	55.53ᵍ	50.52ᵈ	64.33ᶠ	63.18ᶠ	90.53ᶠ	70.75ᵉ
	30	12.25ᵃ	9.51ᵃ	75.43ᵉ	50.35ᵈ	86.40ᵈ	68.22ᶠ	97.76ᵉ	76.51ᵉ
	60	11.90ᵃ	9.48ᵃ	81.04ᵉ	51.38ᵈ	91.01ᵈ	71.04ᵉ	102.36ᵉ	82.99ᵈᵉ
	90	11.73ᵃ	9.49ᵃ	81.34ᵉ	50.93ᵈ	92.03ᵈ	71.51ᵉ	102.79ᵉ	83.46ᵈᵉ
	120	11.82ᵃ	9.49ᵃ	80.95ᵉ	51.40ᵈ	92.90ᵈ	71.54ᵉ	101.69ᵉ	83.58ᵈᵉ
100,000	0	11.13ᵃ	9.09ᵃ	63.13ᶠ	50,36ᵈ	71.92ᶠ	63.77ᶠ	99.93ᵉ	77.78ᵉ
	30	11.22ᵃ	9.02ᵃ	96.19ᶜ	63.54ᶜ	104.68ᶜ	86.62ᵈ	115.01ᵈ	91.32ᵈ
	60	11.21ᵃ	9.10ᵃ	95.19ᶜ	63.82ᶜ	109.68ᶜ	92.42ᵈ	116.83ᵈ	93.85ᵈ
	90	11.29ᵃ	9.10ᵃ	95.94ᶜ	66.45ᶜ	109.98ᶜ	93.02ᵈ	121.03ᵈ	96.59ᵈ
	120	11.41ᵃ	9.10ᵃ	94.69ᶜ	63.80ᶜ	106.63ᶜ	92.99ᵈ	119.03ᵈ	96.03ᵈ
150,000	0	11.48ᵃ	9.63	81.49ᵉ	55.61ᵈ	91.83ᵈ	76.63ᵉ	145.95ᶜ	90.66ᵈ
	30	11.86ᵃ	9.68	132.56ᵃ	92.87ᵃ	172.05a	143.84a	188.52a	151.73a
	60	11.00ᵃ	9.74ᵃ	123.02ᵇ	80.46ᵇ	148.13ᵇ	110.97ᵇ	11.46ᵃ	149.67ᵃ
	90	11.28ᵃ	9.74ᵃ	101.22ᶜ	81.19ᵇ	147.11ᵇ	112.61ᵇ	11.86ᵃ	149.68ᵃ
	120	10.85ᵃ	9.76ᵃ	103.16ᶜ	80.65ᵇ	147.51ᵇ	117.48ᵇ	152.52ᵇ	148.79ᵃ
200,000	0	10.20ᵃ	9.11ᵃ	76.20ᶠ	50.14ᵈ	86.16ᵈ	77.74ᵉ	140.28ᶜ	86.99ᵈ
	30	10.40ᵃ	9.11ᵃ	80.52ᵉ	63.01ᶜ	144.45ᵇ	109.65ᵇ	147.10ᶜ	115.83ᶜ
	60	10.00ᵃ	9.12ᵃ	81.51ᵉ	65.27ᶜ	145.73ᵇ	109.62ᵇ	148.78ᶜ	117.46ᶜ
	90	10.34ᵃ	9.15ᵃ	81.57ᵉ	64.65ᶜ	145.46ᵇ	109.95ᵇ	148.73ᶜ	117.86ᶜ
	120	10.08ᵃ	9.16ᵃ	82.27ᵉ	64.71c	146.01ᵇ	110.65ᵇ	148.76ᶜ	119.55ᶜ
250,000	0	10.09ᵃ	8.10ᵃ	75.57ᵉ	50.60ᵈ	85.36ᵈ	75.48ᵉ	140.71ᶜ	86.90ᵈ
	30	10.40ᵃ	8.46ᵃ	77.28ᵉ	55.65ᵈ	144.18ᵇ	100.31ᶜ	145.68ᶜ	111.57ᶜ
	60	10.26ᵃ	8.14ᵃ	79.28ᵉ	55.16ᵈ	144.76ᵇ	100.63ᶜ	148.06ᶜ	111.67ᶜ
	90	10.43ᵃ	8.48ᵃ	80.13ᵉ	55.49ᵈ	145.18ᵇ	101.86ᶜ	149.83ᶜ	111.72ᶜ
	120	10.17ᵃ	8.48ᵃ	81.06ᵉ	55.51ᵈ	146.33ᵇ	102.23ᶜ	149.83ᶜ	111.66

[c]Means followed the same letter(s) in the column are not significantly different from one another at 5% level of probability WAP = Weeks After Planting. SSP = Single Super Phosphate

Table 10: Effect of rubber effluent and phosphorus on the collar girth (cm) of the maize plant first and second cropping

Rubber effluent (L ha⁻¹)	SSP (kg ha⁻¹)	2 Wap 1st cropping	2 Wap 2nd cropping	4 Wap 1st cropping	4 Wap 2nd cropping	6 Wap 1st cropping	6 Wap 2nd cropping	8 Wap 1st cropping	8 Wap 2nd cropping
0	0	0.44ᵃ	0.40ᵃ	0.51ᵉ	0.40ᵈ	0.72ᵈ	0.58ᵈ	1.65ᶜ	1.21ᵈ
	30	0.49ᵃ	0.42ᵃ	0.55ᵉ	0.46ᵈ	0.76ᵈ	0.60ᵈ	1.83ᶜ	1.24ᵈ
	60	0.50ᵃ	0.42ᵃ	0.61ᵉ	0.51ᵈ	0.83ᶜ	0.67ᵈ	1.86ᶜ	1.26ᵈ
	90	0.50ᵃ	0.44ᵃ	0.61ᵉ	0.52ᵈ	0.84ᶜ	0.68ᵈ	1.85ᶜ	1.28ᵈ
	120	0.53ᵃ	0.41ᵃ	0.62ᵉ	0.52ᵈ	0.84ᶜ	0.68ᵈ	1.85ᶜ	1.27ᵈ
50,000	0	0.51ᵃ	0.41ᵃ	0.61ᵉ	0.44ᵈ	0.91ᶜ	0.70ᵈ	1.90ᶜ	1.26ᵈ
	30	0.55ᵃ	0.42ᵃ	0.62ᵉ	0.50ᵈ	0.92ᶜ	0.72ᵈ	1.93ᶜ	1.28ᵈ
	60	0.54ᵃ	0.42ᵃ	0.63ᵉ	0.54ᵈ	0.95ᶜ	0.80ᵈ	1.97ᶜ	1.29ᵈ
	90	0.56ᵃ	0.43ᵃ	0.67ᵉ	0.55ᵈ	0.97ᶜ	0.82ᶜ	1.96ᶜ	1.30ᵈ
	120	0.56ᵃ	0.43ᵃ	0.69ᵉ	0.60ᵈ	0.98ᶜ	0.82ᶜ	1.99ᶜ	1.31ᵈ
100,000	0	0.49ᵃ	0.40ᵃ	0.88ᵈ	0.60ᵈ	1.17ᶜ	0.89ᶜ	2.08ᵇ	1.56ᶜ
	30	0.50ᵃ	0.40ᵃ	1.00ᶜ	0.69ᶜ	1.29ᶜ	0.92ᶜ	2.28ᵇ	1.69ᶜ
	60	0.49ᵃ	0.40ᵃ	1.14ᶜ	0.74ᶜ	1.52ᵇ	0.96ᶜ	2.36ᵇ	1.70ᶜ
	90	0.49ᵃ	0.40ᵃ	1.14ᶜ	0.74ᶜ	1.51ᵇ	0.95ᶜ	2.37ᵇ	1.70ᶜ
	120	0.49ᵃ	0.40ᵃ	0.92ᶜ	0.74ᶜ	1.32ᶜ	0.96ᶜ	2.38ᵇ	1.70ᶜ
150,000	0	0.51ᵃ	0.43ᵃ	1.10ᶜ	0.78ᶜ	1.24ᶜ	0.97ᶜ	2.66ᵇ	2.64ᵃ
	30	0.52ᵃ	0.41ᵃ	2.21ᵃ	1.34ᵃ	2.50ᵃ	1.79ᵃ	3.99ᵃ	2.98ᵃ
	60	0.52ᵃ	0.42ᵃ	1.60ᵇ	1.20ᵇ	1.86ᵇ	1.42ᵃ	3.17ᵃ	2.70ᵃ
	90	0.52ᵃ	0.43ᵃ	1.57ᵇ	1.23ᵇ	1.65ᵇ	1.42ᵃ	3.18ᵃ	2.70ᵃ
	0120	0.50ᵃ	0.41ᵃ	1.53ᵇ	1.30ᵃ	1.57ᵇ	1.43ᵃ	3.17ᵃ	2.70ᵃ
200,000	0	0.50ᵃ	0.42ᵃ	0.82ᵈ	0.70ᶜ	1.23ᶜ	1.00ᶜ	2.48ᵇ	1.60ᵇ
	30	0.50ᵃ	0.42ᵃ	0.85ᵈ	0.71ᶜ	1.37ᶜ	1.16ᵇ	2.57ᵇ	1.97ᵇ
	60	0.49ᵃ	0.42ᵃ	0.90ᶜ	0.74ᶜ	1.46ᶜ	1.19ᵇ	2.48ᵇ	1.97ᵇ
	90	0.51ᵃ	0.41ᵃ	0.97ᶜ	0.78ᶜ	1.47ᶜ	1.17ᵇ	2.49ᵇ	1.97ᵇ
	120	0.51ᵃ	0.43ᵃ	0.99ᶜ	0.78ᶜ	1.49ᶜ	1.20ᵇ	2.49ᵇ	1.98ᵇ
250,000	0	0.50ᵃ	0.41ᵃ	0.83ᵈ	0.72ᶜ	1.25ᶜ	1.03ᶜ	2.40ᵇ	1.58ᵈ
	30	0.50ᵃ	0.42ᵃ	0.89ᵈ	0.75ᶜ	1.30ᶜ	1.14ᵇ	2.45ᵇ	1.84ᵇ
	60	0.51ᵃ	0.41ᵃ	0.98ᶜ	0.76ᶜ	1.34ᶜ	1.13ᵇ	2.44ᵇ	1.85ᵇ
	90	0.51ᵃ	0.42ᵃ	0.98ᶜ	0.79ᶜ	1.35ᶜ	1.17ᵇ	2.47ᵇ	1.86ᵇ
	120	0.51ᵃ	0.42ᵃ	1.11ᶜ	0.86ᶜ	1.34ᶜ	1.18ᵇ	2.47ᵇ	1.86

ᵇMeans followed the same letter in the column are not significantly different from one another at 5% level of probabilit WAP = Weeks After Planting. SSP = Single Super Phosphate

Table 11: Effect of rubber effluent and phosphorus on number of leaves of the maize plant in first and second cropping

Rubber effluent (L ha⁻¹)	SSP (kg ha⁻¹)	2 Wap 1st cropping	2 Wap 2nd cropping	4 Wap 1st cropping	4 Wap 2nd cropping	6 Wap 1st cropping	6 Wap 2nd cropping	8 Wap 1st cropping	8 Wap 2nd cropping
0	0	3.66ᵃ	3.33ᵃ	6.00ᵃ	5.00ᵃ	6.00ᵃ	6.00ᵃ	7.33ᵃ	6.66ᵃ
	30	3.66ᵃ	3.33ᵃ	6.00ᵃ	5.00ᵃ	6.66ᵃ	6.00ᵃ	8.00ᵃ	7.00ᵃ
	60	3.66ᵃ	3.33ᵃ	6.00ᵃ	5.33ᵃ	7.00ᵃ	6.00ᵃ	8.00ᵃ	7.00ᵃ
	90	3.33ᵃ	3.00ᵃ	6.00ᵃ	5.33ᵃ	7.00ᵃ	6.00ᵃ	8.00ᵃ	7.00ᵃ
	120	3.33ᵃ	3.00ᵃ	6.66ᵃ	5.33ᵃ	7.00ᵃ	6.33ᵃ	8.00ᵃ	7.00ᵃ
50,000	0	3.33ᵃ	3.00ᵃ	6.33ᵃ	5.00ᵃ	6.00ᵃ	6.00ᵃ	7.33ᵃ	7.66ᵃ
	30	3.66ᵃ	3.33ᵃ	6.33ᵃ	5.33ᵃ	7.00ᵃ	6.00ᵃ	8.00ᵃ	7.66ᵃ
	60	3.66ᵃ	3.33ᵃ	6.00ᵃ	5.00ᵃ	7.66ᵃ	6.00ᵃ	8.66ᵃ	7.66ᵃ
	90	3.66ᵃ	3.33ᵃ	6.33ᵃ	5.00ᵃ	6.00ᵃ	6.00ᵃ	8.66ᵃ	7.66ᵃ
	120	3.33ᵃ	3.00ᵃ	6.00ᵃ	5.66ᵃ	7.33ᵃ	6.00ᵃ	8.00ᵃ	7.66ᵃ
100,000	0	3.66ᵃ	3.33ᵃ	6.33ᵃ	5.33ᵃ	6.33ᵃ	6.66ᵃ	8.00ᵃ	8.66ᵃ
	30	3.66ᵃ	3.33ᵃ	6.00ᵃ	5.00ᵃ	7.66ᵃ	7.00ᵃ	9.33ᵃ	8.66ᵃ
	60	3.66ᵃ	3.33ᵃ	6.33ᵃ	5.00ᵃ	8.00ᵃ	7.00ᵃ	10.00ᵃ	8.66ᵃ
	90	3.66ᵃ	3.33ᵃ	6.33ᵃ	5.00ᵃ	8.00ᵃ	7.00ᵃ	10.00ᵃ	8.33ᵃ
	120	3.66ᵃ	3.33ᵃ	6.33ᵃ	5.00ᵃ	8.66ᵃ	7.00ᵃ	10.00ᵃ	8.66ᵃ
150,000	0	3.33ᵃ	3.00ᵃ	6.33ᵃ	5.66ᵃ	8.66ᵃ	8.00ᵃ	9.66ᵃ	8.66ᵃ
	30	3.66ᵃ	3.33ᵃ	6.00ᵃ	5.66ᵃ	9 00ᵃ	8.00ᵃ	10.33ᵃ	10.00ᵃ
	60	3.33ᵃ	3.00ᵃ	6.00ᵃ	5.66ᵃ	9.00ᵃ	8.00ᵃ	10.66ᵃ	10.00ᵃ
	90	3.33ᵃ	3.00ᵃ	6.00ᵃ	5.60ᵃ	9.00ᵃ	8.00ᵃ	10.00ᵃ	10.00ᵃ
	120	3.66ᵃ	3.33ᵃ	6.00a	5.66ᵃ	8.66ᵃ	8.00ᵃ	10.00ᵃ	10.00ᵃ
200,000	0	3.00ᵃ	3.00ᵃ	6.33ᵃ	6.00ᵃ	7.66ᵃ	7.66ᵃ	9.66ᵃ	8.66ᵃ
	30	3.00ᵃ	3.00ᵃ	6.33ᵃ	6.00ᵃ	8.66ᵃ	7.66ᵃ	9.66ᵃ	9.00ᵃ
	60	3.33ᵃ	3.00ᵃ	6.33ᵃ	6.00ᵃ	7.66ᵃ	7.00ᵃ	10.00ᵃ	9.00ᵃ
	90	3.33ᵃ	3.00ᵃ	6.00ᵃ	6.33ᵃ	8.00ᵃ	7.66ᵃ	10.00ᵃ	9.00ᵃ

Table 11: Continued

Rubber effluent (L ha^{-1})	SSP (kg ha^{-1})	2 Wap		4 Wap		6 Wap		8 Wap	
		1st cropping	2nd cropping	1st cropping	2nd cropping	1st cropping	2nd cropping	1st cropping	2nd cropping
	120	3.00^a	3.00^a	6.33^a	6.00^a	7.06^a	7.66^a	10.00^a	9.33^a
250,000	0	3.00^a	3.00^a	6.00^a	5.66^a	7.00^a	7.66^a	9.33^a	9.00^a
	30	3.03^a	3.00^a	5.66^a	5.33^a	7.00^a	7.66^a	9.66^a	9.00^a
	60	3.00^a	3.00a	6.66^a	5.33^a	7.66^a	7.33^a	9.60^a	9.00^a
	90	3.00^a	3.00^a	6.66^a	5.33^a	7.66^a	7.00^a	10.00^a	9.00^a
	120	3.66^a	3.33^a	6.33^a	6.00^a	7.66^a	7.33^a	10.00^a	9.00^a

Means followed the same letter(s) in the column are not significantly different from one another at 5% level of probabilit WAP = Weeks After Planting. SSP = Single Super Phosphate

150,000 L ha^{-1} (30 kg ha^{-1} SSP) than other treatment combination including control 4 WAS in the first and second cropping as well as 6 WAS in the first cropping. In the second cropping at 6 WAS treatment combination of 150,000L ha^{-1} (30, 60, 90, 120 kg ha^{-1} SSP) were not significantly different from one another but better than other treatment combinations. In the second cropping at 8 WAS these treatment combinations of 150,000 L ha^{-1} (30, 60, 90, 120 kg ha^{-1} SSP) were not significantly different from one another but better than other treatments. In the number of leaves (Table 11) the various treatment combinations of effluent-SSP combinations including control were not significantly different from one another throughout the period of the trial.

DISCUSSION

The result of effluent analysis (Table 1) when compared with that of Seneviratne (1997) showed that majority of the parameters depends on the source of the effluent. The fact is that most of the effluent whether obtained from the processing of crepe, crumb and concentrate latex contains the basic plant nutrients. The properties of the soil used (Table 2) revealed that the soil is low in fertility which is typical of an Ultisol. This result also agrees with the findings of Agboola and Ogunkule (1993).

The increase in soil pH, N.K, Ca, Mg, Na (Table 2 and 3) is similar to the result of Poon (1982), Lim and P'ng 1983; Lim *et al.* (1983). The increase in the above mentioned nutrient is due to the nutrient status or properties of (serum) of the effluent as well as the phosphorus applied. This further confirms that combining effluent with phosphorus is not problematic especially when the rate of applications is geared to supply nutrient level corresponding to those in inorganic fertilizer normally applied to promote satisfactory crop performance and that controlled application of effluent combined with phosphorus causes no detrimental changes on soil. Rather it improves soil fertility and has no apparent adverse effect in the environment. Also the

gains or beneficial properties of rubber effluent as an excellent soil conditioner makes it to combine very well with phosphorus as a source of nutrients. The decrease in P with 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 (Elrasidi 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 applications 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 decrease percentage carbon is however contrary to the finding of Lim *et al.* (1983) and seneviratne (1997). Although there was 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 increase in nutrient content of maize plants except N and P (Table 4-6) in the trial was 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 applied effluent-SSP combinations should be at the rates corresponding to crop requirements in the effluent-SSP combinations There is generally a relationship between some of the major elements. The supply of one element can increase, decrease or maintain their percentage in dry matter in leaves (Remison, 1997). These effects are described as antagonistic when the leaf nutrient of an element is reduced by the application of another elements and synergetic when application increases the leaf content of an element. These effects tend to influence nutrient uptake and subsequent nutrient content of plant. The increase in N.P.K, Ca and Fe uptake up to 150,000 L ha^{-1} (30 kg ha^{-1} SSP) (Table 6 and 7) showed that the effluent-SSP combinations should be applied at crop requirements. The uptake of other nutrients such as Mg, Na, H, Zn, Mn were however not definite.

Thus variation in nutrient uptake may have been influence 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 Blum, 1997; O'conner and Anderson, 1974). Loos *et al.* (1979) asserted that reduced nutrient uptake in the presence of effluent could occur due to strong adsorption or degradation in the soil and that the extent of adsorption 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 growth (Table 8-11) up to 150,000 L ha^{-1} (30 kg SSP) combination indicated that the effluent and SSP compliment each other and that the optimum growth at 150,00 L ha^{-1} (30 kg SSP) is a matter of crop preference and the depression in height, girth and leaf area as from 150,000 L ha^{-1} effluent and various SSP combinations could be due to effluent and phosphorus interactions with other elements in the soil. It was remarkable however; that the plants with SSP alone had the least biomass and least mean height, collar girth and leaf area while that of effluent-SSP combination supported most luxuriant growth.

CONCLUSIONS

This trial no doubt examined the influence of effluent-SSP on physiological, nutrition implication on maize plant as well as on soil chemical properties of an Ultisol. Analyses of the effluent revealed that it contained both micro and macro nutrient elements. The application of effluent-SSP combination had an effect on plant performances by altering some of the soil chemical components thereby affecting the rate of uptake, synthesis and translocation of vital mineral elements in maize plant. The vegetative growth as well as soil nutrient elements was enhanced at 150,000 L ha^{-1} effluent (30 kg/ha P) combination. However, maize plant that received higher rate of effluent-phosphorus combination greater than 150,000 L ha^{-1} (30 kg ha^{-1} SSP) 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. Therefore it would be proper from the results to conclude that rubber effluent which contains substantial amount of nutrient element could be used as fertilizer supplement and complement thereby saving the use of inorganic fertilizer. The application of effluent-SSP at rates corresponding to maize crop nutrient requirement can significantly improve the maize crop growth without adverse effect on the crop nutritional status. However more trials should be carried out in both the greenhouse and field over a wide range of time and soils to confirm this fertilizer potential of rubber effluent.

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