Natural Rubber Research, 19(1&2): 58-61, 2006

SUBSTITUTION OF POTASSIUM WITH SODIUM AS NUTRIENT FOR THE GROWTH OF RUBBER SEEDLINGS

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Submitted: 22 September 2004   *Accepted: 29 December 2006*

George, E.S., Punnoose, K I. and Karthikakuttyamma, M. (2006). Substitution of potassium with sodium as nutrient for the growth of rubber seedlings. *Natural Rubber Research*, 19 (1&2): 58-61.

A study was conducted in a rubber nursery to find out the effect of substitution of varying levels of potassium (K) with sodium (Na) on the growth and nutrient uptake of rubber seedlings as well as on soil properties. The experiment was repeated for two years at the same site. The stem diameter of seedlings was not influenced by the substitution of K with Na. Application of 50 and 75 kg K/ha along with 25 and 50 kg Na/ha had a positive effect on the K content in stem and root of rubber seedlings. The application of 75 and 100 kg K alone and combination of 50 kg each of K and Na gave higher K uptake over control. For 75 and 50 kg K/ha application, an increase in soil available K status was noted with 25 and 50 kg Na/ha application while available Na, pH and electrical conductivity (EC) remained unaffected.

Key words: *Hevea brasiliensis*, Potassium, Rubber seedlings, Sodium uptake.

INTRODUCTION

Potassium (K) is an important plant nutrient essential for enzyme activation and protein synthesis. It also mediates osmoregulation during cell expansion and stomatal movements. Most of the rubber growing soils have low potassium status due to kaolinitic type of clay mineral and leaching losses. The widely used and cheapest K fertilizer is potassium chloride commercially known as muriate of potash. Whether sodium (Na), a closely related cation, can replace K in the physiological processes in the plant is an important question since common salt, the source of Na, is much cheaper than muriate of potash. Khanna and Balaguru (1981a, b) reported that majority of plants show selectivity for K when supplied with both K and Na and the degree of selectivity differs between species. Smith (1969) and Mathew *et al.*, (1984) reported that Na could replace K for coconut trees. George *et al.*, (2000) reported that substitution of K_2O by Na_2O even to the extent of 75 per cent did not reduce the dry matter production and uptake of K in young rubber plants. This experiment was aimed at studying the effect of substitution of varying levels of potassium with sodium on the growth and nutrient uptake of seedlings in a rubber nursery.

MATERIALS AND METHODS

The trial was conducted at the Central Nursery of Rubber Board, India, at Karikattoor, Pathanamthitta district, Kerala, for two years. The experiment consisted of using different levels of K_2O and Na_2O in completely randomized design with thirteen treatments and three replications. The plot size was 12 x 1.2 m and the number of gross and net plants in a plot were 40 and 16 respectively. The initial physical and chemical properties of soil are given in Table 1.

First set of planting was done at a

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Table 1. **Initial physico-chemical properties of soil**

Property	Quantity
Texture	Sandy clay
Organic carbon (%)	1.11
Av. phosphorus(mg/ 100g)	7.50
Av. potassium "	5.25
Av. sodium "	9.00
Av. calcium "	17.98
Av. magnesium "	5.41
pH	4.62
EC (d S/ m)	0.054

spacing of 30 x 30 cm during September 2000 and budgrafted during May 2001. The second set of planting was done during October 2001 in the same site after uprooting the first set and budgrafted during June 2002.

Treatments were combinations of 4 levels of K and 3 levels of Na and an absolute control with neither K nor Na. Different K levels tried were 100, 75, 50 and 25 per cent of recommended level of K at the rate of 100 kg per ha and the Na levels tried were at the rate of 0, 25 and 50 kg per ha. In addition, a uniform dose of N, P and Mg at the rate of 250, 250 and 37.5 kg per ha respectively as per recommendation for rubber seedling nursery, was applied as first dose after 8 weeks of planting. The second dose of N alone at the rate of 250 kg per ha was applied after 8 weeks of first application of fertilizer. Plant diameter was recorded 5, 7 and 9 months after planting in both years. After completion of the experiment in the second year, one plant each was uprooted from all the 39 plots The leaf, stem and root were separated, dry weights recorded and the total uptake of N, P, K, Na, Ca and Mg worked out by standard methods (Karthikakuttyamma, 1989).The soil samples were collected during June, 2002 after uprooting the plants and various chemical parameters analyzed (Jackson, 1958).

RESULTS AND DISCUSSION

The data on diameter of seedlings recorded 9 months after planting during 2001 and 2002 is given in Table 2. The treatments showed no significant effect on diameter of seedlings recorded in both the years.

Table 2. **Effect of different levels of K and Na on diameter of seedlings**

Treatments (kg/ha)		Diameter (mm) of seedlings	
K_2O	Na_2O	2000-2001	2001-2002
100	0	10.03	12.45
100	25	9.21	12.92
100	50	8.60	11.95
75	0	9.26	12.46
75	25	9.79	12.87
75	50	10.02	13.44
50	0	9.26	12.24
50	25	9.45	11.87
50	50	9.62	12.53
25	0	9.55	12.20
25	25	9.15	12.95
25	50	9.79	10.36
0	0	8.30	10.21
Mean		9.39	12.24
SE		0.64	0.59
CD ($P \leq 0.05$)		NS	NS

K content in different plant parts were influenced by the treatments (Table 3). Application of K increased its concentration in all the plant parts and significant difference in K content was noted between the treatments. In the case of leaf and root K the application of 100 kg K_2O, 75 kg K_2O with 25 and 50 kg Na_2O and 50 kg K_2O with 50 kg Na_2O gave significantly higher K values over control (no K_2O or Na_2O) and no difference was noted between these treatments. In the case of stem K, application of 75 kg per ha K_2O with Na_2O gave significantly higher K content. The above results indicate that at 75 kg per ha level K application, Na application had a positive effect on the uptake of K in stem and root. The data also indicate that Na concentration generally decreased from the roots upwards and leaves

Table 3. **Effect of different levels of K and Na on K content in different plant parts**

Treatment (kg/ ha)		K content (%)		
K_2O	Na_2O	Leaf	Stem	Root
100	0	0.85	0.75	0.66
100	25	0.86	0.75	0.65
100	50	0.89	0.85	0.69
75	0	0.79	0.53	0.56
75	25	0.85	0.82	0.68
75	50	0.87	0.80	0.72
50	0	0.79	0.51	0.56
50	25	0.79	0.53	0.60
50	50	0.85	0.65	0.64
25	0	0.75	0.41	0.56
25	25	0.77	0.47	0.64
25	50	0.77	0.46	0.62
0	0	0.69	0.46	0.52
Mean		0.81	0.61	0.62
SE		0.04	0.06	0.04
CD ($P \leq 0.05$)		0.11	0.19	0.11

retained low Na status which may be due to lower mobility of Na than K in plants (Balaguru and Khanna, 1982).

The data on total dry weights of plants and uptake of nutrients as influenced by various combinations of K and Na are presented in Table 4. The total dry matter production was not influenced by the treatments. The total uptake of N, P, Ca and Mg did not vary significantly by the treatments while the uptake of K and Na differed significantly which shows that the proportion of K or Na applied to the soil does not affect the uptake of other nutrients from the soil. This is in conformity with the findings of Prema *et al.,* (1987).

The total Na uptake increased with increasing level of Na application. The chemical properties of soil samples are given in Table 5. The data indicated that substitution of various levels of K by Na did not affect the organic carbon content, available P, Na and Mg, pH or EC of the soil while a change in available K status was noted. Similar observation was reported by Prema *et al.,* (1987) for coconut soils. Treatments that received higher quantities of K showed higher availability of K in the soil. For 75 and 50 kg K/ha application, an increase in available K status was noted with 25 and 50 kg levels of Na application. No significant difference

Table 4. **Effect of different levels of K and Na on dry matter production and uptake of nutrients**

Treatment (kg/ha)		Total dry matter	Uptake of nutrients (g /seedling)					
K_2O	Na_2O	(g /plant)	N	P	K	Na	Ca	Mg
100	0	221.56	3.75	0.39	1.46	0.048	1.74	0.62
100	25	131.01	2.3	0.23	0.97	0.062	0.98	0.46
100	50	184.86	3.17	0.35	1.2	0.077	1.54	0.57
75	0	190.77	3.32	0.32	1.35	0.065	1.46	0.62
75	25	215.86	3.54	0.37	1.25	0.074	1.76	0.77
75	50	184.51	3.12	0.32	1.12	0.084	1.6	0.51
50	0	145.57	2.61	0.26	0.69	0.049	0.91	0.44
50	25	160.22	2.71	0.3	0.8	0.051	1.38	0.55
50	50	211.67	3.66	0.43	1.33	0.067	1.93	0.73
25	0	134.08	2.31	0.26	0.7	0.047	0.97	0.44
25	25	156.87	2.88	0.26	0.78	0.055	1.25	0.44
25	50	159.14	3.02	0.28	0.74	0.069	1.46	0.53
0	0	112.48	1.82	0.22	0.63	0.042	0.94	0.46
Mean		169.89	2.94	0.31	1	0.061	1.37	0.55
SE		30.56	0.54	0.06	0.22	0.008	0.28	0.118
CD ($P \leq 0.05$)		NS	NS	NS	0.66	0.025	NS	NS

Table 5. **Effect of different levels of K and Na on soil chemical properties**

Treatment (kg/ha)		OC	Available nutrients (mg /100g soil)					pH	EC
K_2O	Na_2O	(%)	P	K	Na	Ca	Mg		
100	0	1.86	1.47	4.42	4.1	4.47	1.04	4.42	0.029
100	25	1.66	1.59	3.92	4.08	6.92	1.29	4.44	0.019
100	50	1.92	1.65	4.42	4.58	6.47	1.16	4.41	0.029
75	0	1.9	1.39	3.25	4.25	12.49	2.26	4.57	0.027
75	25	1.76	1.84	4.58	5.5	13.78	1.7	4.42	0.022
75	50	1.56	1.89	5.42	5.5	5.69	1.11	4.39	0.035
50	0	1.46	1.86	2.92	4.17	8.93	1.57	4.48	0.027
50	25	1.58	1.63	3.83	4.83	13.48	2.2	4.52	0.031
50	50	1.76	1.57	3.5	4.75	7.71	1.44	4.83	0.024
25	0	1.72	1.57	2.92	4.5	6.41	1.82	4.48	0.021
25	25	1.64	1.45	2.93	4.42	6.73	1.62	4.39	0.029
25	50	2.02	1.43	2.75	4.5	8.71	1.36	4.44	0.027
0	0	1.72	1.63	2.33	4.92	10.5	1.69	4.57	0.025
Mean		1.74	1.61	3.62	4.62	8.64	1.56	4.49	0.027
CD (0.5)		NS	NS	1.18	NS	NS	NS	NS	NS
CD ($P \leq 0.05$)		0.68	0.69	0.4	1.32	2.31	0.71	1.02	0.003

in available Na, pH and EC was noted with sodium application.

CONCLUSION

The results of the study indicated that diameter of seedlings, dry matter production and uptake of nutrients were not influenced by the substitution of potassium with sodium up to 50 per cent. For 50 kg K/ha application, an increase in K uptake was noted when applied with 50 kg/ha of Na. Substitution of various levels of K by Na did not affect soil available nutrient status, pH and EC of rubber growing soils.

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