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EFFECT OF POTASSIUM AND SODIUM ON PERFORMANCE OF YOUNG *HEVEA BRASILIENSIS*

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A pot culture experiment was conducted to study the effect of sodium chloride (NaCl) on the growth of young rubber plants grown in a laterite soil. The treatments comprised substitution of K_2O (applied as KCl) by Na_2O (applied as NaCl) to the extent of zero, 25, 50, 75 and 100 per cent on clone RRII 105. The treatment which received 100 per cent of the recommended dose as K_2O and those with 25 and 50 per cent substitution of K_2O by Na_2O appeared superior to other treatments in total dry matter production and uptake of K. The uptake of N, P, Ca and Mg were not influenced by the substitution. The available K and Na content in the soil increased with increased application of these nutrients while pH and EC remained unaffected.

Key words : Dry matter production, *Hevea brasiliensis*, Nutrient uptake, Potassium chloride, Sodium chloride.

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INTRODUCTION

The widely used and cheapest potash fertilizer for rubber plantations is potassium chloride (muriate of potash) and unit cost of K_2O is Rs.6.20. The question of whether sodium (Na^+) can replace potassium (K^+) in physiological processes in plants is of practical importance in relation to fertilizer usage since the source of Na, common salt, is much cheaper than muriate of potash. Marschner (1971) reported that in less specific processes such as raising cell turgour some replacement is possible and the extent to which substitution can occur, depends much on the uptake potential for Na. Khanna and Balaguru (1981a, b) reported that when supplied with both K and Na, majority of plants show selectivity for K and the degree of selectivity differs widely between species. The growth of cotton plants has been improved through Na application when there was a deficiency of K (Joham, 1955). Smith (1969) reported that Na could replace K in coconut trees. Substitution of K_2O by Na_2O the extent of 50 per cent or even 75 per cent did not reduce the yield of coconut grown in a laterite soil (Mathew *et al.*, 1984).

MATERIALS AND METHODS

A pot culture study was conducted in completely randomised design using budded stumps of rubber as planting material. The pots were filled with surface soil collected from the Rubber Research Institute of India Farm. The soil was sandy clay in texture, deficient in organic carbon, available P and K and was acidic in reaction (Table 1).

Table 1. **Physico-chemical properties of soil**

Organic carbon (%)	0.48
Available nutrients (mg/kg soil)	
Phosphorus	2.00
Potassium	21.00
Sodium	47.00
Magnesium	13.30
Total (%)	
Potassium	0.43
Sodium	0.04
pH	5.0
EC (d S/M)	0.02
Texture	Sandy clay

Concrete pots of 30 cm diameter and 60 cm height were used for growing the plants. The average weight (on air-dry basis) of soil was 35 kg per pot. One budded stump each of *Hevea brasiliensis* clone was planted in the pots. The treatment details are given in Table 2. Each treatment was replicated four times and the experiment was set up in a glass house under completely randomized design.

In addition, the plants in each pot received N, P_2O_5 and MgO at the rate of 67, 67 and 10 g respectively during the two year period. N was applied as urea, P_2O_5 as Mussoorie rock phosphate and MgO as magnesium sulphate. The plants were uprooted two years after planting. The different plant parts *viz.* leaf, petiole, stem and root were separated, their dry weights recorded and analysed for N, P, K, Na, Ca and Mg by standard methods (Jackson, 1973) and the total content of nutrients estimated. Based on the nutrient content and dry matter produced, the total uptake of N, P, K, Na, Ca and Mg by the plants in the different treatments was computed. After uprooting the plants, the soil samples were collected and subjected to chemical analysis. Organic carbon, available P (Bray II), available K (1N NH_4OAc), available Na (1N NH_4OAc), pH and EC were determined (Jackson, 1973).

RESULTS AND DISCUSSION

Two years after planting, symptoms of K deficiency appeared in the treatment T6 (no K_2O or Na_2O) and the older leaf blades of the plants showed marginal paling and scorching. The plants in treatment T5 (100% Na_2O) were either normal in appearance or had mild K deficiency symptoms. Plants in other treatments appeared normal throughout the experiment.

Table 2. **Quantity of K_2O/Na_2O applied (g/pot)**

Treatment No.	Treatment	First year		Second year		Total	
		K_2O	Na_2O	K_2O	Na_2O	K_2O	Na_2O
T1	100% K_2O	9.00	0.00	18.00	0.00	27.00	0.00
T2	75% K_2O + 25% Na_2O	6.75	2.25	13.50	4.50	20.25	6.75
T3	50% K_2O + 50% Na_2O	4.50	4.50	9.00	9.00	13.50	13.50
T4	25% K_2O + 75% Na_2O	2.25	6.75	4.50	13.50	6.75	20.25
T5	100% Na_2O	0.00	9.00	0.00	18.00	0.00	27.00
T6	No K_2O or Na_2O	0.00	0.00	0.00	0.00	0.00	0.00

The data on total dry weight of plants as influenced by various combinations of K and Na are presented in Table 3.

Table 3. **Effect of different levels of K and Na on dry matter production**

Treatment	Mean dry matter production (g/pot)
100% K_2O	556.35
75% K_2O + 25% Na_2O	500.77
50% K_2O + 50% Na_2O	504.86
25% K_2O + 75% Na_2O	473.45
100% Na_2O	412.32
No K_2O or Na_2O	401.46
SE	29.83
CD	88.63

The dry matter production was markedly influenced by the treatments. The treatments *viz.* full dose of K_2O, 25 and 50 per cent K_2O substituted by Na_2O gave significantly higher dry weight over control (No K_2O or Na_2O). No significant difference was noted between these three treatments. The above results indicate that Na could partially substitute the role of K in plants and hence maintain the same level of dry matter production for substitution up to 50 per cent. These findings are in agreement with those reported for cotton by Joham (1955).

The K and Na content of different plant parts as influenced by the treatments are given in Table 4.

The content of K in leaf, petiole, stem and root ranged from 8600 to 12300 ppm, 16100 to 19200 ppm, 9800 to 14600 ppm and 6300 to 9200 ppm respectively while the Na status ranged from 1900 to 3600 ppm, 4300 to 6700 ppm, 4300 to 9900 ppm and 6000 to 25000 ppm in leaf, petiole, stem and root respectively. No significant difference in K content was noted in the different plant parts by the partial substitution of K_2O by Na_2O.

In all the plant parts, Na content generally increased with increasing levels of application of Na. In the case of leaf Na content, the treatments T4 and T5 gave significantly higher values while T1, T2 and T3 were found to be on par. In the case of petiole and stem Na content, T4 and T5 were found to be on par and were significantly higher than the other treatments. In the case of root Na, T6 gave numerically higher values as compared to T1. This can be attributed to the antagonism between K and Na since K applied to T1 would have suppressed the uptake of Na from the soil. The data also indicates that Na concentration generally decreased from the roots

Table 4. **Effect of different levels of application of K and Na on their content (ppm) in plant parts**

Treatment No.	Leaf		Petiole		Stem		Root	
	K	Na	K	Na	K	Na	K	Na
T1	11900	200	19200	400	13300	500	7500	600
T2	11900	200	18500	500	14600	500	9200	1200
T3	12300	200	17900	500	12900	500	8000	1500
T4	11500	300	18400	700	12600	800	7400	2000
T5	9000	400	16100	700	10600	1000	6600	2500
T6	8600	200	17100	500	9800	400	6300	800
SE	—	10	—	100	—	100	—	200
CD	NS	100	NS	200	NS	300	NS	600

Table 5. **Effect of nutrient substitution on K and Na ratio in different plant parts**

Treatment	K and Na ratio			
	Leaf	Petiole	Stem	Root
100% K_2O	58.94	42.75	40.71	10.73
75% K_2O + 25% Na_2O	59.61	34.19	37.21	8.65
50% K_2O + 50% Na_2O	55.48	42.09	36.44	5.78
25% K_2O + 75% Na_2O	49.48	26.96	17.55	3.79
100% Na_2O	25.86	25.26	13.51	2.89
No K_2O or Na_2O	46.62	31.80	15.06	6.87
SE	6.91	4.18	7.88	2.13
CD	20.54	12.43	23.41	6.31

upwards and that the leaves retained lower Na content compared to other plant parts which may be due to lesser mobility of Na than K in plants. Similar results were reported by Amin and Joham (1968) for cotton plants.

The treatments showed no difference in their effect on content of N, P, Ca and Mg in different plant parts. In general, in all the plant parts studied the ratio of K and Na (Table 5) widened with higher levels of K application and narrowed with the application of Na. The ratio was highest in leaves followed by petiole, stem and roots. These observations also confirm the high selectivity of rubber leaves and low selectivity of roots for K over Na. Balaguru and Khanna (1982) reported similar results while studying the effect of replacing K by Na on cation uptake and transport to the shoots in cotton plants.

The total uptake of K and Na differed significantly by the treatments (Table 6). The treatments 100 per cent K_2O and 25 and 50 per cent substitution of K_2O by Na_2O gave higher uptake of K over control but there was no significant difference between these three treatments in terms of uptake of K. In the presence of higher level of Na, the absorption of K from soil would have been affected marginally. Total Na uptake increased with increasing levels of Na application. Marschner (1971) made a survey on the uptake potential of various crops. He grouped rubber in medium Na species and reported that in medium species Na+ contributes to the osmotic potential of the cell and thus has

Table 6. **Effect of substitution on uptake of nutrients**

Treatment	Uptake of nutrients (g/pot)					
	N	P	K	Na	Ca	Mg
100% K_2O	9.87	0.92	5.98	0.24	4.31	0.85
75% K_2O + 25% Na_2O	10.52	0.88	5.98	0.38	4.55	0.77
50% K_2O + 50% Na_2O	10.60	0.69	5.83	0.46	4.43	0.66
25% K_2O + 75% Na_2O	9.90	0.89	4.39	0.60	4.37	0.73
100% Na_2O	9.87	0.75	4.22	0.69	4.71	0.72
No K_2O or Na_2O	10.62	0.65	3.60	0.21	3.91	0.73
SE	—	—	0.55	0.04	—	NS
CD	NS	NS	1.63	0.13	NS	NS

Table 7. **Soil chemical properties**

Treatment	Organic carbon (%)	Available nutrient (mg/kg) P	K	Na	Mg	pH	EC (d S/M)
T1	1.01	39.00	93.20	51.20	37.30	4.4	0.02
T2	1.16	39.40	74.30	72.20	24.30	4.2	0.02
T3	0.91	42.20	56.20	70.30	37.40	4.3	0.02
T4	0.85	29.80	39.60	81.60	23.70	4.2	0.02
T5	0.98	33.20	27.20	100.72	19.10	4.2	0.02
T6	1.17	41.40	21.30	47.80	21.30	4.2	0.02
SE	—	—	6.10	9.30	—	—	—
CD	NS	NS	18.00	27.70	NS	NS	NS

a positive effect on the water regime of plants. The uptake of N, P, Ca and Mg were not influenced by the application of different levels of K and Na.

Chemical properties of the soil studied after uprooting the plants are given in Table 7. The data indicated that substitution of various levels of K by Na did not affect the organic carbon content, available P and Mg, pH or EC of the soil whereas a variation in available K and Na status was noted. Treatments that received higher quantities of either K or Na showed higher availability of the respective nutrient in the soil.

Significant positive correlation of available K with leaf K status (r=0.4712)*, total K uptake by the plants (r=0.6732)** and dry matter production (r=0.6491)** and negative correlation with root Na status (r=0.4377)* were observed. Available Na gave only significant positive correlation with leaf Na (r=0.3923)*, petiole Na (r=0.6133)** and total Na uptake (r=0.6915)**. Antagonism between K and Na is evident from the correlation studies. Similar results have been reported by Prema *et al.*, (1987) for coconut palms in laterite soils. The data also indicates that available Na is not related to dry matter production of the plants. Significant positive correlation between P and K uptake (r=0.6792)** was also observed. The increased uptake of K would have favourably influenced the uptake of P.

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