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QUANTITY-INTENSITY RELATIONSHIPS OF POTASSIUM IN TWO RUBBER GROWING SOILS FROM KERALA AND TRIPURA

In soil systems, solution - exchange phase equilibria are studied for determining nutrient availability to plants and to know how readily cations are subject to leaching and chemical or microbiological transformations. K, Ca and Mg are some of the cations that have undergone the most extensive testing in soil systems in terms of solution-exchange phase interactions (Evangelou *et al.*, 1994). Beckett (1964) had put forward the concept of using quantity - intensity (Q/I) relationships to characterise K status of soils. This provides information about the extent of available K in a soil at a given time and the capacity of the soil to maintain adequate supply of available K. *Hevea* is traditionally cultivated in the south-western India and is now being extended to non traditional regions. The Q/I relationships of K in the rubber growing areas of India are not yet characterised. Considering the importance of generating a data base of Q/I parameters and their influence on the availability of K, a comparative study was conducted in two rubber growing soils one each from the traditional and non traditional regions.

Soils from the Central Experiment Station (CES), Kerala (traditional region) and the Regional Research Station (RRS), Tripura (non-traditional region) of the Rubber Research Institute of India were collected from the surface and subsurface layers. Taxonomically soil from the former represents Paleustalfs and that from the latter Typic Dystrochrults. The samples were air dried and passed through a 2 mm sieve. Available K (Morgan's reagent extracted) and pH (1:2.5 soil-water ratio) were determined by standard methods (Jackson, 1967). Particle size analysis was done by International pipette method and the texture was found from the textural triangle.

For establishing Q/I parameters 5 g of soil was added with 50 ml of 0.01 M $CaCl_2$ solution containing 0, 0.2, 0.5, 1.0, 2.0, 3.0, 4.0 and 5.0 mM KCl. The soil suspension was shaken for 30 minutes in a horizontal shaker, kept intact for 18 h, filtered under suction and the filtrate tested for K (by flame photometer), Ca and Mg (by atomic absorption spetrophotoment). All the estimates were the mean of triplicates on oven dry basis. From these data, activity ratio of K was calculated using the formula

$$AR^K = a_K / \sqrt{a_{Ca} + a_{Mg}}$$

where AR^K is the activity ratio and a_K, a_{Ca} and a_{Mg} are activity coefficients of K, Ca and Mg respectively.

The activity coefficients of individual ions of K, Ca and Mg were calculated using Davis equation (Evangelou and Karathanasis, 1986). ΔK was determined by calculating the gain or loss of K in the extract after equilibration with graded levels of K in 0.01 M $CaCl_2$. The data on AR^K and ΔK were subjected to regression analysis and the best fit was found to be the quadratic equation. For Q/I plot, AR^K and ΔK were taken on X and Y axis respectively.

From the Q/I plots the following

parameters were derived :

AR^K_e (m mole l) $^{0.5}$ = the point where K is neither gained nor lost *i.e.* $\Delta K = 0$;

K_L (microeq./100 g) = the point where the curve intercepts X axis by extrapolation

K_O (microeq./100 g) = obtained by drawing a tangent from the point of AR^K where $\Delta K = 0$

K_X(microeq./100 g) = $K_L - K_O$

PBC^K (cmoles/kg)(moles /l) $^{0.5}$ = KO / AR^K_e

An examination of the soil properties (Table 1) indicates that the pH values for soils from CES (5.10 for surface and 5.13 for subsurface) were more than those for RRS (4.59 and 4.53 respectively). The available K contents were also higher in CES (9.25 and 6.25 mg /100 g in surface and subsurface respectively) than in RRS (4.75 and 3.75 mg /100 g in surface and subsurface correspondingly). The soil texture was classified as sandy clay loam (29.4 % clay) in the surface and sandy clay (39.1 % clay) in the subsoil of CES. In RRS, the texture was sandyloam (19.0 % clay) in the surface and sandy clay loam in the subsurface (24.0% clay).

The shape of Q/I curves (Fig.1) for RRS and CES showed marked differences in Q/I parameters. The derived parameters are presented in Table 2. The following is the description of these Q/I parameters.

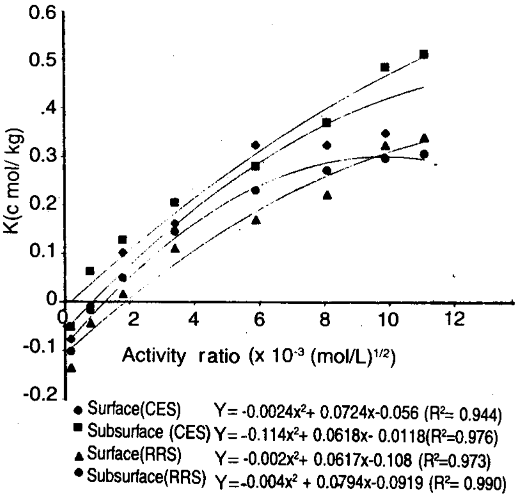

Fig. 1. Q/I relationships of K

The labile K (K_L) represents the amount of K capable of ion-exchange during the equilibration between soil solids and solution. The labile K was more in both surface and subsurface soils of RRS (119 and 103 microeq./ 100 g) than in the soils of CES (59.9 and 12.2 microeq./ 100g). The lower labile K in soils of CES might be due to higher retention of K than in the soils of RRS. Such relation between K and retention was reported by Sharma and Mishra (1989). In general, the retention of K varies with the nature and quantity of clay mineral. The depthwise variation in K in soils of RRS and CES were ascribed to variation in clay content i.e. increasing clay content increases K retention (Sparks and Leibhardt, 1981). Analysing the clay mineralogy of

Table 1. **Some properties of soils of CES, Kerala and RRS, Tripura**

Soil horizon	Depth	pH	Ex.K (mg/100g)	Clay (%)	Texture
CES, Kerala					
Surface	0 - 18	5.10	9.25	29.4	Sandy clay loam
Subsurface	18 - 51	5.13	6.25	39.1	Sandy clay
RRS, Tripura					
Surface	0 - 11	4.59	4.75	19.0	Sandy loam
Subsurface	11 - 33	4.53	3.75	24.0	Sandy clay loam

Table 2. **Derived parameters from Q/I curves**

Soil horizon	K^*_L	K^*_O	K^*	AR^K_e**	PBC^K***
CES, Kerala					
Surface	59.9	58.2	1.7	0.9	64.67
Subsurface	12.2	12.2	0.05	0.2	60.75
RRS, Tripura					
Surface	119.0	111.0	8.0	2.1	52.86
Subsurface	103.0	96.0	7.5	1.4	68.29

* microeq. /100g soil
** $(mmoles/l)^{0.5}$
*** $(cmoles/kg)(moles/l)^{0.5}$

soils of CES, Krishnakumar (1989) reported the presence of illite, a K fixing mineral, in abundance next to kaolinite. However, the information on the clay mineralogy of RRS soil which could explain the K equilibrium is lacking.

Potassium held on non-specific planar sites on the adsorption surfaces (K_O) was higher (111 and 96 microeq./100 g in surface and subsurface respectively) in the soils of RRS than in the soils of CES (58.2 and 12.15 microeq./ 100 g respectively). These variations appear to be associated with differences in nature and quatity of clay. Similar results were recorded by Sharma and Mishra (1989) while comparing the Q/I relations of K in texturally different alluvial soils.

K_X the quantity of K held on specific sites on adsorption surfaces was higher in the soils of RRS (8.0 and 7.5 microeq./100 g in surface and subsurface respectively) than in the soils of CES (1.7 and 0.05 microeq./ 100 g) respectively). The reason for this tremendous variation is also ascribable to variations in the nature (i.e. presence or absence of 2:1 type clay in addition to dominant 1:1 type as normally seen in acid soils) and quantity of clay minerals as shown in Table 1. The CES soils had higher clay content than those of RRS and the presence of illite has already been reported in CES soil (Krishnakumar, 1989).

The estimated K activity ratio at equilibrium (AR^K_e) values were more in the soils of RRS (2.1 and 1.4 m moles/l in the surface and subsurface respectively), than in the soils of CES (0.9 and 0.2 m moles/l). The lower AR^K_e in the soils of CES inspite of higher exchangeable K is evidently due to higher cation retention power, an effect of higher clay content, which allows only a small amount of K to remain in soil solution (Sharma and Mishra, 1989). Both the surface soils had higher AR^K_e values which followed an association of higher retention of K and higher clay content as was shown by Sparks and Leibhardt (1981).

Potential buffering capacity (PBC^K) is a measure of the ability of the soil to maintain a given K activity ratio as K supply to the medium (soil solution) is increased or decreased. Table 2 indicates that surface soil of RRS had lesser PBC^K than that of CES. On the otherhand, the subsurface soil of RRS had higher PBC^K than that of CES. It is difficult to explain such variations in PBC^K with the available data. Dulta and Joshi (1990) reported that the

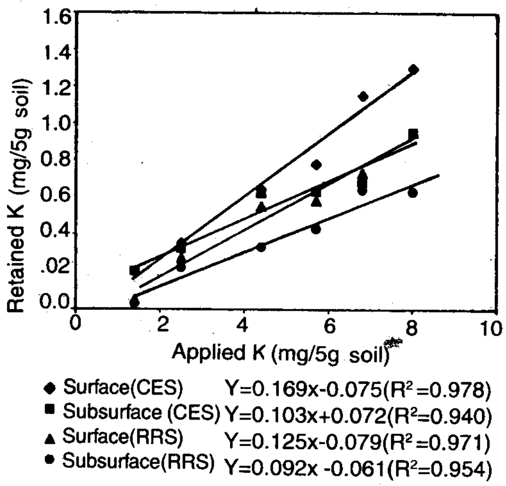

Fig. 2. Relationship between applied and retained K

variations in PBC^K could be a combined effect of different soil parameters.

The results show that the soils of RRS, Tripura had higher AR^K_e and labile K values than the soils of CES. Thus the intensity of K supply in soils of RRS was more than in CES. However, PBC^K showed a different trend in these two soils. The surface soil where bulk of feeder roots are concentrated had higher PBC^K in CES than in RRS. Accordingly the quantity of K supply in the surface soil of CES is more than in that of RRS. Hence, the surface soil of CES can supply K over a long period when compared to that of RRS . The plot showing relationship between K addition to soil and its retention (Fig.2) also indicated that the soils of CES retained more of applied K in comparison to those of RRS which is associated with variations in the PBC^K of the soils.

REFERENCES

Beckett, P.H.T. (1964). Studies on soil potassium: 1. Confirmation of the ratio law: Measurement of potassium potential. *Journal of Soil Science*, **15** : 1-8.

Dutta, B.K. and Joshi, D.C., (1990). Quantity - intensity parameters of potassium and their relationship with available forms and soil properties in dune and interdune soils. *Journal of Indian Society of Soil Science*, **38**: 404-409.

Evangelou, V.P. and Karathanasis, A.D., (1986). Evaluation of potassium quantity - intensity relationships by a computer model employing Gapon equation. *Soil Science Society of America Journal* , **50** : 58-62.

Evangelou, V.P., Wang J. and Phillips, R.E. (1994). New developments and perspectives on soil potassium quantity/intensity relationships. *Advances in Agronomy*, **52**: 173-227.

Jackson, M.L. (1967). Soil chemical analysis. Prentice Hall of India Pvt. Ltd, New Delhi.

Krishnakumar, A.K. (1989). *Soils under Hevea in India: A physical, chemical and mineralogical study with reference to soil moisture, cation influence on yield of Hevea brasiliensis.* Ph.D. Thesis, IIT, Kharagpur, India.

Sharma, B.D. and Mishra,B. (1989). Quantity - intensity relations of potassium in texturally different alluvial soils. *Journal of Indian Society of Soil Science*, **37**: 35-39.

Sparks, D.L. and Leibhardt,W.C., (1981). Effect of long term lime and potassium applications on quantity - intensity (Q/I) relationships in sandy soil. *Soil Science Society of America Journal* , **45**: 786-790.

D.V.K.N.Rao (for correspondence)
Jacob Pothen
Rubber Research Institute of India
Kottayam - 686 009
Kerala, India.