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Red and lateritic soils of India. (Eds. J Seghal, etal). National bureau of soil survey and land use planning, Nagpur.

TRANSFORMATION OF POTASSIUM IN RUBBER GROWING RED AND LATERITIC SOILS OF SOUTH INDIA

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ABSTRACT

An incubation experiment was conducted to study the transformation of applied K in soils from the four major rubber growing regions of South India. Soil samples were incubated with moisture at field capacity for 90 days and the different forms of K were estimated periodically. The exchangeable K content on incubation, increased up to 60th day and maintained the same level upto 75th day and decreased thereafter. The water soluble K as well as the Morgan extractable K had higher values on the 15th day of incubation and thereafter it decreased gradually showing very low values.

INTRODUCTION

In India, rubber is grown extensively in the humid high rainfall areas with annual total rainfall of over 2000 mm. The red and lateritic type of soil predominates in these regions with dominance of kaolinite minerals, and oxides and hydrous oxides of Fe and Al. (Mukherjee et al., 1971; Ghosh and Kapoor, 1982). With excessive rainfall there are more chances of leaching lossess of applied K in these soils. Eventhough a large quantity of K is applied every year, the available K status remains low. The response to applied K is also found negative in most of the field experiments conducted by Rubber Research Institute of India (Ananth et al., 1966; Potty et al., 1978; Abdul Kalam et al., 1980). Considering these aspects, a preliminary study was conducted to assess the transformation of applied K in major rubber growing soils of Southern India.

MATERIALS AND METHODS

An incubation experiment was conducted with the surface soils (0-30 cm) from four major rubber growing regions namely Kanyakumari (Kulasekharam), Calicut (Kinalur), Kottayam (Mundakayam) and Trichur (Pudukad). The treatments were 0, 40, 80, 120, 160, and 200 mg K kg^{-1} soil. The soil moisture was maintained at field capacity and samples were drawn at regular intervals of 15, 30, 45, 60, 75 and 90 days of incubation and analysed for different forms of K. The initial soil samples, both surface (0-30 cm) and subsurface (30-60 cm) were analysed for organic carbon, and CEC by standard method (Jackson, 1958). The mechanical composition was determined by the International Pipette Method (Piper, 1942). The moisture at 33 kPa was estimated using pressure plate apparatus. The water soluble, exchangeable and total K were estimated by the

standard procedures (Jackson, 1958). The fixed K was extracted, using 1N HNO_3 as suggested by Pratt (1965). The Morgan extractable K as an index of available K was also estimated (Morgan, 1941).

RESULTS AND DISCUSSION

The physico-chemical properties of soil (Table 1) revealed that the soils were acidic in reaction (pH 4.8 to 5.2). In the surface layer the organic carbon content of Kulasekharam soil was low but it was in medium to high range in other three cases. The moisture content at 33 kP_a was also very low for Kulasekharam soil compared to the other three regions. The CEC of the initial soil ranged from 5.2 to 12.8 c mol $(P+)kg^{-1}$, which might be due to the predominance of kaolinite and hydrous oxides of Fe and Al. (Mukherjee et al., 1971; Ghosh and Kapoor, 1982). The CEC was also high in the surface soil which might be due to the high organic carbon content.

Among the different forms of K in the initial soil the total K content ranged from 480 to 1240 mg $100g^{-1}$ soil. The water soluble K was found to be very low ranging from 0.10 to 0.70 mg $100g^{-1}$ and the exchangeable K ranged from 3.6 to 12.5 mg 100 g^{-1}. The available K ranged from 3.6 to 11.9 mg $100^{-1}g$ soil.

The water soluble K content on incubation ranged from 1.45 to 11.10 mg $100g^{-1}$. Irrespective of the locations, the treatment T_6 recorded the highest water soluble K and the lowest was recorded by the control. Among the locations Mundakayam recorded the highest values. On incubating the soil, under field capacity the water soluble K content increased considerably from the initial value.

This might be due to the fact that on increasing the moisture content the soil solution gets diluted and the equilibrium between monovalent and divalent cations in the exchange complex gets disturbed resulting

Table 1. Physico-chemical properties of initial soil

Region (Location)	Soil depth (cm)	Particle size			pH	OC (%)	CEC cmol(p+) kg^{-1}	Moist. at 33 kPa (%)	Forms of K (mg 100^{-1} g)					Avail. K (mg 100^{-1} g)
		Sand (%)	Silt (%)	Clay (%)					Water Sol.	Exch.	Fixed	La-ttice	To-tal	
Kanyakumari	0-30	59.6	6.1	34.1	5.1	0.90	7.3	10.8	0.20	8.1	9.2	662	680	5.6
(Kulasekha-ram)	30-60	42.7	7.0	43.1	5.2	0.84	5.2	8.8	0.15	3.6	6.6	830	840	3.6
Calicut	0-30	44.3	10.20	42.4	4.8	2.13	12.5	26.6	0.70	12.5	12.5	574	600	11.9
(Kinalur)	30-60	45.2	9.0	39.7	5.0	1.07	11.5	24.8	0.30	10.0	8.1	462	480	5.3
Kottayam	0-30	46.2	8.1	38.0	5.0	2.79	12.8	23.9	0.40	6.3	9.4	1064	1080	5.8
(Maundaka-yam	30-60	36.2	10.1	38.2	4.8	1.83	10.7	21.9	0.15	6.0	5.9	1128	1140	3.8
Trichur	0-30	49.5	8.4	32.9	5.0	1.26	10.9	23.5	0.30	9.4	13.4	1217	1240	8.3
(Pudukad)	30-60	36.4	4.2	44.1	5.0	0.75	10.1	21.1	0.10	8.4	10.0	1002	1020	6.0

Table 2. Different form of K at various stages of incubation (mg $100g^{-1}$ soil)

Treatments	Water soluble K						Exchangeable k						Morgan extractable K					
	Incubation time in days						Incubation time in days						Incubation time in days					
	15	30	45	60	75	90	15	30	45	60	75	90	15	30	45	60	75	90
Kanyakumari (kulasekharam)																		
T_1	1.2	1.5	1.0	1.2	1.2	0.1	5.1	5.6	6.1	10.6	11.0	10.0	3.7	3.0	3.2	6.2	6.7	3.8
T_2	5.1	3.0	3.0	3.0	3.0	0.2	6.2	20.1	15.5	19.9	18.0	14.3	9.4	12.4	6.3	6.8	12.5	5.7
T_3	8.0	7.5	5.6	4.8	5.2	0.2	6.9	18.7	16.6	23.8	15.5	15.2	10.5	13.7	15.0	13.2	15.4	7.3
T_4	12.6	10.3	7.3	5.7	5.3	0.6	13.6	30.6	22.5	25.6	26.1	16.8	17.6	30.0	16.8	18.4	18.0	9.4
T_5	13.6	10.3	9.6	9.0	10.0	1.2	16.9	29.3	27.0	32.5	33.0	18.7	18.1	25.1	21.8	24.4	25.1	13.1
T_6	20.3	14.7	12.0	9.4	14.0	1.5	24.3	36.8	31.1	34.3	37.2	28.8	24.3	31.2	30.1	30.1	30.2	13.2
Calicut (kinalur)																		
T_1	1.3	2.3	2.2	2.0	2.8	0.3	15.6	16.8	15.1	20.0	21.3	18.7	7.7	8.1	10.0	11.9	13.1	9.4
T_2	3.5	7.6	8.4	4.6	3.7	0.9	26.8	31.4	26.7	28.2	28.1	20.1	24.4	22.3	18.8	20.0	20.2	10.1
T_3	5.2	11.0	8.9	5.8	7.1	0.9	30.0	36.2	30.1	31.1	33.6	21.3	28.1	29.8	22.3	21.6	22.1	12.3
T_4	6.5	10.6	10.4	7.3	8.6	1.0	31.2	39.4	32.6	37.0	37.3	23.6	27.6	30.8	25.1	28.1	25.1	13.2
T_5	6.6	13.1	14.0	9.8	10.4	1.2	35.7	42.5	36.1	37.8	41.3	28.1	38.2	34.3	27.8	26.3	28.9	14.4
T_6	7.6	15.3	13.3	13.6	12.2	1.3	35.6	43.7	36.2	47.0	45.6	35.1	39.7	35.7	26.9	35.1	30.7	13.8
Kottayam (maundakayam)																		
T_1	1.8	2.3	1.8	1.4	2.7	0.4	18.9	7.4	11.0	12.3	15.3	16.5	7.7	6.9	8.6	7.0	7.2	5.0
T_2	5.6	7.5	4.6	3.1	3.4	0.5	23.7	16.4	15.6	22.5	21.0	19.2	16.2	13.1	9.3	15.0	10.4	7.5
T_3	6.8	7.4	6.5	5.8	4.7	0.8	25.1	23.1	20.1	25.6	24.9	20.7	22.3	14.7	15.1	18.6	15.1	9.3
T_4	11.6	12.4	8.4	8.9	10.9	1.0	30.1	29.4	25.1	33.7	35.5	26.3	26.5	24.3	18.2	27.0	26.8	12.6
T_5	11.8	13.0	10.2	9.3	9.7	1.3	34.3	35.0	32.1	38.1	36.7	31.2	31.4	28.5	23.5	26.9	27.5	13.1
T_6	17.0	14.5	14.2	11.1	12.0	1.8	38.7	36.2	34.1	40.0	36.7	40.0	33.5	28.9	27.8	28.0	30.0	15.6
Trichur (pudukad)																		
T_1	1.4	2.4	1.6	1.8	1.3	0.3	16.5	10.0	16.6	20.1	20.4	11.9	11.1	8.7	8.4	13.1	10.6	9.3
T_2	2.8	5.3	3.2	2.8	2.5	0.4	23.8	18.1	18.1	33.4	24.1	13.7	16.4	14.3	13.1	15.6	16.2	9.3
T_3	5.7	6.3	4.7	4.5	3.8	0.5	26.8	18.8	26.6	33.3	27.3	21.4	21.4	18.5	16.9	26.2	18.7	11.3
T_4	5.8	10.2	5.7	4.6	6.2	0.8	37.5	28.4	29.0	37.0	34.1	25.6	31.8	28.2	18.8	26.8	25.0	13.1
T_5	8.1	13.3	9.6	7.6	8.0	1.0	43.1	35.0	39.3	38.5	40.3	22.5	36.8	33.1	25.6	30.7	28.0	15.7
T_6	2.2	14.1	13.2	10.4	9.3	1.4	44.5	38.8	40.4	45.4	43.6	35.7	45.0	36.9	28.7	44.3	30.0	16.4

	S.E.	C.D. (P = 0.05)	S.E.	C.D. (P = 0.05)	S.E.	C.D.(P = 0.05)
Treatment (T)	0.48	1.34	0.66	1.85	0.79	2.21
Location* (L)	0.39	N.S.	0.54	1.51	0.64	1.79
Incubation (I)	0.34	0.67	0.80	2.24	0.60	1.68
IXT	0.58	1.62	1.97	N.S.	1.47	4.12
LXT	0.96	N.S.	1.33	N.S.	1.58	N.S.

in increased adsorption of divalent cations and higher proportion of K in the solution as reported by Wicklander (1969) and Malavolta (1985). The water soluble K content increased upto the 30th day of incubation irrespective of the treatments and thereafter it decreased showing very low values on the 90th day of incubation.

Among the treatments, T_6 recorded the highest exchangeable K. Kinalur soil recorded the highest exchangeable K and the lowest by Kulasekharam. With the increasing levels of K application there was increase in the exchangeable K content. The same trend was noticed at all stages of incubation. Among the incubation intervals, the 60th day recorded the highest values which was at par with the 75th day. Even at 90th day of incubation, the level of exchangeable K was relatively high, suggesting low K fixation rate in these soils explaining the relationship between the clay content and the type of clay mineral and behaviour of K in soil as reported by Thomas and Hipp (1968) and Van Diest (1978). K fixation is poor in soils rich in kaolinite minerals with poor K binding sites. (Dolcater et al., 1968).

With the increasing doses of K, there was an increase in the Morgan extractable K and the highest value was recorded by T_6 on the 15th day of incubation. On the 90th day of incubation the values were reduced considerably as in the case of water soluble K indicating the slow conversion tc exchangeable form for maintaining the chemical equilibrium between different forms of K in the soil (Mengel and Kirkby, 1987).

Irrespective of the locations, increasing the K dose increased different forms of K in soil. The maintenance of moisture at field capacity increased the water soluble K content up to 75th day of incubation and thereafter it decreased considerably. The exchangeable K content increased on incubation up to 60th day and the level was maintained up to 75th day and thereafter it decreased but was maintained at higher level compared to control. Similarly the water soluble K was high on the 15th day of incubation with the application of K and thereafter it showed a decreasing trend. The available K fraction (Morgan extractant) also showed similar trend with higher values on the 15th day of incubation and the same trend was maintained up to 30th day. From this study it is seen that in this type of soils with fairly high organic matter content, the fertilizer K (applied) may be available up to 30th day of application and thereafter it gets converted to exchangeable or fixed forms which is slowly available to the crop.

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