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SOIL ACIDITY PARAMETERS OF LATERITE SOILS UNDER RUBBER

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Abstract: A study was conducted to understand the soil acidity parameters of three selected laterite soils under rubber in Kerala. Pedons were dug to a depth of 2 m at three selected locations viz. Thiruvananthapuram, Angadippuram and Kannur and genetic horizon samples were collected to study various soil acidity parameters. The study showed that all the pedons under investigation have a negative ApH value indicating a net negative surface charge throughout the profiles. Amorphous alumino-silicates could be observed in the surface layers of all three pedons as indicated by high pH (NaF) values. The exchange sites and soil solutions were dominated by exchangeable aluminium and the values were very high in textural-B horizons and hard laterite layers. The base saturation values (sum of cations) for surface horizons were 25.33, 21.90 and 21.57 per cent in pedons at Thiruvananthapuram, Kannur and Angadippuram respectively.

Key words: Acidity, base saturation, exchangeable cations, laterite, rubber.

INTRODUCTION

In Kerala state, India, rubber (*Hevea brasiliensis* Muell. Arg.) is cultivated extensively in laterite and associated soils. Though it is cultivated throughout the length and breadth of the state, more than 85 per cent is grown in the laterite and associated soils, which constitute about 60 per cent of the total geographical area and is spread along the midland region of the state.

Soil acidity parameters constitute one of the important factors, which influence the chemistry as well as fertility management of tropical soils like laterite soils. These acidity parameters will help us in understanding the rate at which the process of laterisation proceeds in a particular land use system. Not much study has. so far been undertaken on the effect of growing rubber on soil acidity parameters in the laterite soils of Kerala. Hence, this paper is aimed at understanding the various soil acidity parameters of three selected laterite soils under rubber from Kerala.

MATERIALS AND METHODS

Three locations, one each at Thiruvananthapuram, Angadippuram and Kannur were identified where laterite soils predominate and where rubber has been continuously grown for more than 10 years. At each location, pedons were dug to a depth of 2 m and genetic horizons identified and marked. Representative genetic horizon samples were collected for analyses. The soil samples were air-dried and sieved through a 2 mm sieve to separate air-dry fine earth from gravel. The processed samples were used for various studies described below.

Soil pH was determined potentiometrically in water (1:2.5), 1*M* KC1 (1:2.5), 0.01*M* $CaCl_2$ (1:2) and 1*M* NaF (1:50) (Black, 1965 and Page *et al.*, 1982). Exchangeable cations, which include Ca, M, K and Na, were determined in neutral 1*N* ammonium acetate extract. Calcium and magnesium were determined using atomic absorption spectrophotometer (AAS) and potassium and sodium using flame photometer. Exchangeable acidity, exchangeable aluminium and exchangeable hydrogen were determined following the methods of Hesse (1971). Extractable acidity was estimated using barium chloride - triethanol amine extract according to the method described by Hesse (1971).

Cation exchange capacity (CEC) of the various samples was determined by the neutral 1*N* ammonium acetate method (Page *et al.*, 1982) and by the sum of cations method (Soil Survey Staff, 1998). The CEC by sum of cations method is determined by adding sum of bases extracted by ammonium acetate method and barium chloride - triethanol amine extractable acidity. The effective cation exchange capacity (ECEC) was estimated by adding sum of bases extracted by neutral 1*N* ammonium acetate and 1*N* KCl exchangeable aluminium (Reeuwijk, 1993). The per cent base satura-

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Table 1. Soil pH, exchangeable acidity and extractable acidity of the pedons

Horizon	Depth (cm)	Soil pH in				Exchangeable, cmol (p^+) kg^{-1}			Extractable acidity, cmol (p^+) kg^{-1}
		H_2O	KC1	$CaCl_2$	NaF	Acidity	H	Al	
Thiruvananthapuram									
Ap	0-9	5.15	3.50	3.65	10.70	0.86	0.15	0.71	8.56
A1	9-20	5.00	3.40	3.40	10.45	1.99	0.35	1.64	6.79
A2	20-34	4.90	3.05	3.35	10.45	2.62	0.20	2.42	6.97
AB	34-43	5.25	3.35	3.20	10.65	3.32	0.25	3.07	7.87
Bt_1	43-114	5.30	3.45	3.20	9.65	3.85	0.10	3.75	5.55
Bt,	114-200	5.20	3.45	3.05	9.50	2.80	0.25	2.55	2.55
Angadippuram									
Ap	0-13	5.15	3.60	3.55	9.10	3.23	0.35	2.88	6.98
E0	13-24	5.05	3.65	3.40	9.35	3.02	0.35	2.67	6.92
B	24-42	5.00	3.15	3.25	9.45	2.24	0.15	2.09	7.39
Bt_1	42-115	5.35	3.50	3.40	9.45	3.50	0.15	3.35	5.40
Bt,	115-200	5.20	3.55	3.15	9.00	2.93	0.15	2.78	2.88
Kannur									
Ap	0-17	4.90	3.35	3.50	10.70	1.81	0.10	1.71	7.81
Al	17-39	4.80	3.30	3.25	10.45	2.67	0.25	2.42	6.22
E0	39-108	4.80	3.00	3.00	10.65	2.12	0.25	1.87	5.87
Bt_1	108-141	5.20	3.35	3.30	9.80	3.93	0.20	3.73	3.43
Bt_2	141-200	5.00	3.30	3.20	9.55	2.45	0.15	2.30	2.60

tion was estimated based on the CEC values obtained both from ammonium acetate and sum of cations methods.

RESULTS AD DISCUSSION

Soil pH

All the three pedons under study were acidic in reaction (Table 1). At all the study sites, the ApH [pH(KCl) - pH(water)] was negative and showed a gradual, though irregular, increase with depth. The high negative ApH in the surface horizon is due to organic matter content (Eswaran and Bin, 1978). The Bt_1 layers had the highest value of negative ApH. The sign of the ApH corresponds to the net surface charge (Parks and De Bruyn, 1962; Yopps and Furestenau, 1964; Mekaru and Uehara, 1972) and accordingly it could be observed that all the horizons had a net negative surface charge.

The pH $(CaCl_2)$ decreased down the profiles, both in Thiuvananthapuram and Angadippuram while at Kannur, there was an increase in Bt_1 and Bt_2 horizons. The pH $(CaCl_2)$ measurements are independent of dilution over a wide range of soil-solution ratios. Also, the soil pH measured represents more nearly the pH of the soil solution under actual field conditions, and, therefore should reflect accurately the H^+ ion environment of plant roots and soil microorganisms than pH water.

The pH (NaF) values were above 9.00 for surface and subsurface layers in pedons at Thiruvananthapuram and Kannur. The surface horizons recorded values of 10.70, 10.70 and 9.10 at Thiruvananthapuram, Kannur and Angadippuram respectively. The pH (NaF) is a measure of "active aluminium" in soils. The higher values observed is indicative of the presence of amorphous alumino-silicates in these horizons (Eswaran and Bin, 1978). Lowest values in the hard laterite layer (Bt_2) in all the three study sites indicate an increase in amounts of crystalline alumino-silicates in hard laterite.

Table 2. Cation exchange capacity (CEC), effective cation exchange capacity (ECEC) and base saturation of the pedons

Horizon	Depth, cm	CEC (NH_4OAc)	CEC (sum of cations)	ECEC	Sum of bases	% Base saturation	
		cmol (p+) kg^{-1}				NH_4OAc	Sum of cations
Thiruvananthapuram							
Ap	0-9	7.65	11.45	3.60	2.90	37.78	25.33
A1	9-20	6.15	8.89	3.75	2.12	34.38	23.75
A2	20-34	6.05	8.85	4,30	1.89	31.15	21.31
AB	34-43	6.50	9.50	4.70	1.63	25.04	17.16
Bt_1	43-114	4.50	6.75	4.95	1.21	26.68	17.84
Bt_2	114-200	2.05	3.05	3.05	0.51	24.61	16.58
Angadippuram							
Ap	0-13	6.20	8.90	4.80	1.92	30.99	21.57
EO	13-24	5.70	8.35	4.10	1.44	25.16	17.19
B	24-42	6.05	8.65	3.35	' 1.27	20.91	14.63
Bt_1	42-115	4.35	6.35	4.30	0.95	21.84	14.96
Bt,	115-200	2.25	3.35	3.25	0.47	20.80	14.01
Kannur							
Ap	0-17	6.90	10.00	3.90	2.19	31.76	21.90
Al	17-39	5.35	7.70	3.90	1.49	27.74	19.27
EO	39-108	5.15	7.20	3.20	1.34	25.95	18.52
Bt_1	108-141	2.85	4.05	4.35	0.63	21.93	15.44
Bt_2	141-200	2.05	3.00	2.70	0.41	19.72	13.50

Exchangeable and extractable acidity

The exchangeable acidity values are given in Table 2. The exchange sites and soil solutions of the pedons are dominated by exchangeable Al. Very high values of exchangeable Al could be observed in Bt_1 and Bt_2 layers compared to the respective surface horizons. The exchangeable H values were negligible compared to exchangeable aluminium.

The extractable acidity was very high compared to exchangeable acidity at all study sites especially in the surface and subsurface horizons. A number of studies show that exchangeable aluminium is generally the predominant cation in highly leached tropical soils when the pH is 5.0 or less (Mc Cart and Kamprath, 1965; Pratt and Alvahydo, 1966). Aluminium in the soil solution has been identified as a factor responsible for poor growth in many acid soils.

CEC and ECEC

The cation exchange capacity (CEC) determined by both methods decreased down the profiles in all study sites. The CEC (sum of cations) values were higher than CEC (NH_4OAc) values in all horizons. Not much variation in CEC values could be observed at different study sites.

The effective cation exchange capacity (ECEC) values were below 5.0 in all the pedons and the textural B-horizons (Bt_1) recorded higher values compared to the hard laterite layer below it.

Base saturation

At all locations, the base saturation (sum of cations) was lower than 35 per cent and these values were lower than base saturation (NH_4OAc) values. The base saturation values

(sum of cations) for surface horizons were 25.33, 21.90 and 21.57 per cent in pedons at Thiruvananthapuram, Kannur and Angadippuram respectively.

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