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INFLUENCE OF LAND USES ON SOIL ACIDITY PARAMETERS IN A TYPICAL LATERITE TERRAIN FROM KERALA

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Abstract: Cassava *(Manihot esculenta* Crantz) and rubber *(Hevea brasilienis* Muell. Arg.) form the major land uses along the midland region of Kerala where laterite soils predominate. This study was conducted to find out the comparative impact of cassava and rubber on soil acidity parameters at Angadippuram in Kerala state, which is considered as the *'typelocality'* of laterite soils. Pedons were dug to a depth of 2 m from three selected land uses viz., cassava, rubber and uncultivated barren and genetic horizon samples were collected to study various soil acidity parameters. The study showed that all the pedons under study have a negative ApH value indicating a net negative surface charge throughout the profiles. Highest negative ApH value was noted, among surface horizons, in soils under rubber. 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 surface horizon of soils under cassava recorded significantly lower exchangeable Al compared to other two land uses. The base saturation values (sum of cations) for surface horizons were 25.60, 21.57 and 19.14 per cent respectively for pedons under cassava, rubber and uncultivated barren.

Key words: Exchangeable acidity, extractable acidity, laterite, ApH.

INTRODUCTION

With respect to laterite soils, Kerala state has got a unique place in Soil Science. It is in Kerala, at a place known as Angadippuram, that laterite soils were identified for the first time in the world and since then Kerala state has been considered as the *'type locality'* of laterite soils. Cassava *(Manihot esculenta* Crantz) and rubber *(Hevea brasiliensis* Muell. Arg.) are the major land uses in this soil type throughout the midland region of Kerala. So far, no detailed study has been done on the effect of these land uses on soil acidity parameters in this *'typelocality'*.

Soil acidity parameters constitute one of the important factors, which influence the chemistry as well as fertility management of tropical laterite soils. The acidity parameters will help in understanding the rate at which the process of laterisation proceeds in a particular land use system. This paper is aimed at studying the impact of cassava and rubber on soil acidity parameters with a view to understand the effect of these land uses on soil acidification and profile development.

MATERIALS AND METHODS

The study area comprised of Angadippuram (Malappuram district) in Kerala, which lies at 11° 30' N latitude and 76° 40' E longitude. The study site was at an altitude of 50 m above mean sea level. The average annual precipitation is 2907 mm and the laterite number of the area is 68. This is a typical *in situ* laterite soil with ustic soil moisture and isohyperthermic soil temperature regimes.

Three land uses viz., cassava, rubber and uncultivated barren, lying adjacent, were selected where the soil has been under the same land use for more than 10 years. Pedons were dug to a depth of 2 m and replicate genetic horizon samples were collected for different studies. The soil samples were air-dried and sieved through a 2 mm sieve to separate air-dry fine earth from gravel for various analyses.

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, Mg, 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 method 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 samples was determined by the neutral 1*N* ammonium acetate method (Page *et al.*; 1982) and by the sum of cations

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

Horizon	Depth (cm)	Soil pH				Exchange-able acidity	Exchnge-abe H	Exchan-geable Al	Extractable acidity
		H_2O	KC1	$CaCl_2$	NaF	cmol kg^{-1}			
Cassava									
Ap	0-21	5.00	3.55	3.65	9.60	2.74	0.30	2.44	6.59
EB	21-40	4.85	3.50	3.40	9.80	2.90	0.20	2.70	6.70
B	40-108	4.80	3.25	3.15	9.95	2.41	0.15	2.26	7.46
Bt,	108-142	5.20	3.60	3.30	9.95	3.65	0.15	3.50	4.85
Bt_2	142-200	5.05	3.50	3.20	9.50	3.15	0.15	3.00	2.55
Rubber									
Ap	0-13	5.15	3.60	3.55	9.10	3.23	0.35	2.88	6.98
E_0	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_2	115-200	5.20	3.55	3.15	9.60	2.93	0.15	2.78	2.88
Uncultivated Barren									
A1	0-8	4.85	3.45	3.50	9.30	3.57	0.25	3.32	6.67
A2	8-37	4.80	3.60	3.45	8.95	2.96	0.15	2.81	6.31
E	37-74	4.85	3.45	3.30	9.00	2.57	0.25	2.32	6.72
Bt_l	74-108	5.25	3.75	3.50	9.00	3.51	0.15	3.36	4.76
Bt_2	108-200	5.05	3.55	3.45	8.75	3.67	0.25	3.42	2.57
CD (0.05)		0.14	0.19	0.15	NS	NS	NS	0.41	1.51

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 17V ammonium acetate and 1*N* KC1 exchangeable aluminium (Reeuwijk, 1993). The per cent base saturation was estimated based on the CEC values obtained both from ammonium acetate and sum of cations methods.

RESULTS AND DISCUSSION

Soil pH

The results of soil pH measured in water, 1*M* KC1, 0.01*M* $CaCl_2$ and 1*M* NaF are given in Table 1. All the pedons studied are acidic in reaction as shown by pH (water) values. A significant difference in pH (water) was observed among the surface horizons of soils under rubber (5.15), cassava (5.00) and uncultivated barren (4.85). In the case of textural-B horizon (Bt_1) as well as hard laterite horizon (Bt_2), soils under rubber had significantly higher pH (water) than those of cassava. In the case of pH (KC1) of surface horizons, no significant difference could , be observed among different land uses. Similar trend was also observed for hard laterite layers (Bt_2). The pH (KC1) of textural B-horizon of soils under rubber was significantly lower than that of uncultivated barren. In all the pedons, the ApH [pH (KC1) - pH (water)] was negative and they 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 sign of ApH corresponds to the net surface charge (Parks and De Bruyn, 1962; Mekaru and Uehara, 1972).

The pH ($CaCl_2$) values of surface horizons did not give any significant difference among different land uses. The pH (NaF), which was a measure of 'active aluminium' in soils, was more than 9.00 in surface horizon of soils under all land uses.

Table *1*. CEC, ECEC and base saturation of the pedons

Horizon	Depth (cm)	CEC (NH_4OAc)	CEC (sum of cations)	ECEC	PBS (%)	
		cmol (p+) kg^{-1}			NH_4OAc	Sum of cations
Cassava						
Ap	0-21	6.15	8.85	4.70	36.81	25.60
EB	21-40	5.65	8.15	4.15	25.65	17.79
B	40-108	6.10	9.05	3.85	26.17	17.63
Bt,	108-142	4.15	6.00	4.65	27.82	19.25
Bt_2	142-200	2.10	3.05	3.50	24.05	16.55
Rubber						
Ap	0-13	6.20	8.90	4.80	30.99	21.57
Eo	13-24	5.70	8.35	4.10	25.16	17.19
B	24-42	6.05	8.65	3.35	20.91	14.63
Bt_1	42-115	4.35	6.35	4.30	21.84	14.96
Bt_2	115-200	2.25	3.35	3.25	20.80	14.01
Uncultivated barren						
A1	0-8	5.85	8.25	4.90	27.02	19.14
A2	8-37	5.35	7.70	4.15	25.97	18.05
E	37-74	5.75	8.00	3.60	22.28	16.02
Bt_1	74-108	3.75	5.55	4.65	21.16	14.32
Bt_2	108-200	2.15	3.15	3.90	22.54	15.89
CD (0.05)		2.06	0.20	NS	5.81	5.67

Exchangeable and extractable acidity

In the case of surface horizons, soils under rubber recorded lower value compared to that of other two land uses, though no significant difference could be observed. The exchangeable hydrogen did not show any significant difference. The exchange sites and soil solutions of the different pedons are dominated by exchangeable Al. The surface horizon of soils under cassava recorded significantly lower exchangeable Al compared to other land uses. The extractable acidity was very high compared to exchangeable acidity. Soil acidity is produced by natural processes like laterisation and the intensity is affected by different land uses. Removal of basic cations during biomass harvesting and accelerated leaching of base cations will contribute in a significant way to soil acidification (Marcar and Khanna, 1997).

CEC, ECEC and base saturation

The results of cation exchange capacity (CEC), effective cation exchange capacity (ECEC) and per cent base saturation (PBS) are given in Table 2. Though no definite pattern of CEC (NH_4OAc) was observed among similar horizons under different land uses, the CEC (sum of cations) of the hard laterite layer under cassava was significantly lower compared to that of rubber. Down the profiles, the CEC determined by both the methods decreased from epipedon to Bt_1 to Bt2 horizons. The ECEC didn't differ significantly among similar horizons under different land uses.

The per cent base saturation, determined by NH_4OAc method, revealed that there was significant difference in values between surface horizons of cassava (36.81%) and rubber (30.99 %). But in the case of Bt_1 horizon, highest value was noted in soils under cassava (27.82%) compared to those of rubber (21.84%) and uncultivated barren (21.16%). The base saturation (sum of cations) values were lower than base saturation (NH_4OAc) values in all three pedons.

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