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CHEMICAL AND PHYSICO-CHEMICAL CHARACTERISTICS OF THE RED SOILS OF KERALA*

K. Harikrishnan Nair and M. M. Koshy
College of Agriculture, Vellayani 695 522, Kerala

The studies of physical properties of the red soils revealed that these are highly weathered and porous soils. The plant growth is governed not only with the physical properties but also the chemical reactions in the soils, supply and availability of plant nutrients, the concentration of toxic or injurious substances in the soil solution etc. The present investigation was, therefore, undertaken to evaluate the chemical and physico-chemical characteristics of the red soils.

Materials and Methods

Twentyfour soil samples from twelve different sites studied for physical properties were investigated for their chemical characteristics. The pH of the samples was determined in 1:2.5 soil water suspension using photovolt pH meter and the electrical conductivity using solubridge. Organic carbon was estimated by the Walkely and Black's rapid titration method and total nitrogen by the Kjeldahl method using sulphuric acid-salicylic acid mixture. The cation exchange capacity was determined in neutral normal ammonium acetate and in the leachate, theexchangeable bases were determined (Piper, 1950). The available nitrogen was determined by the alkaline permanganate method (A 0 A C, 1960), available P by Bray's molybdenum blue method and available K using Morgan's reagent. In the HCl extract of the soil samples total sesquioxides, total Fe, Al, P, K, Ca and Mg were estimated (Jackson, 1958).

Results and Discussion

The soils are found to be acidic in reaction, the pH varied from 4.9 to 5.7 with an average of 5.3 for the surface samples and in the sub-surface samples the range of variation was from 4.8 to 5.9, the average being 5.3 (Table 1). The low salt content expressed as electrical conductivity in both the surface and sub-surface sampies ranged from 0 to 0.2 mmho/cm and the average values are 0.067 mmho/cm and 0.092 mmho/cm respectively. The organic carbon content in surface and sub-surface samples ranged from 0.41 to 0.88% and 0.41 to 0.85% and the average being 0.72 and 0.69% respectively. The average total N content in the surface and sub-surface samples ranged from 0.064 to 0.063%.

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Table 1

Physico-chemical properties of the soils

Sl. No.	pH	Conductivity m mho/cm	Moisture %	% on oven dry basis: Loss on ignition %	% on oven dry basis: Organic carbon %	Organic matter %
1 a	4.9	0.0	4.69	9.53	0.87	1.50
b	5.1	0.1	6.76	9,50	0.85	1.46
2 a	5.1	0.1	6.55	11.33	0.85	1.46
b	4.9	0.1	6.63	9.90	0.77	1.32
3 a	5.1	0.2	10.98	16.08	0.78	1.34
b	4.8	0.1	10.35	16.10	0.70	1,20
4 a	5.1	0.0	4.53	10.03	0.68	1.17
b	5.3	0.0	2.62	7.30	0.67	1.15
5 a	5·0	0.1	8.83	7.28	0.85	1.46
b	4.8	0.2	7.50	6.70	0.79	1.36
6 a	5.2	0.0	3.50	9,75	0.83	1.39
b	5.3	0.0	383	8.07	0.79	1.34
7 a	5.4	0.1	3.40	8.80	0.59	1.21
b	5.9	0.1	5.13	11.25	0.58	0.90
8 a	5.7	0.0	6.15	11.60	0.59	1.21
b	5.4	0.0	6.60	13.53	0.52	0.89
9 a	5.6	0.1	2.20	5.91	0.41	0.71
b	5.7	0.1	2.65	7.13	0.41	0.70
10 a	5.7	0.0	1.55	4.70	0.56	0.98
b	5,5	0.0	1.00	4.25	0.55	0.95
11 a	5.5	0.1	2.60	8,15	0.88	1.51
b	5.5	0.2	3.70	9,65	0.84	1.44
12 a	5.3	0.1	3.75	9.75	0.81	1,39
b	5.4	0.2	3.50	8.07	0.78	1,34

The organic matter and total N contents were very low, significant positive correlation was noted between them, and the contents decreased with depth (Tables 1 and 2).

One of the root causes for the low fertility of thered soils is the low content of organic matter and nitrogen. Raychaudhuri *et al*. (1943) reported that organic matter decomposed and depleted easily due to high temperature. Thomas (1962), Mahalingam (1962) and Iyengar (1963) obtained a high correlation between organic carbon and nitrogen. The average P_2O_5, K_2O, CaO and MgO contents were 0.125% 1.21%, 0.135% and 0.242% in the surface soils and 0.122%, 1.18%, 0.109% and 0.264% in the sub-surface soils respectively (Table 2).

Table 2

Distribution of N, P, K, Ca and Mg in the soils

Sl. No.	Percentage on oven dry basis				
	N%	P_2O_5%	K_2O%	CaO%	MgO%
1 a	0.08	0.09	1.44	0.17	0.27
b	0.08	0.09	1.32	0.12	0.24
2 a	0.07	0.09	1.21	0,11	0.15
b	0.07	0.09	1.20	0.08	0,36
3 a	0.07	0.11	1.31	0.12	0.15
b	0.06	0.10	1.34	0.11	0.18
4. a	0.06	0.10	0.92	0.10	0.33
b	0.06	0.09	0.87	0.07	0.23
5 a	0.08	0.14	1.16	0.15	0.22
b	0,07	0.15	1.09	0.14	0.18
6 a	0.07	0.13	1.20	0.17	0.15
b	0.07	0.13	1.26	0.12	0.24
7 a	0.05	0.16	1.31	0 22	0.54
b	0.05	0.14	1.37	0.17	9.69
8 a	0,04	0.18	1.22	0.12	0.24
b	0.03	0.17	1.27	0.11	0.20
9 a	0.04	0.08	1.12	0.10	0.45
b	0.04	0.11	1.08	0.08	0.33
10 a	0.05	0.11	1.16	0.14	0.18
b	0.05	0.11	1,08	0.12	0.18
11 a	0.08	0.13	1.17	0.07	0.09
b	0.07	0.14	1.11	0,06	0.13
12 a	0.08	0.18	1.31	0.17	0.15
b	0.07	0.17	1.20	0.12	0.24

The acidic nature of these soils is mainly due to the low base content especially calcium and magnesium. Koshy and Thomas Varghese (1971) reported a low lime status in these soils. These soils may be considered as containing a low level of P_2O_5 and a satisfactory level of K_2O. The average contents of Fe_2O_3, Al_2O_3, soluble silica and acid insolubles in the surface samples and sub-surface samples were 3.53 and 4.14%; 8.12 and 7.83%; 0 38 and 0.36% and 80.30 and 81.04* respectively (Table 3).

Table 3

Distribution of sesquioxides in the soils

Sl No.	Fe_2O_3 %	Al_2O_3 %	Soluble silica %	Acid insolubles %
1a	1.8	3,8	0,55	80.61
b	2.8	4.2	0.41	84.93
2a	2.6	9.1	0.44	80.35
b	3.1	7.4	0.46	80.30
3a	2.7	9.8	0.35	70.83
b	3.5	9.0	0.45	70,45
4a	2.6	4.7	0.28	82.25
b	3.8	4.2	0.31	90.83
5a	3.5	5.0	0.24	84.85
b	4.2	6.9	0.26	85,70
6a	4.7	7.5	0.15	78.73
b	5.1	7.6	0.22	79.63
7a	3.7	8.7	0.28	81.45
b	4.3	10.9	0.35	77.23
8a	2.9	10.3	0.55	76.60
b	3.3	12.7	0.24	78.30
9a	4.0	6.0	0.53	85.68
b	4.5	8.0	0.56	83.40
10a	3.6	6.9	0.53	88.00
b	4.0	5.2	0.53	86.08
11a	5.7	17.9	0.52	75.50
b	6.1	10.2	0.30	75.90
12a	4.5	7.7	0.18	78.78
b	5.0	7.7	0.25	79.68

The proportions of Fe_2O_3 and Al_2O_3 were generally very high and the silica sesqui-oxide ratio very low, indicating the extent of weathering.

The average cation exchange capacity in the surface and sub-surface samples were 4.85 and 4.16 me/100 g respectively (Table 4),

Table 4

Exchange properties of the soils

Sl. No.	CEC me/ 100g	Total exch. bases	% base satur- ation	Ca me/ 100g	Mg me/ 100g	K me/ 100g	Na me/ 100g	H me/ 100g
la	4.8	3.94	82 08	1.54	1.20	1.11	0.09	0.84
b	4.0	3.36	81.50	1 07	1.15	1.03	0.01	0.74
2a	5.3	4.37	82.45	1 75	1.32	1.22	0.08	0.93
b	4.0	3.71	90.28	1.54	1.09	1.00	0,08	029
3a	5.0	4.15	83.00	1.62	1.28	1.22	0.03	0.85
b	3.7	3.55	95.95	1.65	0 93	1.03	0.04	0.15
4a	2.9	1.85	63.79	0.93	0.07	0.80	0.05	1.05
b	2.6	1.63	62.69	0.87	0.05	0.67	0.04	0.97
5a	4.6	3.82	83.05	1.51	1.21	1.10	0.002	0.68
b	4.3	3.70	86.05	1.58	1.12	1.00	0.004	0 60
6a	5.1	4.20	82.35	1.88	1.26	1.05	0.011	0.90
b	4.7	3.85	81.92	1.65	1.17	1.02	0.012	0.85
7a	6.5	4,85	74.61	1.95	1.59	1.30	0.006	1.65
b	4,8	4.04	84.16	1.88	1.10	1.06	0 001	0.76
8a	4.9	3.94	80.41	1.69	1.19	1.08	0.031	0.96
b	4.5	3.65	81.11	1.41	1.22	1.01	0.012	0.85
9a	5.0	4.03	80.60	1.67	1.31	1.05	O.C02	0.97
b	4.1	3.23	78.78	1.63	0.61	0.99	0.002	0.87
10a	5.2	3 96	76.15	1.55	1.29	1,11	0.006	1.24
b	4 6	2.79	82.37	1.46	1.24	1.08	0,012	0.81
11a	3.9	3.14	80.51	1.08	1.13	0.92	0.009	0.76
b	3.8	3.02	84.74	1.22	0.91	0.88	0,011	0.78
12a	5.0	4.09	81.80	1.65	1 33	1.11	0.002	0.91
b	4.8	3 80	79.17	1.54	1.22	1.03	0.007	1.00

The low CEC must be due to the low organic matter content and the low pH. Menon and Mariakulandai (1957) reported that the CEC was much lower than the black soils on account of the presence of kaolinite type of clay mineral in the red soils of Tamil Nadu. The exchangeable Ca, Mg, K and Na in the surface soils varied from 0.98 to 1.95, 0.07 to 1.59, 0.80 to 1.30 and 0.002 to 0.09 me/100g respectively. The range of variation for these exchangeable cations in the sub-surface samples were 0.87 to 1.88, 0.05 to 1.24, 0.67 to 1.08 and 0,001 to 0.08 me/1 OOg respectively. The surface samples recorded a higher CEC and other exchangeable bases than the sub-surface samples. The exchangeable calcium forms the largest portion in the exchange complex. The particular cation dominating in the exchange complex is responsible to a great extent for the development of soil structure. Divalent cations such as calcium, if present, improves the general tilth of soil unlike the high concentration of monovalent sodium ions. Menon and Mariakulandai (1957) reported similar results as regard to the cation exchange properties of the red soils. The CEC of the soil is known to include individual contributions made both by the quantity and quality of the individual clay minerals. The low cation exchange capacity also indicates the poor fertility status of the soils.

As regards to the available major nutrients (Table 5} the average contents of N, P_2O_5 and K_2O in the surface samples were 80 ppm, 3 ppm and 32 ppm

Table 5

Distribution of available N, P and K in the soils

Sl, No.	Available N (ppm)	Available P (ppm)	Available K (ppm)
1 a	129	0.88	33.2
b	103	0.44	33.2
2 a	86	0.44	24.9
b	60	0.44	24.9
3 a	60	0.88	33.2
b	60	0.88	33.2
4 a	60	0.88	16.6
b	52	0.44	12.5
5 a	129	1.76	20.8
b	60	2.20	20.8
6 a	86	1.32	24.9
b	86	1.32	24.9
7 a	62	2.20	33.2
b	52	1.76	33.2
8 a	43	2.64	24.9
b	43	2.20	29.1
9 a	43	0.44	24.9
b	43	0.88	20.8
10 a	52	0.88	24.9
b	52	0.88	20.8
11 a	129	1.32	24.9
b	86	1.32	24.9
12 a	86	2.64	33.2
b	60	2.64	29.1

respectively. The values for the sub-surface samples wers 63 ppm, 3ppm and 31 ppm respectively. Here also the values are higher for surface samples than the sub-surface ones. From the fertility stand point, the availability of nutrients in the soils is important. The low available N content may be due to low organic matter and the low total N content. The high leaching of these soils tends to deplete them of the available N. Krishnamoorthy (1986) obtained high correlations between different forms of N in soils and its availability. As for P_2O_5, the low availability may be due to fixation and low P_2O_5 status and the low availability of K_2O may be attributed to the low exchange capacity.

Summary

Red soils are acidic with low salt concentration. The low contents of organic matter, major nutrients and their low availability, poor cation exchange capacity and other exchange characteristics indicate that these are low fertile soils Since the red soils are with good physical properties, the soil productivity can be substantially increased with the judicious application of organic manures and chemical fertilizers.

സംഗ്രഹം

കേരളത്തിലെ ചുവന്ന മണ്ണിന്റെ രാസഗുണങ്ങൾ പരിശോധിച്ചപ്പോൾ, അവ സാമാന്യം അമ്ലമുള്ളതും, ലവണാംശം കുറഞ്ഞതും ആണെന്ന് കണ്ടു. ജൈവാംശത്തിന്റെയും മുഖ്യ പോഷകമൂലകങ്ങളുടെ അളവിലും അവയുടെ ലഭ്യതയിലുമുള്ള കുറവും ധനായണ വിനിമയത്തിലുള്ള കുറവും കാരണം ഈ മണ്ണ് ഫലപുഷ്ടി കുറഞ്ഞതായി തെളിഞ്ഞു. ഭൗതിക ഗുണങ്ങൾ പൊതുവേ അനുയോജ്യമായ കാരണം ക്രമാനുഗതമായ ജൈവവളപ്രയോഗവും രാസവളപ്രയോഗവുംകൊണ്ട് ഇത്തരം മണ്ണിന്റെ ഉൽപാദനശേഷി വർദ്ധിപ്പിക്കാവുന്നതാണ്.

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