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Characterization and Classifications of Soils in an Experimental Farm in the Tiruvannamalai District, Tamil Nadu, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

It is essential to characterize and classify soil resources in order to plan agricultural land use agroforestry, agri-horticulture and silvipastoral farming systems. In the present study, an attempt was made to characterize and classify the soils occurring on different topography in an experimental farm in Tiruvannamalai District of Tamil Nadu, India. A detailed soil survey was carried out using cadastral map. Physiographically, the area has been characterized into Pediplain shallow weathered and Pediplain moderately weathered which were further subdivided based on slope and erosion categories. Six typical pedons were identified based on landform and their soil morphological properties. The soils were very shallow to moderately deep, dark reddish brown to

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yellowish red (red soils) in colour with sub-angular blocky in structure, These soils were sandy loam to sandy clay loam in texture, slightly acidic to mildly alkaline (3.28-7.70) in reaction (non-saline soils) and had low to medium (1.2 to 6.4 g/kg) organic carbon content. Calcium and magnesium were the dominant exchangeable cations followed by sodium and potassium. Taxonomically these soils were classified as Typic Rhodustalfs, Typic Haplustalfs, Vertic Haplustepts and Typic Haplustepts at the subgroup level.

Keywords: Soil survey; soil characterization; soil classification; soil physical; chemical characteristics.

1. INTRODUCTION

"Soil is a dynamic natural resource that determines the ultimate sustainability of any agricultural system. Water movement, water quality, land use, and vegetation productivity are all influenced by the soil" [1]. "Soil is recognized as a base for every production system and knowledge of their properties, extent and spatial distribution is extremely important to maintain soil resources to sustain the ecosystem and site-specific soil management practices". [2] "The indigenous ability of soils to supply sufficient amount of essential nutrients has decreased with higher plant productivity levels associated with increased human demand for food. Therefore, one of the greatest challenge today for every stakeholder of agriculture is to develop and implement such soil, crop and nutrients management technologies that could enhances the plant productivity and also improve the quality of soil, water and air. The understanding of the processes through profile study helps of basis their characterization. The systematic study of morphology, physicochemical characteristics and taxonomy of soils provides information on the nature and type of soils, their constraints, potentials, capabilities and their suitability for various uses" [3,4]. "The data generated through systematic soil resource inventory and characterization will help to formulate agro-interventions for management of these soils under existing delivery extension systems agriculture schemes, and value chains, so that new technologies could be adopted for sustainable production" [5,6]. The information on characteristics of different layer of soils in the experimental farm is lacking and hence present study was carried out.

2. MATERIALS AND METHODS

2.1 Description of the Study Area

The study was carried out in in soils of experimental farm of Agricultural college and TResearch Institute, Vazhavachanur, Tamil Nadu Agricultural university in Tiruvannamalai district,

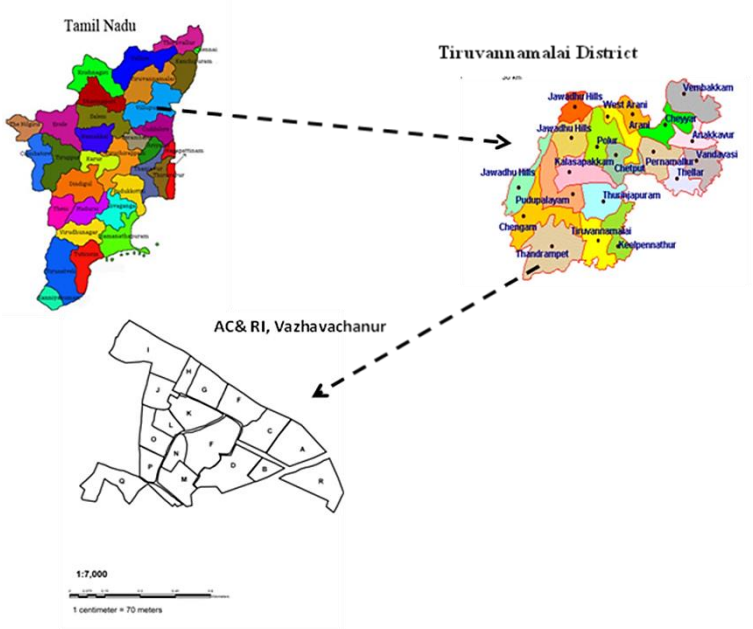

Fig. 1. Study area located in AC & RI, Vazhavachanur farm of Tiruvannamalai District, Tamil Nadu, India

Tamil Nadu, India. Geographically the study area is located between 12°4'15" N to 12°4'45" N Latitude and 78°59'0" E to 77°59'25" E Longitudes at an elevation of 168 m above the mean sea level (MSL) (Fig. 1). The annual rainfall of the region is 759.4 mm. The mean maximum and minimum temperatures are 38°C and 21°C, respectively. Geologically it is underlain by granites. Geomorphologically, the Vazhavachanur farm is categorized as Pediplain.

2.2 Soil Sampling Methodology

"A detailed soil survey was carried out using cadastral map of Vazhavachanur village. The soils belong to Kurumbalur series. Six typical pedons were selected based on landform and their soil morphological properties. The horizon-wise soil samples were collected, processed and analysed using standard analytical methods and soils were classified" [7].

3. RESULTS AND DISCUSSION

3.1 Physiography and Soils

Physiographically, the area has been characterized into Pediplain shallow weathered and Pediplain moderately weathered which were further subdivided based on slope and erosion categories. Six soil profiles were dug in C, D, G, J, O and P blocks of AC&RI, Vazhavachanur farm based on the physiography of the soils. The soils of C, D and O Block are categorized as pediplain moderately weathered. The soils of G, J and P block belongs to pediplain shallow weathered.

3.2 Morphological Features of Soils

The soils of Pediplain shallow weathered (soils of G, J and P block) are moderately shallow, well drained, noncalcareous and severely eroded. The soils of nearly level pediplain moderately weathered (soils of C, D and O Block) are moderately deep, moderately well drained, non calcareous and moderately eroded. The soils of the farm belong to the Kurumbalur soil series. Based on the properties, the soils were grouped under Inceptisol and Alfisol (Table 1).

3.3 Physical Properties of Soils

The coarse fragments of the pedons varied from 9.55 to 59.89 per cent (Table 1). The coarse fragments were mainly of quartz fragments. The irregular nature of gravels suggested that they were formed in situ. The surface soils possessed loamy sand to sandy clay loam texture and subsurface soils possessed sandy loam to sandy clay loam texture. The clay content of these soils ranged from 11.00 per cent in G block to 38.28 per cent in P Block. Unimodal distribution i.e., increase of clay upto certain depth and then decrease was observed in soils of O block. An increase in clay content was primilary due to illuviation. The clay content gradually increased with the depth in soils of C, D and J blocks. This may be due to combined effect of *insitu* clay formation and illuviation [8]. "In P block there was no wide textural class variation. This could be ascribed to increased compaction and decreased aggregation caused by decreased OC and clogging of pores by dispersed clay in sub-soil layers" [9].

3.4 Chemical Properties of Soils

The soils are slightly acidic (pH 6.28) to mildly alkaline (pH 7.70) and this variation was attributed to the nature of parent material (Table 2). The electrical conductivity values (dS m^{-1}) varied from 0.01 in C Block to 0.40 in J Block. The OC content ranged from 1.2 to 6.4 g/kg, and categorized as low to the medium. The surface horizons had higher than the sub-surface horizons because of more biomass addition [10,11]. The $CaCO_3$ ranged from 0.13 to 0.88 %. The cation exchange of the soils (cmol $P^{(+)}$ kg^{-1}) varied from 6.44 in D Block to 27.57 in C block. The wide range of CEC is related to the amount and type of clay, and the of organic carbon content in these soils [12,13]. "The depth wise distribution of CEC had same trend as that of clay distribution. The exchangeable bases in the all the pedons were in the order of Ca^{+2}> Mg^{+2}> Na^{+} > K^{+}" [14].

3.5 Classification of Soils

Based on the morphological, physical and chemical properties of the soils were classified (4 Soil Survey Staff 2022). viz. Inceptisol and Alfisols. J Block and P block soils were grouped under Inceptisols based on the presence of Cambic subsurface horizon. J Block soils was placed under Vertic Haplustepts due to the presence of Vertic properties. "C Block soils were classified as classified as Rhodustalfs because of occurrence of sub-horizons in the upper 100 cm of the argillic horizon or throughout the entire argillic horizon if less than 100 cm thick, more than 50 per cent colours that have hue of 2.5YR

Table 1. Morphological and physical properties of soils of AC &RI, Vazhavachanur farm

Horizon	Depth	Colour	Texture	Structure	Bulk density M gm^{-3}	Particle density M gm^{-3}	Gravel (%)	Clay (%)	Silt (%)	Sand (%)
C block- Loamy skeletal, Mixed, isohyperthermic, Typic Rhodustalfs										
Ap	0-35	5YR4/6	sl	2msbk	1.27	2.30	26.47	15.10	9.20	75.70
Bt1	35-60	2.5YR4/6	scl	3msbk	1.33	2.00	31.76	25.00	22.20	52.80
Bt2	60-80	2.5YR4/6	scl	2msbk	1.41	1.80	59.89	27.60	22.00	50.40
D Block –Loamy skeletal, Mixed, isohyperthermic, Typic Haplustalfs										
Ap	0-30	7.5YR 6/6	sl	2msbk	1.14	2.50	9.55	18.90	13.50	67.60
Bt1	30-50	5YR5/6	scl	2msbk	1.43	2.20	15.76	24.38	10.73	64.89
Bt2	50-60	5YR5/6	scl	2msbk	1.51	2.00	25.81	29.43	9.99	60.58
G Block –Fine loamy, Mixed, isohyperthermic, Typic Haplustalfs										
Ap	0-20	5YR3/4	ls	1mgr	1.26	2.22	28.47	11.00	13.40	75.60
Bw	20-50	2.5YR3/6	scl	1msbk	1.42	2.00	43.35	37.28	4.82	57.90
J Block – Fine loamy, Mixed, isohyperthermic, Vertic Haplustepts										
Ap	0-20	10YR 3/2	scl	3msbk	1.46	2.16	9.68	19.20	15.68	65.12
B1	20-40	7.5YR3/4	sl	3msbk	1.22	2.05	24.68	14.20	12.26	73.54
O Block–Fine loamy, Mixed, isohyperthermic, Typic Haplustalfs										
Ap	0-25	5YR 4/4	scl	2msbk	1.11	2.22	11.67	24.00	5.10	70.90
Bt1	25-40	2.5YR 4/8	scl	2msbk	1.25	2.17	15.93	26.80	7.00	66.20
Bt2	40-70	2.5YR 4/6	scl	2msbk	1.17	1.96	22.83	23.20	18.80	58.00
P Block –Fine loamy, Mixed, isohyperthermic, Typic Haplustepts										
Ap	0-30	5YR 4/3	scl	2msbk	1.33	1.81	13.74	38.28	8.25	53.47
B1	30-60	5YR 4/6	scl	3msbk	1.25	1.66	24.93	36.11	3.87	60.02

Soil texture: sl - Sandy loam; scl – sandy clay loam; ls - loamy sand; cl - Clay loam; sc – sandy clay; c - Clay

Soil structure: f- fine; m - Medium; c - coarse; 1 -weak; 2 - moderate; 3-strong;gr – granular; sbk - subangular blocky, abk -angular blocky

Table 2. Chemical properties of soils of AC &RI, Vazhavachanur farm

Horizon	Depth	PH (1:2.5)	EC (dSm^{-1})	OC (g/kg)	$CaCO_3$ (%)	CEC cmol (p^+) kg^{-1}	Exchangeable Cations cmol (p^+) kg^{-1}				BSP (%)	ESP (%)
							Ca	Mg	Na	K		
C block- Loamy skeletal, Mixed, isohyperthermic, Typic Rhodustalfs												
Ap	0-35	6.56	0.02	6.4	0.75	27.57	15.00	4.50	0.54	0.19	73.40	1.97
Bt1	35-60	6.28	0.01	5.6	0.25	16.92	8.00	4.00	0.22	0.16	73.15	1.28
Bt2	60-80	6.15	0.01	3.6	0.13	21.41	4.24	2.12	0.26	0.15	31.62	1.21
D Block –Loamy skeletal, Mixed, isohyperthermic, Typic Haplustalfs												
Ap	0-30	6.30	0.10	5.1	0.53	6.44	2.38	1.92	0.05	0.05	68.32	0.78
Bt1	30-50	6.60	0.10	4.8	0.35	13.35	2.12	1.06	0.44	0.28	29.14	3.26
Bt2	50-60	6.90	0.10	3.9	0.18	10.00	4.00	1.62	0.44	0.28	63.30	4.35
G Block –Fine loamy, Mixed, isohyperthermic, Typic Haplustalfs												
Ap	0-20	6.90	0.05	4.8	0.42	9.25	5.00	2.50	0.51	0.03	86.96	5.52
Bw	20-50	7.10	0.02	4.5	0.28	15.62	10.80	0.42	0.68	0.02	76.31	4.35
J Block – Fine loamy, Mixed, isohyperthermic, Vertic Haplustepts												
Ap	0-20	7.20	0.40	4.6	0.48	21.41	4.24	2.12	0.26	0.15	31.62	1.21
B1	20-40	6.90	0.30	3.0	0.41	14.72	7.50	3.00	0.22	0.19	74.11	1.48
O Block– Fine loamy, Mixed, isohyperthermic, Typic Haplustalfs												
Ap	0-25	6.85	0.12	2.4	0.65	10.60	3.20	1.40	0.07	0.39	47.74	0.66
Bt1	25-40	6.27	0.17	4.5	0.45	9.80	2.40	2.40	0.01	0.27	51.84	0.10
Bt2	40-70	7.15	0.22	4.2	0.33	8.60	2.10	1.70	0.01	0.12	45.70	0.12
P Block – Fine loamy, Mixed, isohyperthermic, Typic Haplustepts												
Ap	0-30	6.40	0.20	2.9	0.88	16.19	10.05	4.38	0.36	0.11	92.07	2.41
B1	30-60	7.70	0.20	1.2	0.75	14.76	9.49	4.75	0.36	0.15	98.97	2.43

Table 3. Soil mapping units and taxonomic classification of AC &RI, Vazhavachanur farm

Name of the block- name of the series	Mapping unit	Taxonomic classification
C Block - Kurumbalur	$\frac{Kbr\text{-}sl(g)\text{-}d_4}{A\text{-}e_2}$	Loamy skeletal, Mixed, isohyperthermic, Typic Rhodustalfs
D Block- Kurumbalur	$\frac{Kbr\text{-}sl(g)\text{-}d_4}{A\text{-}e_2}$	Loamy skeletal, Mixed, isohyperthermic, Typic Haplustalfs
G Block- Kurumbalur	$\frac{Kbr\text{-}ls\text{-}d_3}{B\text{-}e_1}$	Fine loamy, Mixed, isohyperthermic, Typic Haplustalfs
J Block- Kurumbalur	$\frac{Kbr\text{-}scl\text{-}d_3}{B\text{-}e_1}$	Fine loamy, Mixed, isohyperthermic, Vertic Haplustepts
O Block- Kurumbalur	$\frac{Kbr\text{-}scl\text{-}d_4}{B\text{-}e_1}$	Fine loamy, Mixed, isohyperthermic, Typic Haplustalfs
P Block- Kurumbalur	$\frac{Kbr\text{-}scl\text{-}d_4}{B\text{-}e_1}$	Fine loamy, Mixed, isohyperthermic, Typic Haplustepts

or redder and value, moist, of 3 or less. Similarly at sub group level, these soils did not exhibit any integration with other taxa nor deviated from central concept of Rhodustalfs are placed in Typic Rhodustalfs. C, D and G block soils were grouped under Alfisols since the illuviation of clay and the presence of base saturation more than 35% throughout the depth of the soil horizons and ustic moisture regime" [15].

4. CONCLUSION

The study showed that the soils of Pediplain shallow weathered (soils of G, J and P block) are moderately shallow, well drained, noncalcareous and severely eroded. The soils of nearly level pediplain moderately weathered (soils of C, D and O Block) are moderately deep, moderately well drained, non calcareous and moderately eroded. The formation of diverse group of soils could be attributed to the effect of topography, vegetation and climate leading to various pedogenic processes. The soils of the study area were slightly acidic to mildly alkaline in reaction (non saline) and had low to medium OC content and low to medium CEC. These soils were classified as Typic Rhodustalfs, Typic Haplustalfs, Typic Haplustepts and Vertic Haplustepts. The main constraints were depth, slope, excessive drainage and low water holding capacity in these soils.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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