



Assessment of Physico-chemical Properties of Soil from Different Blocks of Theni 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

An assessment of Physico-chemical properties of soil from different blocks of Theni district, Tamil Nadu carried out 2022. The prime objectives of this study were to carry out the physico-chemical properties of soil at different depths of various sites of Andipatti, Theni and Bodi Blocks of Theni District in the state of Tamil Nadu for assessing the availability of macro-nutrient present in soil of selected locations. Soil samples were collected with depth of 0-15 cm, 15-30 cm and 30-45 cm respectively. Soil textural classes were sandy loam. It clearly indicated that soil has good Water Holding Capacity (39.60 to 44.93%) and good physical condition, Bulk Density (0.938 Mg m⁻³ to 1.365 Mg m⁻³). Particle Density (2.124 Mg m⁻³ to 2.866 Mg m⁻³). % Pore Space (42.143% to 48.118%). The pH of soil is slightly acidic to neutral in nature (5.517 to 6.687) and the Electrical Conductivity (0.121 to 0.229 dS m⁻¹) was suitable for all crops. Organic carbon ranged from medium to high (0.17 to 0.48%). These soils have low Nitrogen (127 kg ha⁻¹ to 252 kg ha⁻¹) in all villages. Phosphorus (9.74 kg ha⁻¹ to 17.8 kg ha⁻¹) content is Medium at eight locations and low at

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one location. Potassium (82.03 kg ha^{-1} to $164.26 \text{ kg ha}^{-1}$) is low to medium. Exchangeable calcium ($6.26 \text{ cmol (p}^+) \text{ kg}^{-1}$ to $10.26 \text{ cmol (p}^+) \text{ kg}^{-1}$) and Magnesium ($1.93 \text{ cmol (p}^+) \text{ kg}^{-1}$ to $5.13 \text{ cmol (p}^+) \text{ kg}^{-1}$) are very sufficient in this soil. There is an including awareness of the need to pay greater attention in the role of macronutrients enhancement in the soil for good soil health and proper nutrition of plant so as to attain optimum economic yield.

Keywords: Theni district; physico-chemical properties; soil health.

1. INTRODUCTION

“Soil is the soul of infinity life and is generally refer to the loose material composed of weathered rock and other materials including partly decayed organic matter. It is a reservoir of nutrients and place a pivotal role in supporting the growth of crops and other vegetation maintaining the earth’s environment clean. It also acts as a source and sinks for atmospheric gases” (Ratan et al. 2011). “Soil testing makes complete nutrient control possibility Fertilizer experiments are being patterned to determine economically optimum rates of nutrients application high yields with low production costs per unit are a must in modern farming. Farmers of today are different in the failure is more certain and sooner unless they are obtaining reasonably high yields, improved drainage, many improved Cultural practices, disease have helped to set the stage for high yields” [1]. “Soil provides food, fuel and fodder for meeting the needs of human and animal. With the growth in human and animal population demand for more food production is in the increase. However, the capacity of soil to produce is limited and limits to production and set by intrinsic characteristics, agro ecological setting. This demand systematic appraisal of our soil resources with respect to their extent, distribution, characteristics, behavior and use potential, which is very important for developing an effective land use system for augmenting agricultural production on sustainable basis” (FAO, 1993)

Keeping in view of importance of soil's physical and chemical properties, the present study of Physico-chemical properties of soil collected from various locations of district of Theni, Tamil Nadu undertaken. The soil sample collection is from 3 blocks of Theni District in the state of Tamil Nadu. Each selecting 3 villages. Samples will be collected randomly from a site of each village using soil auger, Khurpi Knife by composite sampling method at a depth of 0-15, 15-30 and 30-45 cm.

A comparison of the Physico-chemical Properties of some of the soils of different regions of the Tamil Nadu state has been undertaken by comparing the results of the present study with the studies done earlier in the other regions of the state. Hence, a detailed study for evaluation of soils is needed to realize the concept of Physico-chemical analysis successfully. With this background a study has been undertaken in soil resources inventory for sustainable land use planning in Theni district of Tamil Nadu.

2. MATERIALS AND METHODS

2.1 Sampling Site and Collection

Tamil Nadu, state of India, located in the extreme south of the subcontinent. It is bounded by the Indian Ocean to the east and south and by the states of Kerala to the west, Karnataka (formerly Mysore) to the northwest, and Andhra Pradesh to the north. Enclosed by Tamil Nadu along the north-central coast are the enclaves of Puducherry and Karaikal, both of which are part of Puducherry union territory. The capital is Chennai (Madras), on the coast in the north eastern portion of the state.

Soil samples were collected from 3 different Blocks of Theni district in Tamil Nadu. Three different locations selected from each block. Samples were collected randomly from three site of each block using soil auger, Khurpi, Knife by composite sampling method at depths of 0-15, 15-30 and 30-45cm. Twenty Seven Samples are collected with the help of GPS . “All the samples were divided into four parts and then among them two samples are collected and only half kg sample is being taken for the soil analysis by the conning and quartering method” [2].

2.2 Methods

“Analysis of the soil samples were under the methods, the physical parameters include Soil Colour, Soil Texture, Bulk Density, Particle Density, Pore Space and Water Holding Capacity whereas chemical parameters include pH,

Electrical Conductivity, Organic Carbon and Macro-Nutrients (N, P, K, Ca and Mg) Soil textural class was determined by using Hydrometer” [3]. “Bulk density, Particle density, Water holding capacity was determined by using Graduated Measuring Cylinder method (Muthuaval et al. 1992), pH was estimated with the help of Digital pH meter after making 1:2 soil water suspension [4], Electrical Conductivity was estimated with the help of Digital Conductivity meter (Wilcox, 1950) and Percent Organic Carbon was estimated by Wet Oxidation method” [5].

“Available Nitrogen was estimated by Alkaline Potassium Permanganate method, using Kjeldahl apparatus [6], available Phosphorus was estimated by Olsen’s extraction followed by Spectrophotometric method [7], available Potassium was estimated by Neutral normal Ammonium Acetate extraction followed by Flame photometric method [8], Exchangeable Ca^{2+} and Mg^{2+} were estimated by EDTA method” (Cheng and Bray, 1951) [9-14].

3. RESULTS AND DISCUSSION

3.1 Physical Properties

The Soil Textural classes identified were Sandy Loam. The sand, silt and clay percentage varied from 68.3 to 75.7 sand, 12.7 to 19.2 silt and 12.7 to 25.3 clay in Sandy Loam. Bulk Density was varied from the 0.938 Mg m^{-3} to 1.365 Mg m^{-3} and the highest Bulk Density was found in S_5 (1.365 Mg m^{-3}) which sites from Theni Block. The

Particle Density varied from 2.124 Mg m^{-3} to 2.866 Mg m^{-3} and the highest Particle Density was found in S_3 (2.866 Mg m^{-3}) which site from the Andipatti Block. The Pore Space (%) ranged from 42.143% to 48.118%. The highest Pore Space % was found at site S_6 (48.118) from the Theni Block. The Water Holding Capacity (%) ranged from 39.60 to 44.93% and S_6 from the Theni Block hold the water best at 44.93% [15-18].

3.2 Chemical Properties

“The pH value ranged from 5.517 to 6.687 and the highest value was recorded at site S_6 (pH 6.687) from the Theni Block. The Electrical Conductivity ranged from 0.121 to 0.229 dS m^{-1} and the highest value was recorded at the site S_4 (0.229 dS m^{-1}) from the Theni Block and the soil was found to be normal. The value of total Organic Carbon (%) varied from 0.17 to 0.48% and the organic carbon content was found low in all sites” [2].

3.3 Primary Nutrients

The available Nitrogen content of soil ranged from 127 to 252 kg ha^{-1} and nitrogen content was low in all villages. The available Phosphorus content of soil ranged from 9.74 to 17.8 kg ha^{-1} . 5 Samples have low phosphorous content and 22 Samples are having medium phosphorus content. Available Potassium content of soil ranged from 82.03 to $164.26 \text{ kg ha}^{-1}$. 20 number of Samples having Medium and 7 samples have low in potassium content [19-22].

Table 1. Soil texture and soil colour of Theni district

Block Name & Sites	Soil Colour		Soil Texture
	Range (Dry Condition)	Range (Wet Condition)	
Andipatti			
S1	Brown	Dark brown	Sandy Loam
S2	Yellowish brown	Very Dark brown- Dark brown	Sandy Loam
S3	Yellowish Red	Yellowish red – Yellow greyish red	Sandy Loam
Theni			
S4	Very Dark Greyish Brown – Darkesh grey	Dark brown	Sandy Loam
S5	Brown	Brown	Sandy Loam
S6	Very Dark brown – Dark brown	Dark brown	Sandy Loam
Bodi			
S7	Brownish brown	Very Dark brown	Sandy Loam
S8	Reddish brown	Reddish brown - Yellowish Red	Sandy Loam
S9	Yellowish red	Dark Reddish brown	Sandy Loam

Table 2. Evaluation of bulk density and particle density soils of Theni district

Block Name & Sites	Bulk Density (Mg m ⁻³)			Particle Density (Mgm ⁻³)		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Andipatti						
S ₁	0.810	0.906	1.100	2.223	2.225	2.229
S ₂	1.001	1.006	1.231	2.513	2.516	2.521
S ₃	0.902	0.905	1.256	2.862	2.865	2.872
Theni						
S ₄	1.006	1.010	1.234	2.120	2.124	2.129
S ₅	1.362	1.365	1.368	2.221	2.225	2.229
S ₆	1.189	1.193	1.427	2.226	2.231	2.235
Bodi						
S ₇	1.045	1.049	1.363	2.227	2.231	2.235
S ₈	1.193	1.198	1.414	2.507	2.510	2.514
S ₉	1.057	1.059	1.237	2.220	2.225	2.228
	F-Test	S. Em. ±	C.D @5%	F-Test	S. Em. ±	C.D @5%
Depth (0-15 cm)	S	0.091266	0.271166	S	0.022323	0.066
Depth (15-30 cm)	S	0.090919	0.270135	S	0.036777	0.10927
Depth (30-45 cm)	S	0.089722	0.266579	S	0.025971	0.077162

Table 3. Estimation of and pore space (%) and water holding capacity

Block Name & Sites	Pore Space (%)			Water holding (%)		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Andipatti						
S ₁	47.001	46.132	45.231	42.42	41.38	40.36
S ₂	47.168	45.114	44.12	43.23	42.20	41.18
S ₃	48.045	47.131	46.122	45.87	44.98	43.96
Theni						
S ₄	46.13	45.019	44.074	42.22	41.19	40.17
S ₅	46.164	45.201	44.091	41.89	40.86	39.85
S ₆	49.135	48.121	47.098	45.76	44.74	43.72
Bodi						
S ₇	43.258	42.143	41.029	39.92	38.89	37.87
S ₈	48.145	47.031	46.022	44.28	43.26	42.23
S ₉	44.123	43.029	42.197	40.63	39.61	38.58
	F-Test	S. Em. ±	C.D @5%	F-Test	S. Em. ±	C.D @5%
Depth (0-15 cm)	S	0.944951	2.807593	S	0.846978	2.5165
Depth (15-30 cm)	S	0.590994	1.755932	S	0.505298	1.501319
Depth (30-45 cm)	S	0.565983	1.681621	S	0.5903351	1.755485

Table 4. Estimation of soil pH (1:2), EC (d_{sm}⁻¹) and OC (%)

Block Name & Sites	pH			EC(d _{sm} ⁻¹)			OC (%)		
	0-15 cm	15-30 cm	30-45cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Andipatti									
S ₁	5.331	5.710	5.512	0.133	0.123	0.107	0.21	0.20	0.19
S ₂	5.353	5.257	5.253	0.127	0.196	0.131	0.19	0.18	0.17
S ₃	5.744	5.615	5.557	0.168	0.148	0.146	0.21	0.19	0.18
Theni									
S ₄	5.854	5.863	5.866	0.286	0.224	0.177	0.48	0.45	0.44
S ₅	6.245	6.377	6.398	0.162	0.142	0.113	0.30	0.27	0.26
S ₆	6.510	6.733	6.818	0.235	0.195	0.154	0.33	0.32	0.30
Bodi									
S ₇	6.277	6.327	6.330	0.247	0.187	0.161	0.36	0.34	0.33
S ₈	6.192	6.225	6.227	0.273	0.216	0.152	0.41	0.40	0.39
S ₉	6.257	6.265	6.273	0.194	0.144	0.108	0.42	0.40	0.39
	F-Test	S. Em. ±	C.D @5%	F-Test	S. Em. ±	C.D @5%	F-Test	S. Em. ±	C.D @5%
Depth (0-15 cm)	S	0.091266	0.271166	S	0.002735	0.008125	S	0.002891	0.008591
Depth (15-30 cm)	S	0.090919	0.270135	S	0.002278	0.006769	S	0.004106	0.0122001
Depth (30-45 cm)	S	0.089722	0.266579	S	0.002376	0.00706	S	0.002823	0.0088389

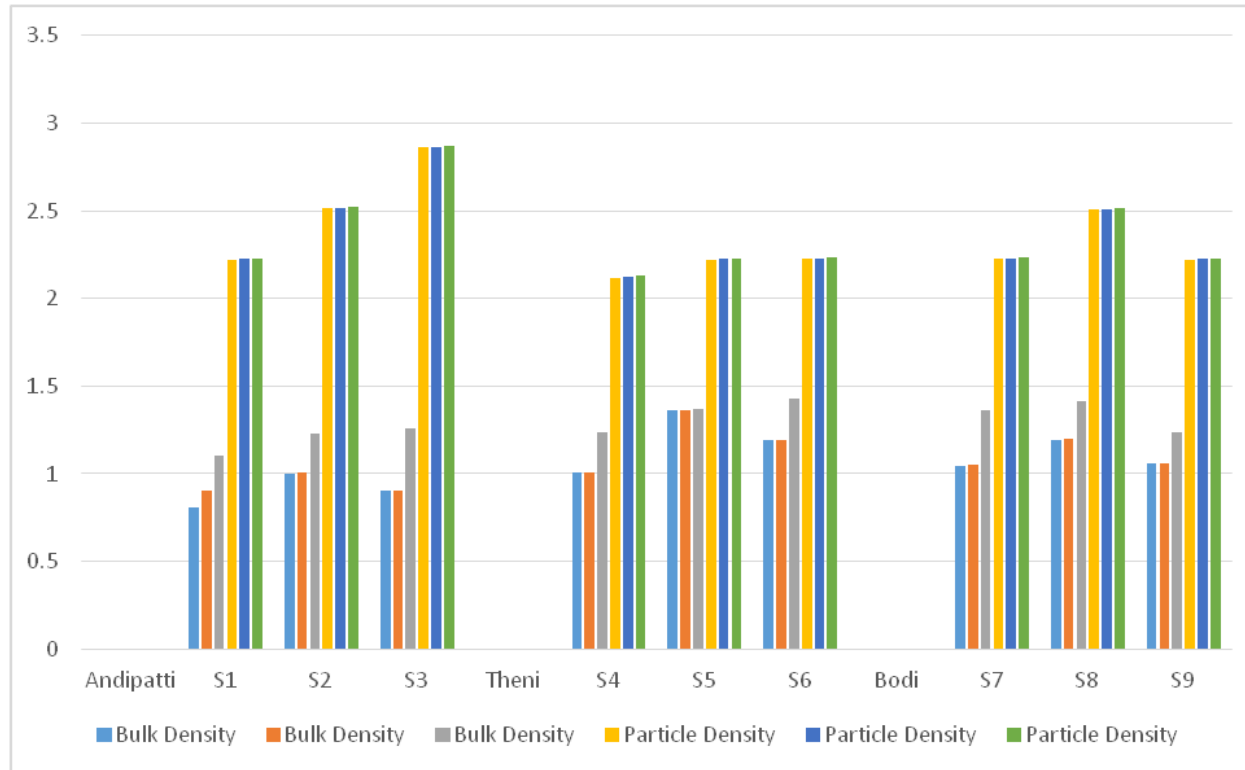


Fig. 1. Bulk density, particle density

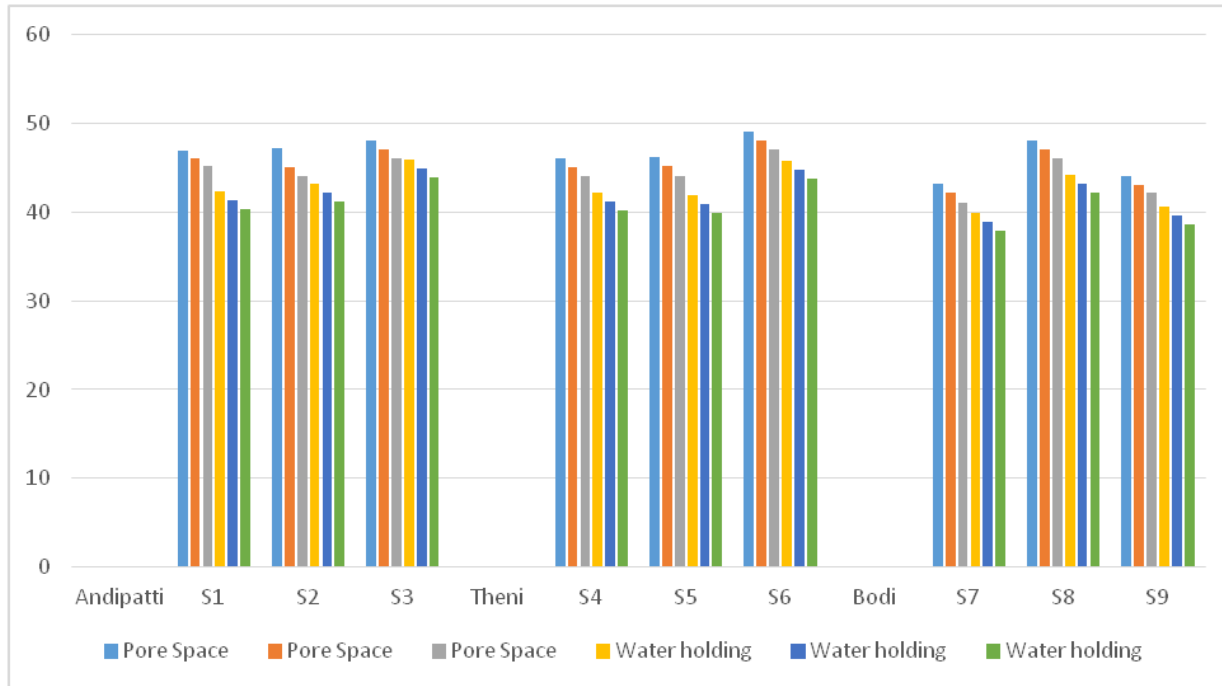


Fig. 2. Pore space and water holding capacity

Table 5. Evaluation of available nitrogen (Kg ha⁻¹), available phosphorous (Kg ha⁻¹) and potassium (Kg ha⁻¹)

Block Name & Sites	N (Kg ha ⁻¹)			P (Kg ha ⁻¹)			K (Kg ha ⁻¹)		
	0-15 cm	15-30 cm	30-45cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Andipatti									
S ₁	143	125	115	18	14.80	12	179.20	134.40	112.20
S ₂	137	155	145	18.2	15	13.3	157.18	148.62	101.54
S ₃	173	155	148	10.87	9.52	8.84	76.30	88.40	81.40
Theni									
S ₄	268	258	255	11.44	11.02	9.51	156.80	123.20	89.60
S ₅	262	252	237	16.45	14.69	13.71	159.28	122.40	148.83
S ₆	249	247	247	15.84	13.78	11.41	85.32	92.28	101.54
Bodi									
S ₇	260	252	244	19	16.87	12.83	201.60	168	123.20
S ₈	265	249	242	17.52	13.47	12.25	156.68	132.51	148.26
S ₉	252	229	244	20.21	17.64	15.55	170.70	123.20	109.8
	F-Test	S. Em. ±	C.D @5%	F-Test	S. Em. ±	C.D @5%	F-Test	S. Em. ±	C.D @5%
Depth (0-15 cm)	S	3.39772	10.09515	S	0.177737	0.528084	S	3.115472	9.256544
Depth (15-30 cm)	S	3.424591	10.17498	S	0.254447	0.756	S	1.771538	5.263500
Depth (30-45 cm)	S	3.226093	9.585215	S	0.185687	0.551705	S	1.513708	4.497655

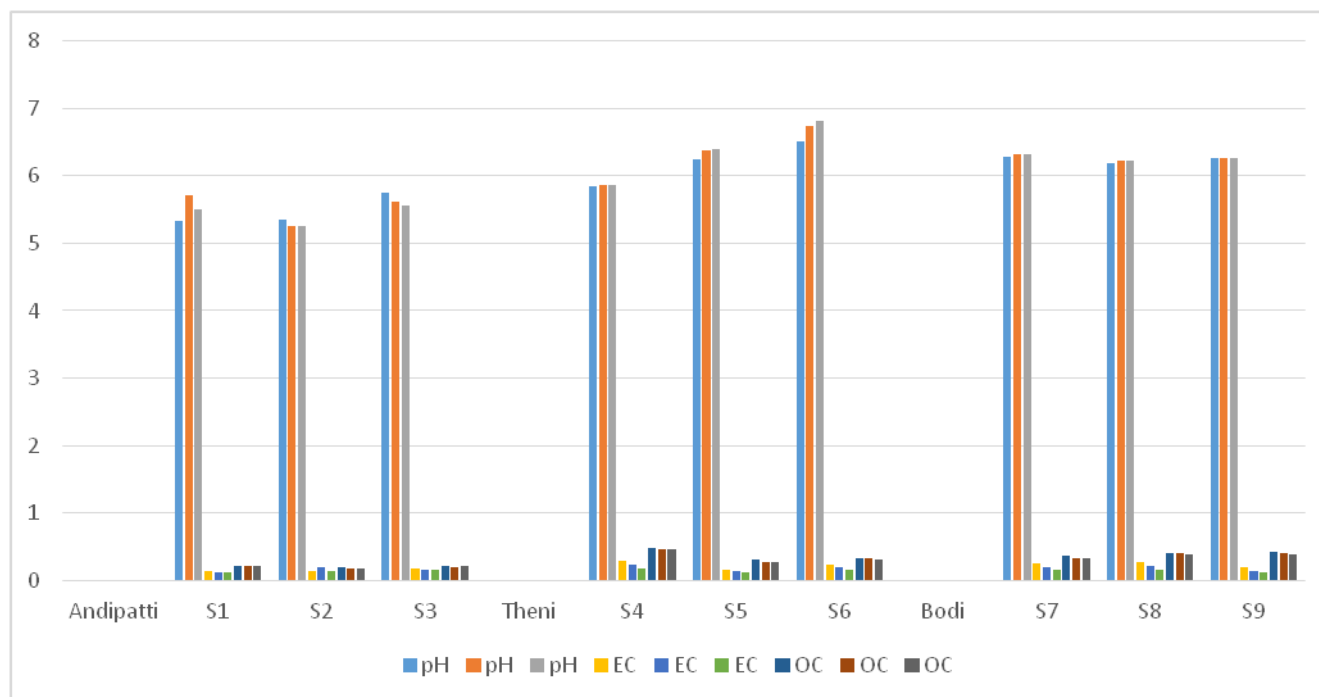


Fig. 3. pH, EC and organic carbon

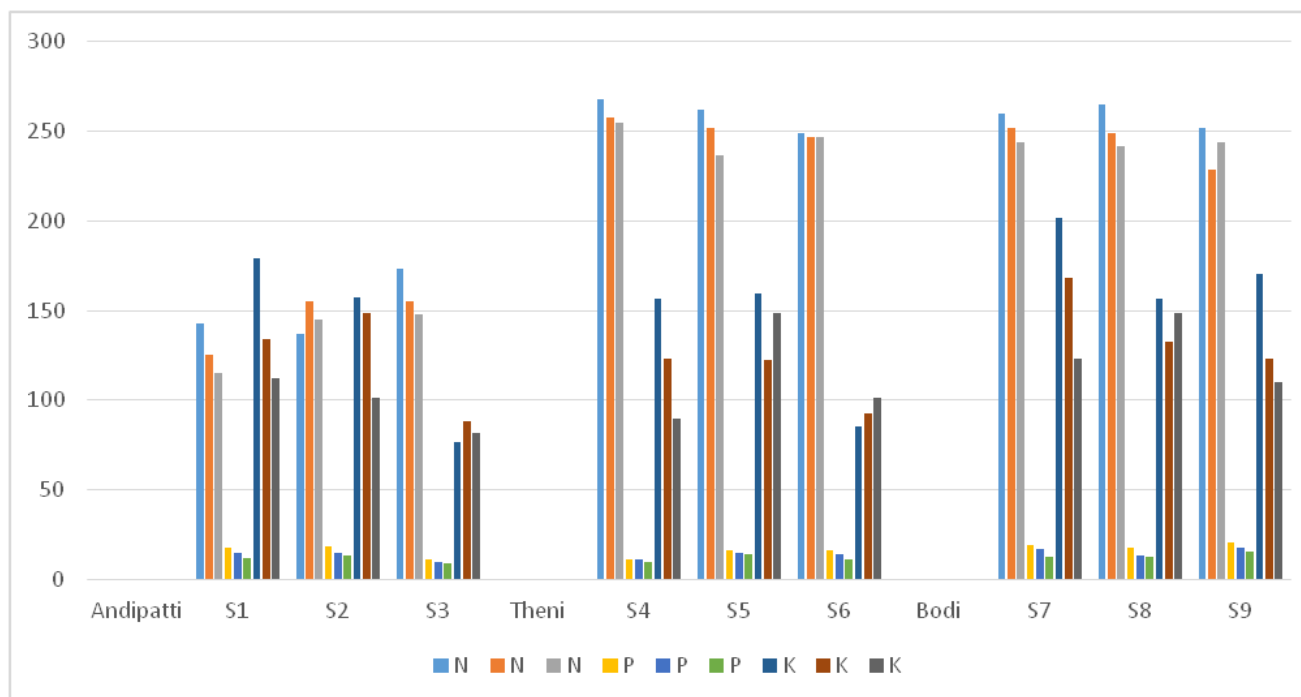


Fig. 4. Available N,P and K

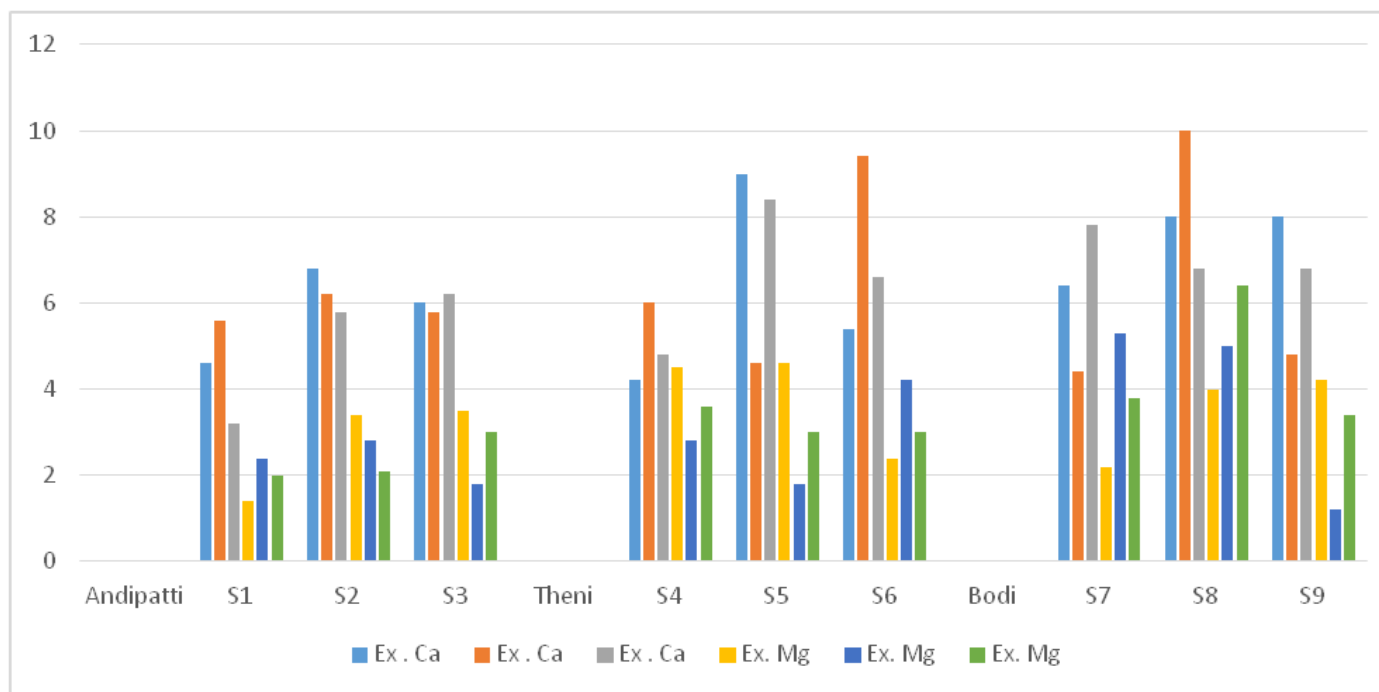


Fig. 5. Exchangable calcium and exchangeable magnesium

Table 6. Evaluation exchangeable calcium [c mol kg⁻¹] and exchangeable magnesium[c mol kg⁻¹]

Block Name & Sites	Ex . Ca [c mol kg ⁻¹]			Ex. Mg [c mol Kg ⁻¹]		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Andipatti						
S ₁	4.6	5.6	3.2	1.4	2.4	2
S ₂	6.8	6.2	5.8	3.4	2.8	2.1
S ₃	6	5.8	6.2	3.5	1.8	3
Theni						
S ₄	4.2	6	4.8	4.5	2.8	3.6
S ₅	9	4.6	8.4	4.6	1.8	3
S ₆	5.4	9.4	6.6	2.4	4.2	3
Bodi						
S ₇	6.4	4.4	7.8	2.2	5.3	3.8
S ₈	8	10	6.8	4	5	6.4
S ₉	8	4.8	6.8	4.2	1.2	3.4
	F-Test	S. Em. ±	C.D @5%	F-Test	S. Em. ±	C.D @5%
Depth (0-15 cm)	S	0.0676807	0.201465	S	0.009139	0.027153
Depth (15-30 cm)	S	0.063984	0.190106	S	0.016092	0.047812
Depth (30-45 cm)	S	0.067459	0.20043	S	0.01442	0.042845

3.4 Secondary Nutrients

Exchangeable Calcium content of soil ranged from 6.26 cmol (p⁺) kg⁻¹ to 10.26 cmol (p⁺) kg⁻¹ with the highest value recorded at site S₈(10.26) c mol (p⁺) kg⁻¹) from the Bodi Block. Exchangeable Magnesium content of soil ranged from 1.93 cmol (p⁺) kg⁻¹ to 5.13 cmol (p⁺) kg⁻¹ with the highest value recorded at S₈ (5.13) c mol (p⁺) kg⁻¹) from the Bodi Block. Calcium and Magnesium are very sufficient in this soil.

4. CONCLUSION

It was concluded that soil parameters studied during the course of investigation clearly indicated that soil has good water holding capacity and good physical condition. The pH of soil is slightly acidic to neutral in nature and the Electrical conductivity was suitable for all crops. Organic carbon ranged from low to medium. These soils have low Nitrogen in all villages. Phosphorus content is low to medium in all sites. Potassium is low to medium in all sites. Calcium and Magnesium are very sufficient in this soil. According to soil depths, the nutrients distribution is varying with different depths. The major reason for the lacking of nutrients is leaching due to higher amount of precipitation in the area, nutrient uptake by plants and inappropriate management practices. It suggest that still improvement can be done by improving cropping pattern , decomposition of organic waste, mulching, tillage practices and proper irrigation by management practices with knowledge and experience gained through studies and suggest the farmers to achieve quality produce and high yield through Soil Health Card report as well as practices soil conservation.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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