

Original Research Article

**ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES OF SOIL
FROM DIFFERENT BLOCKS OF KANDHMAL DISTRICT,
ODISHA**

Abstract

An Assessment of Physico-chemical properties of soil from different blocks of Kandhmal district, Odisha 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 G. Udayagiri, Raikia, Tikabali blocks of Kandhmal District, Odisha to determine the availability of macro nutrient in soil of these soil samples and provide the assessment. 9 sampling locations were selected. Soil samples were collected with depth of 0-15 cm, 15-30 cm and 30-45 cm respectively. The Soil colour (Dry Condition) of soil varied from Brownish yellow, Yellowish red, Reddish yellow. Soil colour (Wet Condition) of the soil varied Dark reddish brown, Dark brown. The soil texture was dominantly sandy loam in almost every site. The bulk density (Mg m^{-3}) ranged from 1.01 (Mg m^{-3}) to 1.49 (Mg m^{-3}). The practical density (Mg m^{-3}) ranged from 2.14 (Mg m^{-3}) to 2.52 (Mg m^{-3}). The pore space (%) ranged from 47.64(%) to 41.11(%). The water holding capacity (%) ranged from 45.17(%) to 39.17(%). The soil pH ranged from 5.01 to 6.15 Indicating Moderately Acidic in nature. The electrical conductivity ranged from 0.17 (dS m^{-1}) to 0.41 (dS m^{-1}). The soil organic carbon (%) ranged from 0.21(%) to 0.41(%). The Available nitrogen (kg ha^{-1}) ranged from 134 (kg ha^{-1}) to 330 (kg ha^{-1}). The Available Phosphorous (kg ha^{-1}) ranged from 3.56 (kg ha^{-1}) to 23.82 (kg ha^{-1}). The Available Potassium (kg ha^{-1}) ranged from 108.39 (kg ha^{-1}) to 256 (kg ha^{-1}). The Exchangeable calcium [$\text{cmol (p}^+) \text{ kg}^{-1}$] ranged from 3.32 to 4.02 [$\text{cmol (p}^+) \text{ kg}^{-1}$]. The Exchangeable Magnesium [$\text{cmol (p}^+) \text{ kg}^{-1}$] ranged from 2.6 to 3.6 [$\text{cmol (p}^+) \text{ kg}^{-1}$]. 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 plants so as to attain optimum economic yield and soil is suitable for all major tropical and sub-tropical crops.

Key words: Kandhmal district, Physico-chemical properties, nutrients distribution etc.

INTRODUCTION

Soil is the natural medium for the growth of plants. Soil has also been defined as a natural body consisting of layers (soil horizons) that are composed of weathered mineral materials, organic materials, air and water. Soil is the end product of the combined influence of climate, topography, organisms (flora, fauna and human) on parent materials (original rocks and minerals) over time. As a result, soil differs from its parent material in texture, structure, consistency, colour, chemical, biological and physical characteristics. 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. 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, agroecological setting. This demand systematic appraisal of our soil resources with respect to their extent, distribution, characteristics, behaviour and use potential, which is very important for developing an effective land use system for augmenting agricultural production on sustainable basis. 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 Kandhmal, Odisha undertaken. The soil sample collection is from 3 blocks of Kandhmal District in the state of Odisha. 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 0-15cm, 15-30cm, 30-45 cm. A comparison of the Physico-chemical Properties of some of the soils of different regions of the Odisha 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 forevaluation of soils is needed to realize the concept of Physico-chemical analysis successfully. With this following objective, a study has been undertaken in soil resources inventory for sustainable land use planning in Kandhmal region of Odisha.

MATERIALS AND METHODS

Sampling site and collection

Odisha is one of the States of India. It is located between the parallels of 17.49°N and 22.34°N latitudes and meridians of 81.27°E and 87.29°E longitudes. It is bounded by the Bay of Bengal on the east; Chhattisgarh on the west and Andhra Pradesh on the south. It has a coast line of about 450 kms. Odisha typically receives about 71.43 millimeters (2.81 inches) of precipitation and has 109.64 rainy days (30.04% of the time) annually. The soil type ranges from fertile, alluvial, deltaic soil in the coastal plains, mixed red and black soil in the central tableland, to red and yellow soil with low fertility in the northern plateau and red, black and brown forest soil in the eastern ghat region. Kandhmal District is located in central Odisha and is bounded by Boudh District on the north, Rayagada District on the south, Ganjam and Nayagarh Districts on the East and Kalahandi District on the west. Kandhmal experiences sub-tropical hot and dry climate in summer. Dry and cold climate in winter. The maximum temperature recorded in the district is 45.5°C and minimum temperature is 2°C. The average annual rainfall recorded is 1522.95 mm.

Soil samples were collected from 3 different Blocks of Kandhmal district in Odisha. Three different locations selected from each block. Samples were collected randomly from three sites of each block using soil auger, Khurpi, Knife by composite sampling method at depths of 0-15cm, 15-30cm, 30-45cm. 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 coning and quartering method.

Methods

Analysis of the soil samples were under the methods, the physical parameters include Soil Colour, Soil Texture, Bulk Density, Particle Density, Pore Space, Water Holding Capacity, whereas chemical parameters include pH, Electrical Conductivity, Organic Carbon, Macronutrients (N, P, K, Ca, Mg.) Soil textural class was determined by using Hydrometer (Bouyoucos, 1927). 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 1:2.5 soil water suspension (Jackson, 1958). Electrical Conductivity was estimated with the help of Digital Conductivity meter (Wilcox, 1950). Percent Organic Carbon was estimated by Wet Oxidation method (Walkley and Black, 1947). Available Nitrogen was estimated by Alkaline Potassium Permanganate method, using Kjeldahl apparatus (Subbiah and Asija, 1956), Available Phosphorus was estimated by Bray's extraction method (Bray and

Kurtz, 1945), Available Potassium was estimated by Neutral normal Ammonium Acetate extraction followed by Flame photometric method (Toth and Prince, 1949), Exchangeable Calcium and Magnesium were estimated by EDTA method (Cheng and Bray, 1951).

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RESULTS

Physical Properties

The Soil Textural classes identified as Sandy Loam. The sand, silt and clay percentage varied from 63.5 to 75.0 sand, 11.10 to 18.00 silt and 15.10 to 22.10 clay in Sandy Loam. Bulk Density was varied from the 1.01 Mg m⁻³ to 1.49 Mg m⁻³ and the highest Bulk Density was found in S₇ (1.49 Mg m⁻³) which sites from Tikabali Block. The Particle Density varied from 2.14 Mg m⁻³ to 2.52 Mg m⁻³ and the highest Particle Density was found in S₉ (2.52 Mg m⁻³) which site from the Tikabali Block. The Pore Space (%) ranged from 47.64% to 41.11%. The highest Pore Space % was found at site S₁ (47.64%) from the G. Udayagiri Block. The Water Holding Capacity (%) ranged from 45.17 to 39.17% and S₁ from the G. Udayagiri Block hold the water best at 45.17%.

Table 1: Soil texture and soil colour of Kandhmal District

Block Name & Site	Soil Colour		Soil Texture
	Range (Dry Condition)	Range (Wet Condition)	
G. Udayagiri			
S1	Yellowish red	Dark reddish brown	Clay Loam
S2	Reddish yellow	Brownish yellow	Sandy Loam
S3	Reddish yellow	Brownish yellow	Clay Loam
Raikia			
S4	Brownish yellow	Dark brown	Sandy Loam
S5	Brownish yellow	Brown	Sandy Loam
S6	Yellowish brown	Yellowish-brown	Sandy Clay Loam
Tikabali			
S7	Yellowish brown	Dark brown	Sandy Loam
S8	Yellowish brown	Dark brown	Sandy Loam
S9	Brown	Strong brown	Sandy Loam

Table 2: Evaluation of Bulk density and Particle density of Soils of Kandhmal District

Block Name & Sites	Bulk Density (Mg m ⁻³)			Particle Density (Mg m ⁻³)		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
G.udayagiri						
S ₁	1.01	1.10	1.25	2.14	2.18	2.27
S ₂	1.11	1.31	1.42	2.25	2.34	2.47
S ₃	1.05	1.17	1.33	2.17	2.27	2.34
Raikia						
S ₄	1.11	1.19	1.31	2.26	2.31	2.39
S ₅	1.18	1.33	1.45	2.34	2.42	2.46
S ₆	1.16	1.25	1.41	2.31	2.37	2.41
Tikabali						
S ₇	1.25	1.33	1.49	2.27	2.33	2.38
S ₈	1.12	1.23	1.37	2.26	2.34	2.38
S ₉	1.16	1.21	1.39	2.33	2.41	2.52
	F-Test	S. Em. ±	C.D @5%	F-Test	S. Em. ±	C.D @5%
Depth (0-15 cm)	S	0.0168	0.0500	S	0.0267	0.0794
Depth (15-30 cm)	S	0.0165	0.0491	S	0.0426	0.1268
Depth (30-45 cm)	S	0.0255	0.0758	S	0.0269	0.0801

Table 3: Estimation of Water Holding Capacity, Pore Space (%) of Soils of Kandhmal District

Block Name & Sites	Water Holding Capacity (%)			Pore Space (%)		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
G.udayagiri						
S ₁	45.17	43.19	41.78	47.64	45.54	43.93
S ₂	44.15	42.03	40.35	46.32	44.01	42.81
S ₃	43.31	41.17	39.17	45.21	43.63	41.11
Raikia						
S ₄	44.19	42.81	40.18	46.13	44.61	42.11
S ₅	42.76	40.78	39.37	44.32	43.04	41.85
S ₆	43.83	41.34	39.27	45.12	43.31	41.93
Tikabali						
S ₇	44.13	42.30	40.39	46.39	44.11	42.71
S ₈	43.39	41.78	40.19	45.12	43.20	41.51
S ₉	43.07	41.35	39.73	45.84	43.07	41.13
	F-Test	S. Em. ±	C.D @5%	F-Test	S. Em. ±	C.D @5%
Depth (0-15 cm)	NS			NS		
Depth (15-30 cm)	NS			NS		
Depth (30-45 cm)	NS			NS		

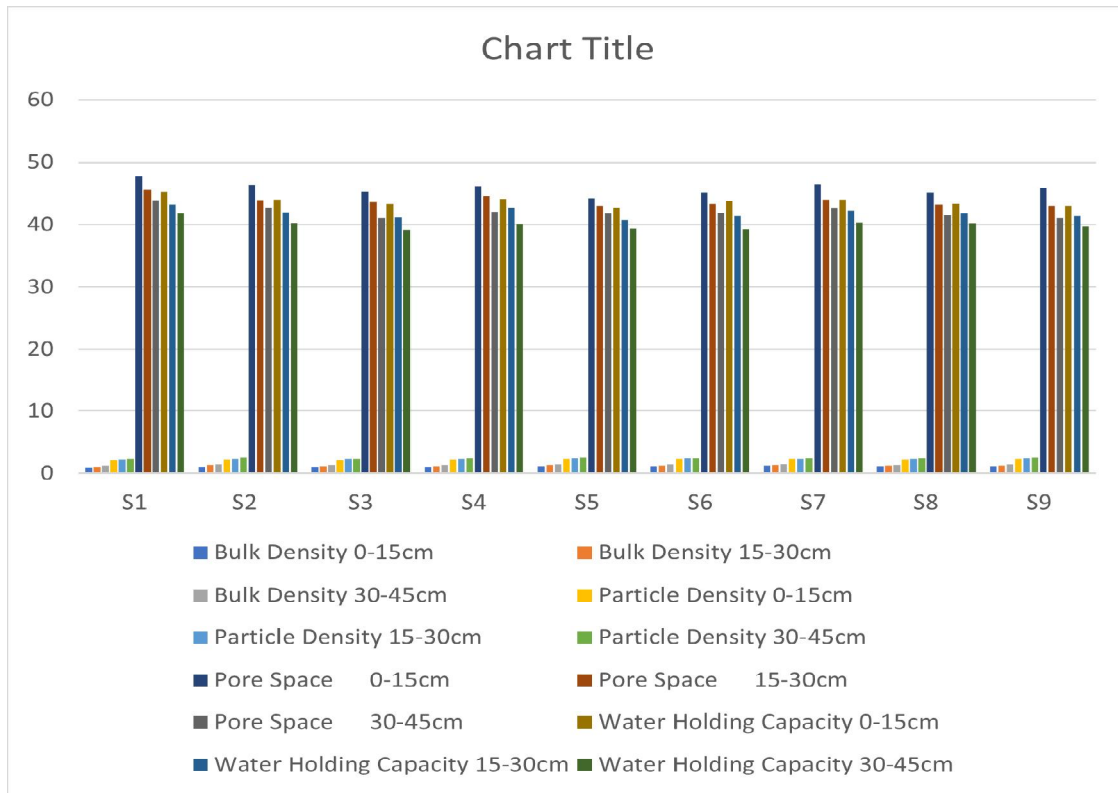


Fig 1: Bulk density, Particle density, Water Holding Capacity and Pore Space

UNDER PEER

Chemical Properties

The pH value ranged from 5.01 to 6.15. The maximum value found is 6.15 in S₇ from the Tikabali Block. The electrical conductivity ranged from 0.17 to 0.41(dS m⁻¹). The maximum value found is 0.41 (dS m⁻¹) in S₇ from the Tikabali Block and the soil was found to be normal. The value of total Organic Carbon(%) varied from 0.21 to 0.44% and the range of organic carbon content was found low to medium.

Table 4: Estimation of soil pH (1:2), EC (dsm⁻¹) and Organic Carbon (%)

Block Name Sites	pH			EC (ds m ⁻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
G.udayagiri									
S ₁	5.07	5.01	5.16	0.17	0.20	0.23	0.44	0.41	0.39
S ₂	5.67	5.88	5.79	0.21	0.24	0.26	0.41	0.39	0.37
S ₃	6.12	6.07	6.08	0.24	0.28	0.31	0.42	0.39	0.35
Raikia									
S ₄	5.31	5.45	5.19	0.29	0.34	0.38	0.35	0.32	0.30
S ₅	5.57	5.96	5.68	0.31	0.37	0.39	0.33	0.31	0.29
S ₆	5.98	6.05	5.93	0.32	0.36	0.38	0.29	0.26	0.23
Tikabali									
S ₇	6.15	5.88	6.07	0.33	0.37	0.41	0.28	0.24	0.23
S ₈	5.43	5.11	5.18	0.24	0.28	0.32	0.26	0.24	0.21
S ₉	5.47	5.26	5.57	0.26	0.29	0.34	0.27	0.25	0.22
	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	0.0684	0.2034	S	0.004	0.0147	S	0.0052	0.0155
Depth (15-30 cm)	S	0.0728	0.2163	S	0.005	0.0147	S	0.0051	0.0152

Depth (30-45 cm)	S	0.1041	0.3093	S	0.005	0.0161	S	0.0032	0.0097
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UNDER PEER REVIEW

Primary Nutrients

The Available Nitrogen content of soil ranged from 134 to 330 kg ha⁻¹ and Nitrogen content was Medium in all villages. The Available Phosphorus content of soil ranged from 3.56 to 23.82 Kg ha⁻¹. The phosphorus content was found low to medium. Available Potassium content of soil ranged from 108.39 to 256 kg ha⁻¹. The potassium content was found Medium in range in all the villages.

Table 5: Evaluation of Available Nitrogen (Kg ha⁻¹), Available Phosphorous (Kg ha⁻¹) and Available Potassium (Kg ha⁻¹)

Block Name Sites	Nitrogen (Kg ha ⁻¹)			Phosphorous (Kg ha ⁻¹)			Potassium (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
G.udayagiri									
S ₁	330	291	244	13.34	13.02	8.90	256.00	238.70	231.30
S ₂	310	281	249	23.82	19.76	16.83	243.87	221.79	208.13
S ₃	299	272	251	12.01	11.25	8.63	231.80	214.96	206.33
Raikia									
S ₄	302	284	263	9.34	8.52	7.15	239.89	223.71	204.11
S ₅	280	261	236	12.34	9.89	8.62	212.57	197.60	185.31
S ₆	220	196	184	10.97	8.42	6.31	140.54	128.98	115.31
Tikabali									
S ₇	185	147	134	6.63	6.27	5.03	118.70	112.85	108.39
S ₈	220	186	168	12.56	10.87	8.34	154.65	146.00	138.80
S ₉	210	181	173	4.52	4.05	3.56	138.70	129.87	113.67
	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	4.4077	13.096	S	0.2299	0.6832	S	3.2699	9.7156
Depth (15-30 cm)	S	2.9722	8.8311	S	0.1271	0.3776	S	2.7880	8.2835
Depth (30-45 cm)	S	2.5122	7.4641	S	0.1267	0.3767	S	2.6794	7.9611

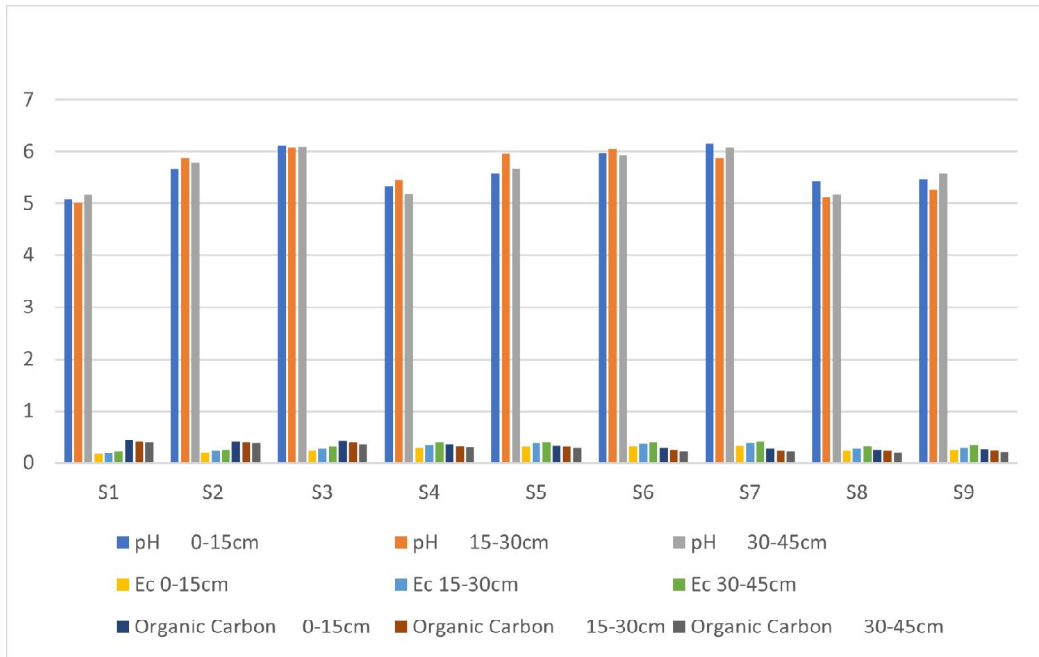


Fig 2: pH, EC and Organic Carbon

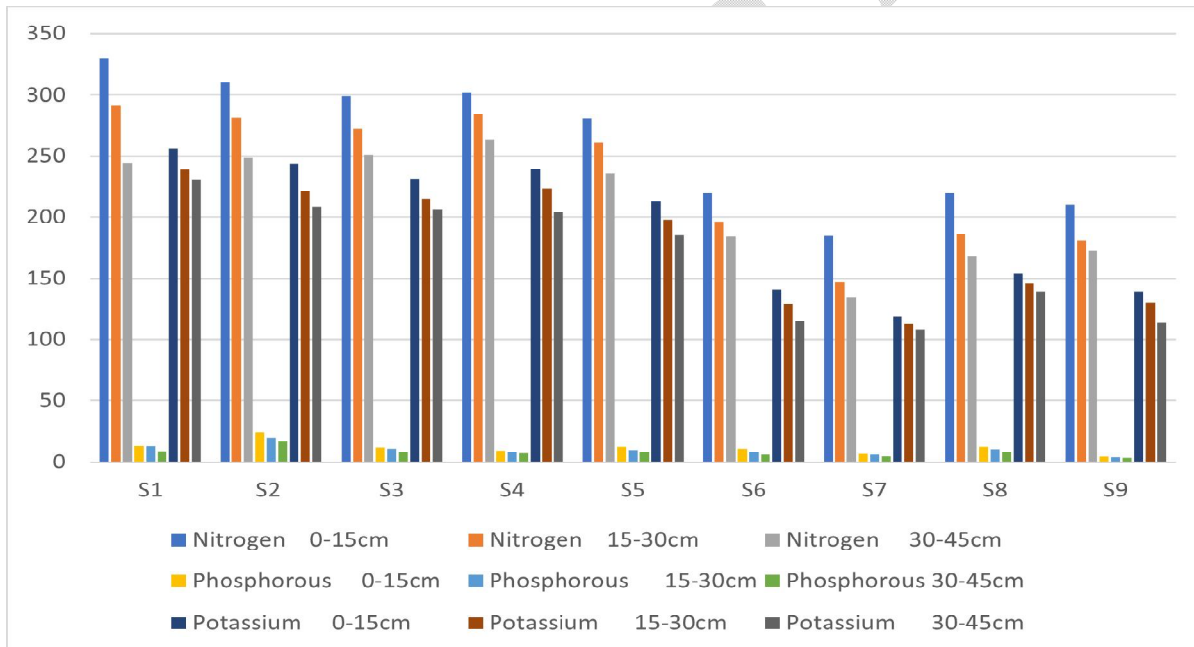


Fig 3: Available Nitrogen, Available Phosphorous and Available Potassium

Secondary Nutrients

The Exchangeable calcium [cmol (p⁺) kg⁻¹] ranged from 3.32 to 4.02 [cmol (p⁺) kg⁻¹]. The maximum value found is 4.02[cmol kg⁻¹] in S₄ from the Raikia Block. The Exchangeable Magnesium [cmol (p⁺) kg⁻¹] ranged from 2.6 to 3.6 [cmol (p⁺) kg⁻¹]. The maximum value found is 3.6 [cmol (p⁺) kg⁻¹] in S₄ from the Raikia Block. Calcium and Magnesium are very sufficient in this soil.

Table 6: Evaluation of Exchangeable Calcium and Magnesium [c mol Kg⁻¹]

Block Name & Sites	Exchangeable Calcium [c mol kg ⁻¹]			Exchangeable Magnesium [c mol Kg ⁻¹]		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
G.udayagiri						
S ₁	3.32	3.52	3.61	2.6	2.8	2.9
S ₂	3.54	3.73	3.94	2.7	2.8	3.2
S ₃	3.45	3.64	3.81	2.7	3.1	3.3
Raikia						
S ₄	3.81	3.92	4.02	3.1	3.3	3.6
S ₅	3.71	3.84	3.98	2.9	3.1	3.3
S ₆	3.69	3.77	3.92	3.1	3.3	3.4
Tikabali						
S ₇	3.78	3.86	3.95	3.2	3.3	3.4
S ₈	3.68	3.76	3.81	3.1	3.2	3.3
S ₉	3.57	3.62	3.87	3.0	3.1	3.2
	F-Test	S. Em. ±	C.D @5%	F-Test	S. Em. ±	C.D @5%
Depth (0-15 cm)	S	0.0591	0.1757	S	0.0412	0.1224
Depth (15-30 cm)	S	0.0445	0.1324	S	0.0424	0.1260
Depth (30-45 cm)	S	0.0674	0.2003	S	0.0517	0.1536

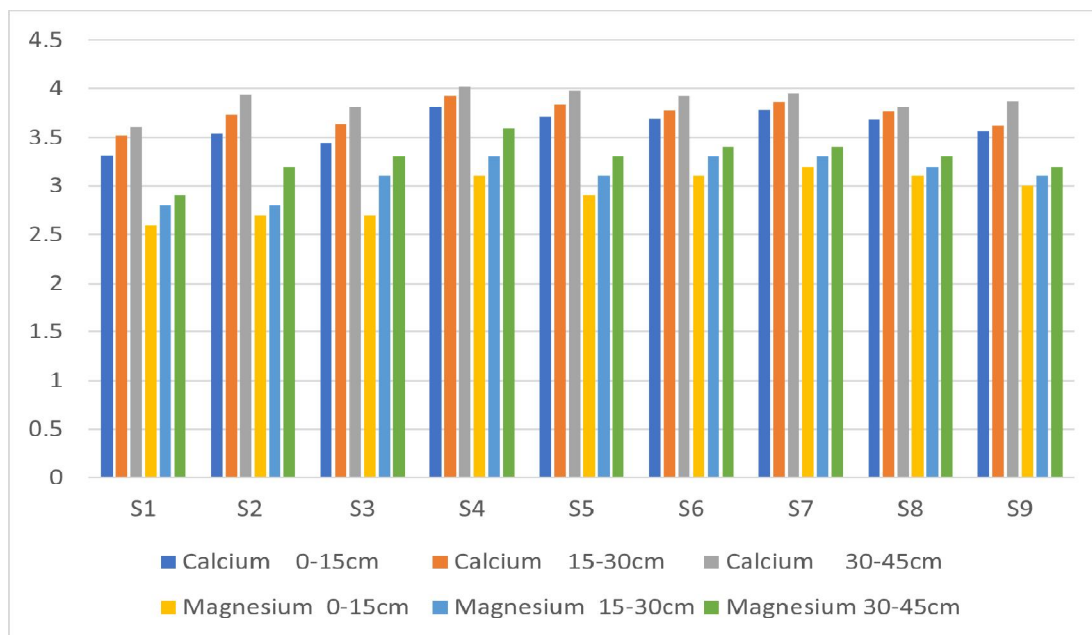


Fig 4: Exchangeable Calcium and Magnesium [c mol Kg^{-1}]

CONCLUSION

It is concluded from the trial that the soils of three blocks of the district are sandy loam to clay loam with adequate BD, PD and pore space. It is moderately Acidic electrical conductivity as favourable for plant growth but with some management practices, with low to medium organic carbon content and nitrogen is low to medium, phosphorus are low and medium to high Potassium. The deficiency of the nutrients can be mitigated by the use of organic and inorganic fertilizers. It shows that the soils are good for cultivation of Turmeric, Paddy, Maize, Beans, Mustard, potato horticulture crops etc. Farmers are required to maintain Soil Health Card according to the guidelines of central and state government for crop cultivation and advise to adopt suitable management practices and provide proper nutrition to soil health. Time to time inventory should be maintained to overcome the pollution effect in their respective soil.

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