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Assessment of Physico-chemical Properties of Soil from Different Blocks of Visakhapatnam District, Andhra Pradesh

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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 Visakhapatnam district, Andhra Pradesh was carried out in 2022-23. To determine the availability of macro nutrient in soil of these soil samples and provide the assessment of 9 sampling locations were selected. Soil samples were collected at the depth of 0-15 cm, 15-30 cm and 30-45 cm respectively. Soil textural classes were Sandy loam and Loamy sand. Bulk Density varies from (1.36 to 1.59 Mg m^{-3}). Particle Density varies from (2.37 to 2.54 Mg m^{-3}). %Pore Space (39.85 to 48.32 %), The Water

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Holding Capacity varies from (34.89 to 44.28%), the physical condition of the soil was found good. The pH of soil is Slightly alkaline in nature (6.82 to 8.08) and the Electrical Conductivity (0.17 to 0.37 dSm^{1}) was suitable for all crops. Organic carbon was found low (0.33 to 0.47%). These soils have low Nitrogen (197.00 to 220.00 kg ha^{-1}) in all villages. Phosphorus (16.96 to 26.68 kg ha^{1}) is found medium to high. Potassium (201.96 to 266.01 kg ha^{-1}) is found medium in range. Calcium (3.22 to 5.66 meq $100g^{-1}$) and Magnesium (1.85 to 2.79 meq $100g^{-1}$) are 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 and soil is suitable for all major tropical and sub-tropical crops.

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

1. INTRODUCTION

Soil is a non-renewable dynamic natural resource that is essential to life. Soil has also been defined as a natural body consisting of layers (soil horizons) that are composed of weathered mineral materials, organic material, 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. “The physical and chemical characteristic of soil plays a big role in the plants ability to extract water and nutrients. High quality soils not only produce better food and fibre, but also help to establish natural ecosystem and enhance air and water quality. The physical properties of soil depend upon the shape, structure, size, pore space, amount of organic matter and mineral composition of soil. The chemical properties of the soil are the interactions of various chemical constituents among soil particles and sail solution” [1]. The physical and chemical properties are soil texture, bulk density, water holding capacity, soil structure, soil colour, pH, electrical conductivity, cation exchange capacity, organic carbon and soil nutrients (macro and micro).

Keeping in view of importance of soil's physical and chemical properties, the present study of Physico-chemical properties of soil samples were collected from various locations of district of Visakhapatnam, Andhra Pradesh undertaken. The soil sample collection is from 3 blocks of Visakhapatnam District in the state of Andhra Pradesh. Each selecting 3 villages. Samples was 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 Andhra Pradesh 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 following objective, a study has been undertaken in soil resources inventory for sustainable land use planning in Visakhapatnam region of Andhra Pradesh.

2. MATERIALS AND METHODS

2.1 Sampling Site and Collection

Andhra Pradesh is a state in the south-eastern coastal region of India. It is bordered by Andhra Pradesh to the north-west, Chattisgarh to the north, Odisha to the north-east, Tamil Nadu to the south, Karnataka to the west and the Bay of Bengal to the east.

Soil samples were collected from 3 different Blocks of Visakhapatnam district in Andhra Pradesh during kharif-2022. 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 0-15cm,15-30cm, 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. Completely Randomized Design was used as the experiment design in the analysis (CRD).

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, 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" [2]. "Bulk density, Particle density, Water holding capacity was determined by using Graduated Measuring Cylinder method" [3]. 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 [5]. Percent Organic Carbon was estimated by Wet Oxidation method [6]. Available Nitrogen was estimated by Alkaline Potassium Permanganate method, using Kjeldahl apparatus [7], Available Phosphorus was estimated by Olsen's extraction followed by Spectrophotometric method [8], Available Potassium was estimated by Neutral normal Ammonium Acetate extraction followed by Flame photometric method [9], Exchangeable Calcium and Magnesium were estimated by EDTA method [10].

3. RESULTS AND DISCUSSION

3.1 Physical Properties

The Soil Textural classes identified as Sandy loam and Loamy sand. The sand, silt and clay percentage varied from 66.46 to 72.36 sand, 17.16 to 23.26 silt and 9.18 to 11.43 clay. Bulk Density was varied from the 1.36 to 1.59 Mg m^{-3} and the highest Bulk Density was found in S_8 (1.59 Mg m^{-3}) from Anandapuram Block. "The bulk density increases with the increase in soil depth. The reason is soil compactness, which will be more at high depth and soil organic carbon will be decreased with increases the depth because of lower organic carbon and higher compactness of soil bulk density will be increased with increase in depth" [11]. The Particle Density varied from 2.37to 2.51 Mg m^{-3} and the highest Particle Density was found in S_5 (2.51 Mg m^{-3}) from Pendurthi Block. The Pore Space (%) ranged from 39.8 to 48.32 %. The highest Pore Space % was found at site S_2 (48.32%) from Atchuthapuram Block. The Water Holding Capacity (%) ranged from 34.89 to 44.28 % and the highest Water Holding Capacity was found at site S_6 (44.28%) from Atchuthapuram Block. "The water holding capacity value decrease with increase in depth because of soil compaction and reduction in pore space. Soils vary in their water holding capacity according to their structure, texture, and bulk density relationship to total pore size distribution" [12].

3.2 Chemical Properties

The pH value ranged from 6.82 to 8.08 and the highest value was recorded at site S_7 (pH 8.08) from Anandapuram Block. pH value increases with the increasing depth because at upper horizons receive maximum leaching by rainfall and by dissolved carbonic acids and presence of high amount of exchangeable sodium ions The Electrical Conductivity ranged from (0.17 to 0.37 dS m^{-1}) and the highest value was recorded at the site S_6 (0.37 dS m^{-1}) from Pendurthi Block and the soil was found to be normal. The value of total Organic Carbon (%) varied from 0.33 to 0.47% and the range of organic carbon content was found low to medium.

Table 1. Evaluation of bulk density and particle density of soils of Visakhapatnam District

Block Name & Sites	Bulk Density (Mg m^{-3})			Particle Density (Mg m^{-3})		
Atchuthapuram	**0-15 cm**	**15-30 cm**	**30-45 cm**	**0-15 cm**	**15-30 cm**	**30-45 cm**
S_1	1.41	1.44	1.47	2.41	2.43	2.47
S_2	1.38	1.41	1.45	2.37	2.41	2.44
S_3	1.39	1.42	1.44	2.41	2.43	2.45
Pendurth						
S_4	1.36	1.38	1.41	2.39	2.41	2.44
S_5	1.43	1.45	1.49	2.45	2.48	2.51
S_6	1.45	1.47	1.50	2.37	2.42	2.46
Anandapuram						
S_7	1.51	1.54	1.57	2.41	2.43	2.47
S_8	1.53	1.54	1.59	2.42	2.45	2.48
S_9	1.52	1.56	1.58	2.43	2.46	2.49
	F-Test	**S. Em. ±**	**C.D. @5%**	**F-Test**	**S. Em. ±**	**C.D. @5%**
Depth (0-15 cm)	S	0.009919	0.029471	NS	0.038805	-
Depth (15-30 cm)	S	0.026213	0.026213	NS	0.037809	-
Depth (30-45 cm)	S	0.030413	0.030413	NS	0.044017	-

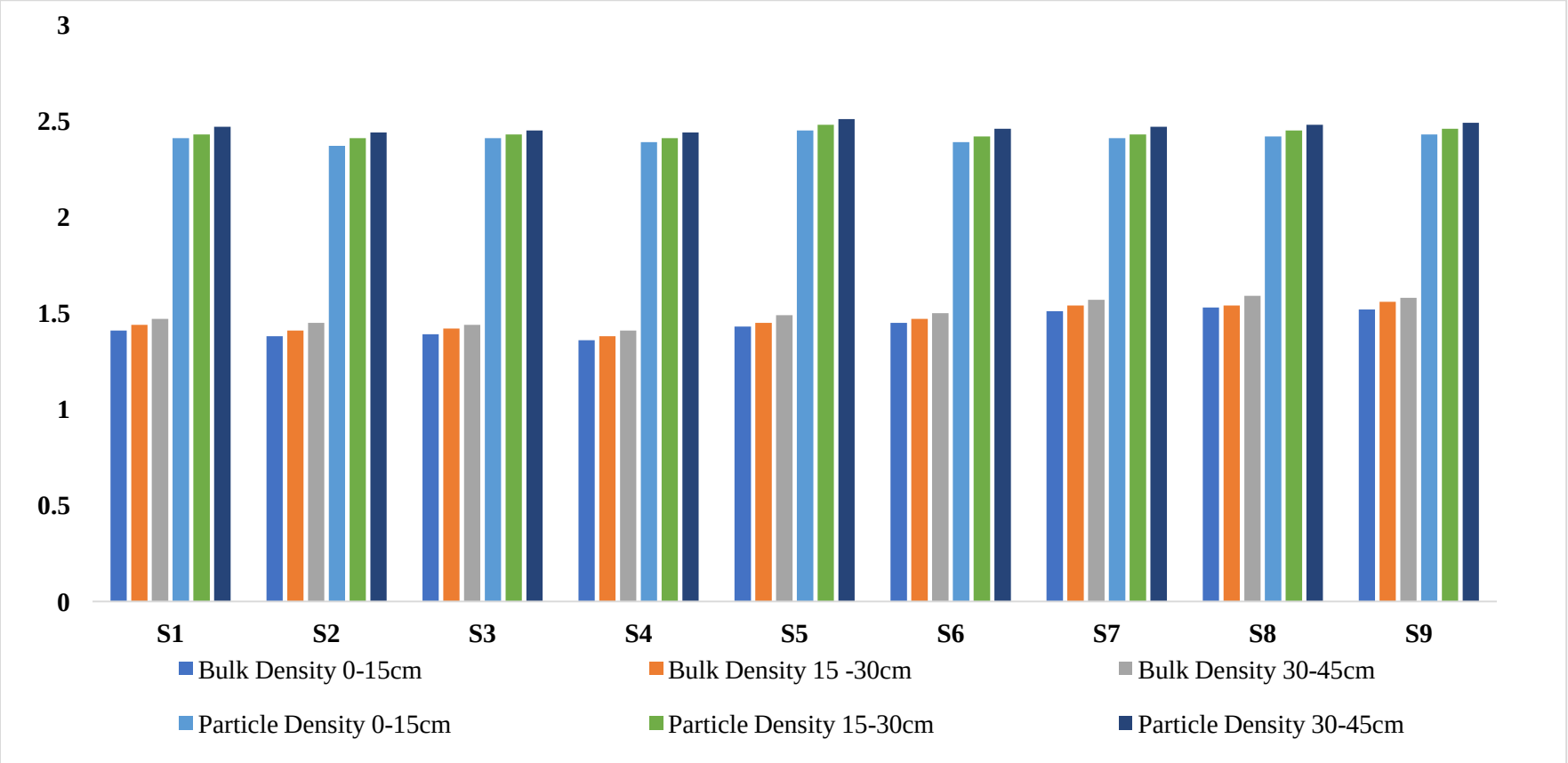

Fig. 1. Bulk density and particle density (Mg m^{-3})

Table 2. Estimation of Water Holding Capacity, Pore Space (%) of Soils of Visakhapatnam District

Block Name & Sites	Pore Space (%)			Water Holding Capacity (%)		
Atchuthapuram	**0-15 cm**	**15-30 cm**	**30-45 cm**	**0-15 cm**	**15-30 cm**	**30-45 cm**
S_1	47.42	45.84	44.28	43.86	41.56	40.18
S_2	48.32	46.75	43.86	44.28	42.39	39.36
S_3	47.98	44.54	42.26	43.56	40.12	38.95
Pendurthi						
S_4	44.35	42.64	41.32	40.95	39.25	38.86
S_5	45.78	43.86	41.86	40.28	39.86	37.62
S_6	46.52	44.32	42.16	41.86	40.18	38.78
Anandapuram						
S_7	44.32	42.89	40.28	39.62	38.76	34.23
S_8	42.25	41.89	39.96	38.76	37.56	35.42
S_9	43.76	41.38	39.85	38.26	37.89	34.89
	F-Test	**S. Em. ±**	**C.D. @5%**	**F-Test**	**S. Em. ±**	**C.D. @5%**
Depth (0-15 cm)	S	0.639547	1.900191	S	0.495011	1.470754
Depth (15-30 cm)	S	0.684547	2.033895	S	0.514911	0.514911
Depth (30-45 cm)	S	0.640989	1.904477	S	0.042973	0.042973

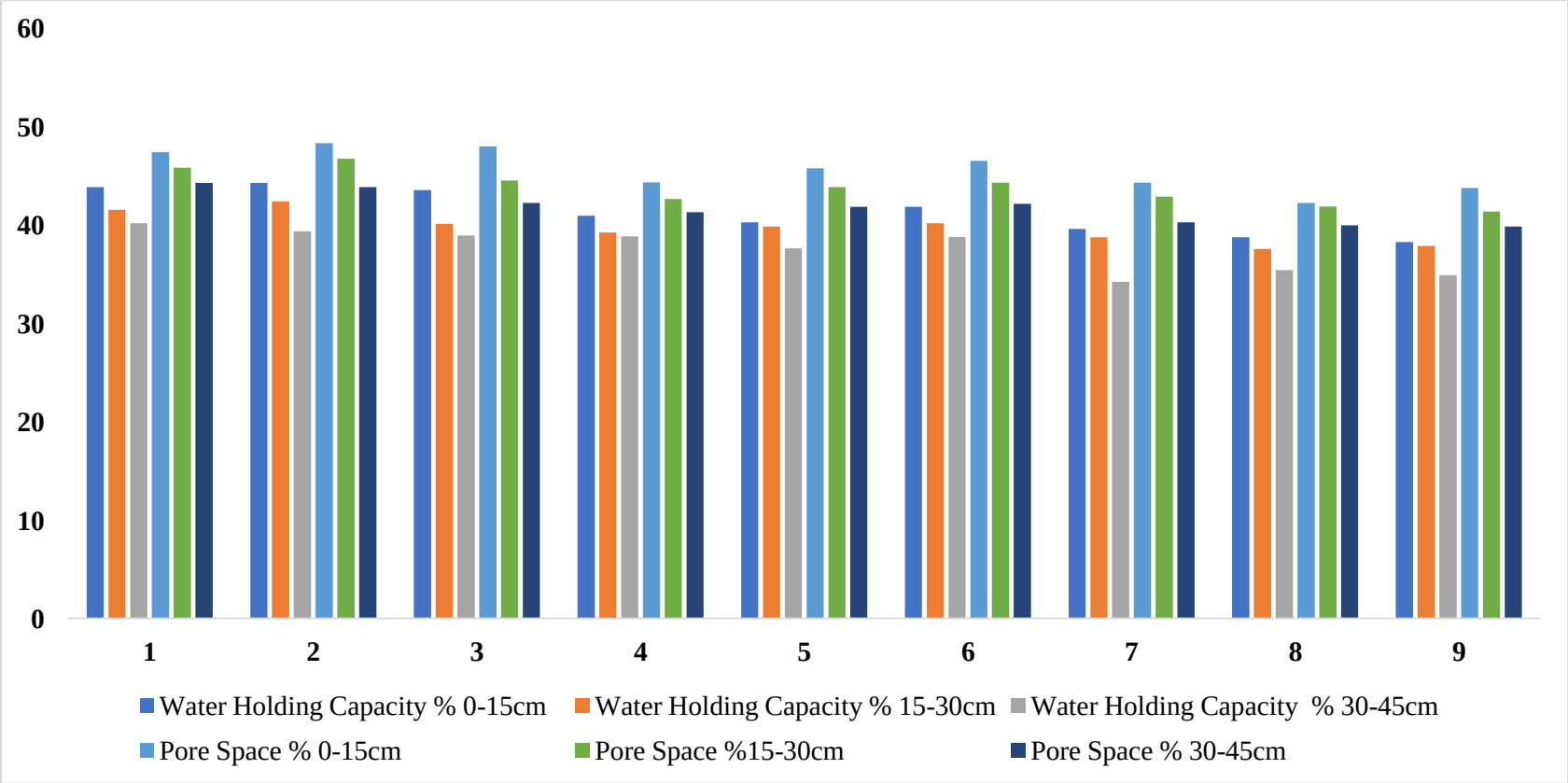

Fig. 2. Pore space and water holding capacity (%)

Table 3. Estimation of soil pH (1:2), EC (dS m^{-1}) and Organic Carbon (%)

Block Name Sites	pH			EC (dS m^{-1})			OC (%)		
Atchuthapuram	**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**
S_1	6.82	6.84	7.32	0.22	0.25	0.26	0.42	0.41	0.39
S_2	6.86	7.33	7.39	0.21	0.24	0.25	0.41	0.39	0.38
S_3	7.18	7.28	7.97	0.17	0.19	0.23	0.43	0.41	0.40
Pendurthi									
S_4	7.98	8.02	8.06	0.24	0.26	0.29	0.42	0.41	0.39
S_5	7.87	7.92	8.03	0.29	0.31	0.34	0.45	0.43	0.42
S_6	7.97	8.01	8.05	0.30	0.33	0.37	0.47	0.45	0.43
Anandapuram									
S_7	7.98	8.04	8.08	0.21	0.24	0.27	0.39	0.37	0.36
S_8	7.94	8.03	8.07	0.29	0.31	0.34	0.38	0.37	0.35
S_9	7.85	7.98	8.03	0.23	0.26	0.29	0.37	0.36	0.35
	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	0.130596	0.38802	S	0.00492	0.014631	S	0.005917	0.017581
Depth (15-30 cm)	S	0.143163	0.42535	S	0.00474	0.014089	S	0.004583	0.013618
Depth (30-45 cm)	S	0.003809	0.01131	S	0.00619	0.018419	S	2.800417	8.320466

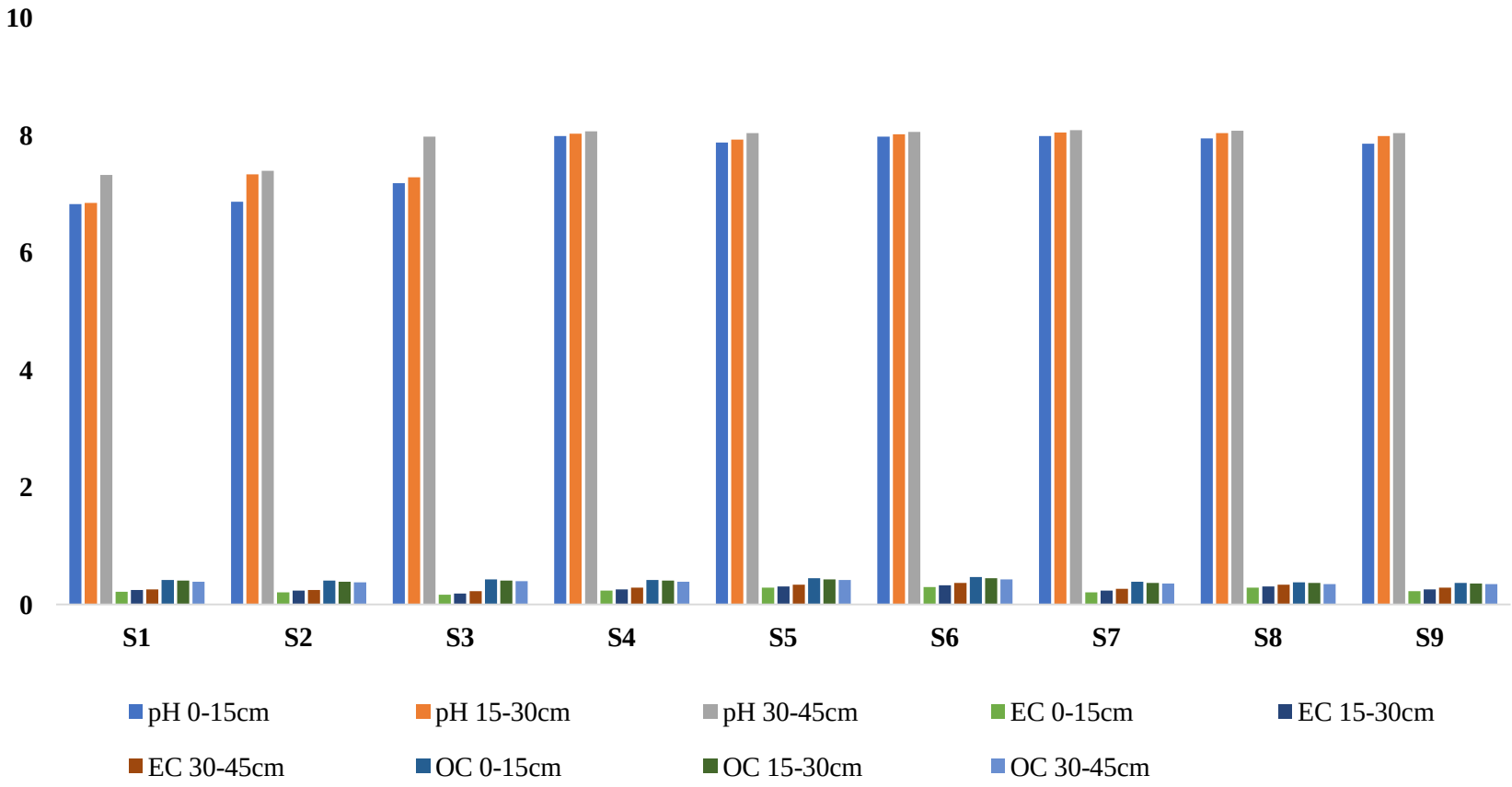

Fig. 3. pH, EC (ds m^{-1}) and organic carbon (%)

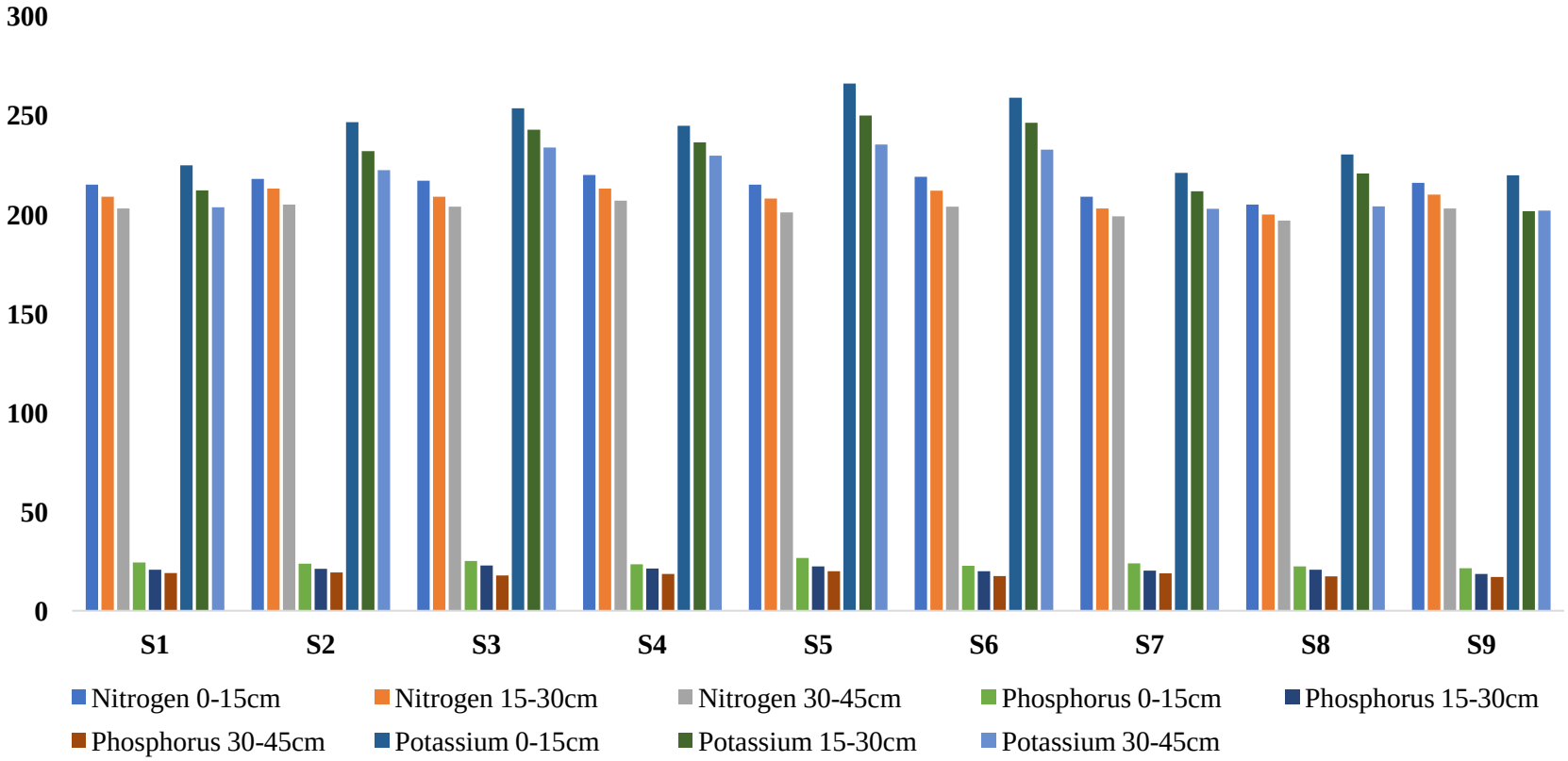

Fig. 4. Available nitrogen, available phosphorous and available potassium (kg ha^{-1})

Table 4. Evaluation of available nitrogen, available phosphorous and available potassium (kg ha^{-1})

	Nitrogen (kg ha^{-1})			Phosphorous (kg ha^{-1})			Potassium (kg ha^{-1})		
Anandapuram	**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**
S_1	215.00	209.00	203.00	24.36	20.75	18.96	224.85	212.18	203.56
S_2	218.00	213.00	205.00	23.68	21.12	19.28	246.55	231.93	222.36
S_3	217.00	209.00	204.00	25.12	22.85	17.85	253.56	242.85	233.72
Pendurthi									
S_4	220.00	213.00	207.00	23.42	21.28	18.54	244.75	236.38	229.63
S_5	215.00	208.00	201.00	26.68	22.42	19.87	266.01	249.91	235.37
S_6	219.00	212.00	204.00	22.68	19.92	17.45	258.89	246.22	232.65
Atchuthapuram									
S_7	209.00	203.00	199.00	23.86	20.17	18.86	220.96	211.65	202.84
S_8	205.00	200.00	197.00	22.37	20.67	17.37	230.34	220.75	204.12
S_9	216.00	210.00	203.00	21.52	18.62	16.96	219.79	205.62	201.96
	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	2.62398	7.7962	S	0.347482	1.032421	S	3.28570	9.76233
Depth (15-30 cm)	S	3.25308	2.7816	S	0.372509	1.10678	S	3.03380	9.01389
Depth (30-45 cm)	S	0.44877	1.3348	S	4.239471	12.5961	S	0.07997	0.23762

Table 5. Evaluation of exchangeable calcium and magnesium [meq $100g^{-1}$]

Block Name & Sites	Exchangeable Calcium [meq $100g^{-1}$]			Exchangeable Magnesium [meq $100g^{-1}$]		
Jainath	**0-15 cm**	**15-30 cm**	**30-45 cm**	**0-15 cm**	**15-30 cm**	**30-45 cm**
S_1	4.72	4.52	4.13	2.68	2.42	2.24
S_2	4.35	4.15	3.88	2.66	2.44	2.31
S_3	4.26	4.01	3.84	2.62	2.53	2.34
Ichoda						
S_4	5.66	5.38	5.02	2.76	2.66	2.54
S_5	5.27	5.12	4.86	2.79	2.65	2.42
S_6	5.65	5.21	4.95	2.71	2.59	2.38
Boath						
S_7	4.18	3.83	3.53	2.34	2.24	2.11
S_8	4.04	3.54	3.22	2.21	2.05	1.94
S_9	3.95	3.64	3.41	2.12	1.93	1.85
	F-Test	**S.Em. ±**	**C.D. @5%**	**F-Test**	**S.Em. ±**	**C.D. @5%**
Depth (0-15 cm)	S	0.051435	0.152822	S	0.034384	0.102161
Depth (15-30 cm)	S	0.069413	0.206236	S	0.033348	0.099081
Depth (30-45 cm)	S	0.034498	0.102499	S	0.032623	0.096928

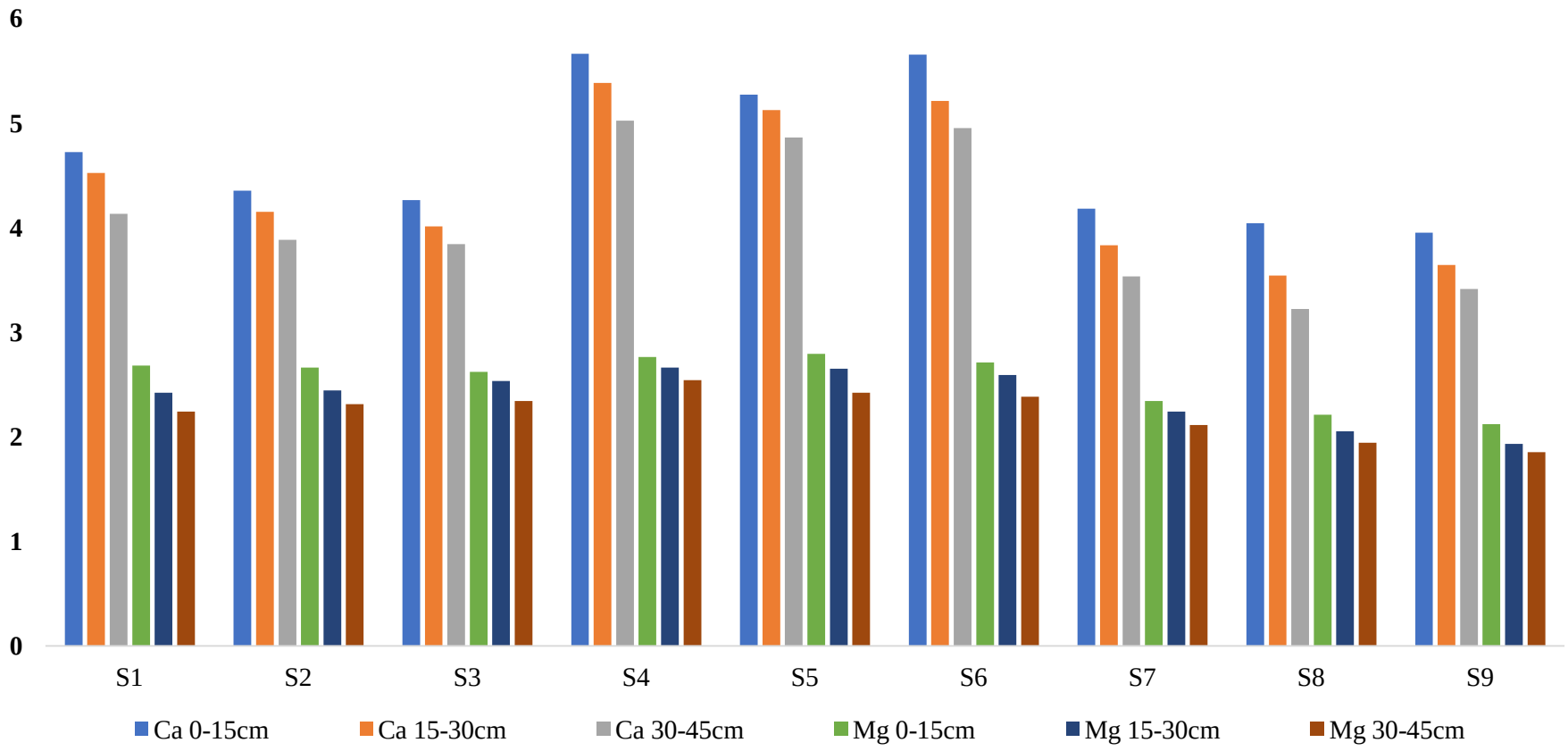

Fig. 5. Exchangeable calcium and magnesium [meq $100g^{-1}$]

3.3 Primary Nutrients

The Available Nitrogen content of soil ranged from 197 to 220 kg ha^{-1} and Nitrogen content was low in all villages. The Available Phosphorus content of soil ranged from 16.96 to 26.68 kg ha^{-1}. The phosphorus content was found medium to high. Available Potassium content of soil ranged from 201.96 to 266.01 kg ha^{-1}. The potassium content was found Medium in range in all the villages [13-18].

3.4 Secondary Nutrients

Exchangeable Calcium content of soil ranged from (3.22 meq $100g^{-1}$to 5.66 meq $100g^{-1}$with the highest value recorded at site S_4 (5.66) meq $100g^{-1}$) from the Pendurthi Block. Exchangeable Magnesium content of soil ranged from 1.85 meq $100g^{-1}$ to 2.79 meq $100g^{-1}$with the highest value recorded at S_5 (2.79) meq $100g^{-1}$) from the Pendurthi Block. Calcium and Magnesium are very sufficient in this soil. "Exchangeable Calcium and Magnesium decreases with the increasing in depth due to the attributes of high pH towards the depth" [19-22].

4. CONCLUSION AND SUGGESTION

It is concluded that the soils of three blocks of the district are Sandy loam and Loamy sand with adequate BD, PD and pore space. It is slightly alkaline in nature, electrical conductivity as favourable for plant growth but with some management practices, organic carbon is low content, and Nitrogen was found to be low and phosphorus are medium to high and potassium is found be medium in range. Secondary nutrients i.e., calcium and magnesium are quite adequate. 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 paddy, wheat, jowar, soya bean, horticulture crops etc. Farmers are advised to implement acceptable management methods and supply proper nourishment to soil health in accordance with the standards of the central and state governments for crop cultivation and are obliged to maintain their Soil Health Cards. It implies that there is still room for improvement in cropping patterns, organic waste decomposition, mulching, and tillage techniques. With the knowledge and experience gained from research, these practices may be developed in the future to assist farmers in producing high yields through soil conservation and maintaining better environmental protection.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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