International Journal of Plant & Soil Science

Volume 35, Issue 16, Page 1-11, 2023; Article no.IJPSS.101362
ISSN: 2320-7035

Assessment of Physico-chemical Properties of Soil from Different Blocks of West Godavari District, Andhra Pradesh, India

Chennuri Alekhya [a++*], Narendra Swaroop [a#], Tarence Thomas [a†], Anurag Kumar Singh [a‡] and Indar Raj Naga [a++]

[a] Department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India.

Authors' contributions

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

Article Information

DOI: 10.9734/IJPSS/2023/v35i163123

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/101362

Original Research Article

Received: 08/04/2023
Accepted: 10/06/2023
Published: 17/06/2023

ABSTRACT

The study of nutrient status in West Godavari District of Andhra Pradesh was carried out in 2022-2023. Representative soil samples were collected covering three mandalas of West Godavari division before sowing of crop. The soil samples were analysed for their Physico-chemical Properties. The samples were taken from different blocks and depths like 0-15cm,15-30cm and 30-45cm. There are many reasons leading to soil quality deterioration, including changes in land use types from forest to arable land and the consequences from intensive land use. The colour of soil

[++] *M.Sc. Scholar;*
[#] *Associate Professor;*
[†] *Professor;*
[‡] *Ph.D. Scholar*
**Corresponding author: E-mail: alekhyachennuri1997@gmail.com;*

changes between the three depths at all the locations. There was also a difference in colour of dry and wet soils was dark brown to dark yellowish brown. Results show that soil Bulk Density varied from 1.31 to 1.48 % Mg m^{-3}, soil Particle Density varied from 2.44 to 2.57 % Mg m^{-3}, Percent of Pore Space from 43.09 to 48.21 %, Water Holding Capacity from 35.73 to 44.24 % respectively. Soil p^H varied from 77.25 to 8.92 % and EC is 0.18 to 0.37 % respectively while soil Organic Carbon varied from 0.28to 0.55 % and Available Nitrogen varied from low to medium i.e., 216 to 323 % kg ha^{-1} Available Phosphorous varied from medium to high range i.e., 14.05 to 25.71 % kg ha^{-1}. and Available Potassium was found to be medium range i.e.,137.00 to 236.00 % kg ha^{-1}, Exchangeable Calcium and Magnesium low from 3.34 to 5.66 % (meq $100g^{-1}$) and 1.36 to 2.74 % (meq $100g^{-1}$) respectively. Results show that the soil samples of the areas of Eluru division were found to be mildly alkaline and non-saline.

Keywords: Physico-chemical; properties; organic carbon; pH; nitrogen; phosphorus; soil; potassium; analysis.

1. INTRODUCTION

"Soil is all unconsolidated material of the earth's crust in which land plants can grow, if water and temperature are adequate at least the minimum nutrients are available and toxic substances are in low concentration. Soil sampling is the most vital step for any soil analysis. It is a dynamic natural body developed as a result of pedogenic processes during weathering of rocks. It consists of minerals and organic constituents, exhibits definite physical, chemical and biological properties of variable depth. Over the surface of earth provides a suitable medium for plant growth. Soil mainly consists of 50% pore space (air and water) and 50% solid phase. The soil phase is broadly composed of 45% mineral matter and 5% organic constituents (Soils and Plant Nutrients)" [1].

"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 soil solution. 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)" [2].

"Physical properties play an important role in determining soil's suitability for agriculture. The supporting capability, movement, retention and availability of water and nutrients to plants, ease in penetration of roots and flow of heat and air are directly associated with physical properties of the soil. Physical properties also influence the chemical and biological properties" [2]. An overview of the physical properties of soils and their importance on the mobility of water and nutrients and the development of a vegetation cover. It also gives some examples of why the use of agricultural residues can affect positively on soil physical properties. The store house of nutrient on any farm

"Chemical properties of soil include the following aspects: inorganic matters of soil, organic matters in soil, colloidal properties of soil particles and soil reactions and buffering action in acidic soils & basic soils. The chemical side of a soil is extremely important of course and is about the correct balance of the available nutrients in the soil. This is largely determined by the organic-matter content and its humus percentage; this is the store house of nutrient on any farm. The extent to which minerals have a dominant presence or not affects the release of specific nutrients. Supplementing shortage is important, but the right balance is even more important. The soil only produces nutrients if you have the right balance, chemical and physical properties impact biological properties" [3]. Optimal chemical and physical properties will lead to optimal biological properties and soil functions i.e., nutrient and water cycling. 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 West Godavari, undertaken.

2. MATERIALS AND METHODS

Location: The location of West Godavari district in Eluru is located on the map with the GPS coordinates of 16°71'07''N and 81°09'52''E.

Soil and climate: In West Godavari District, the climate is moderate both in winter and summer seasons in delta area. The normal maximum and minimum temperatures recorded in the district are 36.20°C to 19.0°C respectively. The annual rainfall is between 1045 and 1170 mm in northern Andhra Pradesh. Districts of the southern region of the Andhra Pradesh state receive less rain during the southwest monsoon. Andhra Pradesh contains various soil types, some of which are red soil, Alluvial soil, Black soil, Saline soil, Sandy coastal soil, Rocky hill soil red soil is the most abundant among these soils. These soil types allow the planting of a variety of fruits and vegetable crops such as mangoes, Lemon, coconut, sugarcane, paddy, Maize and Chilies.

Sampling and analysis: The soil sample collection is from 3 blocks of West Godavari district in the state of Andhra Pradesh each selecting 3 villages. Samples were collected randomly from a site of each village using soil khurpi by composite sampling method at a depth of 0-15cm, 15-30cm and 30- 45cm**.** After sampling the samples were air dried in shade and then these samples were processed for various physical and chemical tests. The data was recorded during the course of investigation were subjected to statistical analysis by analysis of Completely Randomized Design (CRD) as per the method of "Analysis of Variance" (ANOVA) technique.

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,). The samples were matched against the standard Munsell colour chart [4]. "Soil textural class was determined by using Hydrometer [5]. Bulk density, Particle density, Water holding capacity was determined by using Graduated Measuring Cylinder method" (Muthuvel et al*.,* 1992). "pH was estimated with the help of Digital pH meter after making 1:2 soil water suspension" [6]. "Electrical Conductivity was estimated with the help of Digital Conductivity meter" [7]. "Percent Organic Carbon was estimated by Wet Oxidation method" [8]. "Available Nitrogen was estimated by Alkaline Potassium Permanganate method, using Kjeldahl apparatus [9], Available Phosphorus was estimated by Olsen's extraction followed by Spectrophotometric method [10], Available Potassium was estimated by Neutral normal Ammonium Acetate extraction followed by Flame photometric method [11], Exchangeable Calcium and Magnesium were estimated by EDTA method" [12].

3. RESULTS AND DISCUSSION

Physical properties: The experimental results of the present investigation entitled "Assessment of Physico- chemical properties of soil from different blocks of West Godavari district Andhra Pradesh, India''. "The texture of the soil of West Godavari district varied from Sandy clay loam to clay. The colour (Dry method) of soil samples is shown Brown, red, Dark brown, Black and in (Wet method) colour of soil samples are shown Dark brown, Dark yellowish brown, Red, very dark greyish brown". [13] The sand, silt and clay percentage varied from 15.34 to 71.32% sand, 5.62 to 24.83% silt and 18.16 to 69.44% clay in Sandy Loam. Bulk density was varied from the 1.31 to 1.48 Mg m^{-3} (Table 1). (B_2V_6) Chodimella village reported lowest and (B_3V_9) Palagudem village reported highest Bulk density. Bulk density was found to increase with the increase soil depth in some sites due to increase in compaction in the subsurface comparatively. The range of Particle density varied from 2.44 to 2.57 Mg m^{-3} (Table 2). (B_2V_6) Chodimella village reported lowest and (B_3V_9) Palagudem village reported highest Particle density of soil varies according to the mineral composition of the soil particle.

The particle density did not change with increases in depth in the sites. Similar findings also reported by Ahad et al*.,* [14] and Lalitha Kumari et al*.,* [15]. The range of Pore space (%) was varied from 40.24 to 48.21% (Table 2). (B_2V_6) Chodimella village reported lowest porosity and (B_2V_4) Chodimella village reported highest porosity. The pore space was found to decrease with increase in depth attributed to increase in compaction in the subsurface. The range of Water Holding Capacity (%) ranged from 35.73 to 44.24% (Table 2). (B_2V_6) Chodimella village reported lowest Water holding capacity and (B_3V_8) Palagudem reported highest Water holding capacity. These variations were due to the silt, clay and organic carbon content and low WHC in sandy soil due to high sand and less silt content. The irregular trend of WHC with depth due to illuviation and eluviation of finer fraction in different horizons. Similarly reported by Das et al., [3].

Table 1. Bulk density and Particle density (Mg m^{-3}) of soil in different villages of West Godavari district at 0-15, 15-30 and 30-45cm depth

Villages	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
Denduluru (B1)						
V1	1.42	1.43	1.44	2.48	2.50	2.51
V2	1.41	1.43	1.45	2.52	2.53	2.55
V3	1.44	1.45	1.46	2.53	2.55	2.56
Chodimella (B2)						
V4	1.32	1.34	1.35	2.52	2.54	2.55
V5	1.33	1.35	1.37	2.51	2.52	2.56
V6	1.31	1.34	1.37	2.44	2.47	2.52
Palagudem (B3)						
V7	1.42	1.45	1.46	2.52	2.55	2.56
V8	1.39	1.43	1.47	2.49	2.53	2.55
V9	1.39	1.44	1.48	2.54	2.55	2.57
	F-test	**S.Em. (±)**	**C.D @5%**	**F-test**	**S.Em. (±)**	**C.D @5%**
Depth (0-15cm)	S	0.018331	0.054465	NS	0.02561	-
Depth (15-30cm)	S	0.018713	0.00556	NS	0.037888	-
Depth (30-45cm)	S	0.021473	0.063801	NS	0.028383	-

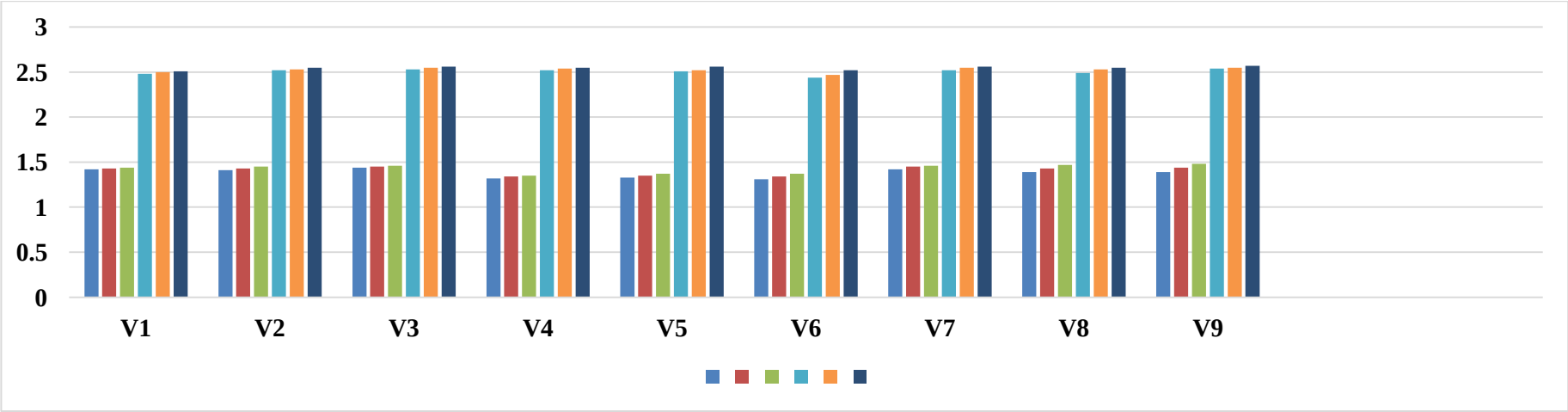

Fig. 1. Bulk density and Particle density (Mg m^{-3}) of soil in different villages of West Godavari district at 0-15, 15-30 and 30-45 cm depth

Table 2. Pore Space and Water Holding Capacity (%) of soil in different villages of West Godavari district at 0-15, 15-30 and 30-45 cm depth

Villages	Pore Space (%)			Water Holding Capacity (%)		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Denduluru (B1)						
V1	46.87	44.15	42.98	40.08	38.15	37.63
V2	46.80	43.83	41.48	40.41	37.83	36.75
V3	47.16	45.49	43.09	41.73	39.12	37.23
Chodimella (B_2)						
V4	48.21	46.62	44.42	42.76	40.62	38.92
V5	46.18	44.82	42.86	40.51	38.54	37.61
V6	44.07	42.13	40.24	38.04	37.02	35.73
Palagudem (B3)						
V7	45.62	43.48	41.36	39.42	38.82	36.67
V8	48.09	46.83	44.69	44.24	41.76	39.54
V9	47.81	45.88	43.75	43.64	40.26	38.56
	F-test	**S.Em. (±)**	**C.D @5%**	**F-test**	**S.Em. (±)**	**C.D @5%**
Depth (0-15cm)	S	0.752825	2.236757	S	0.635445	1.888004
Depth (15-30cm)	S	0.750192	2.228539	S	0.530659	1.576669
Depth (30-45cm)	S	0.689357	2.048186	S	0.699695	2.078902

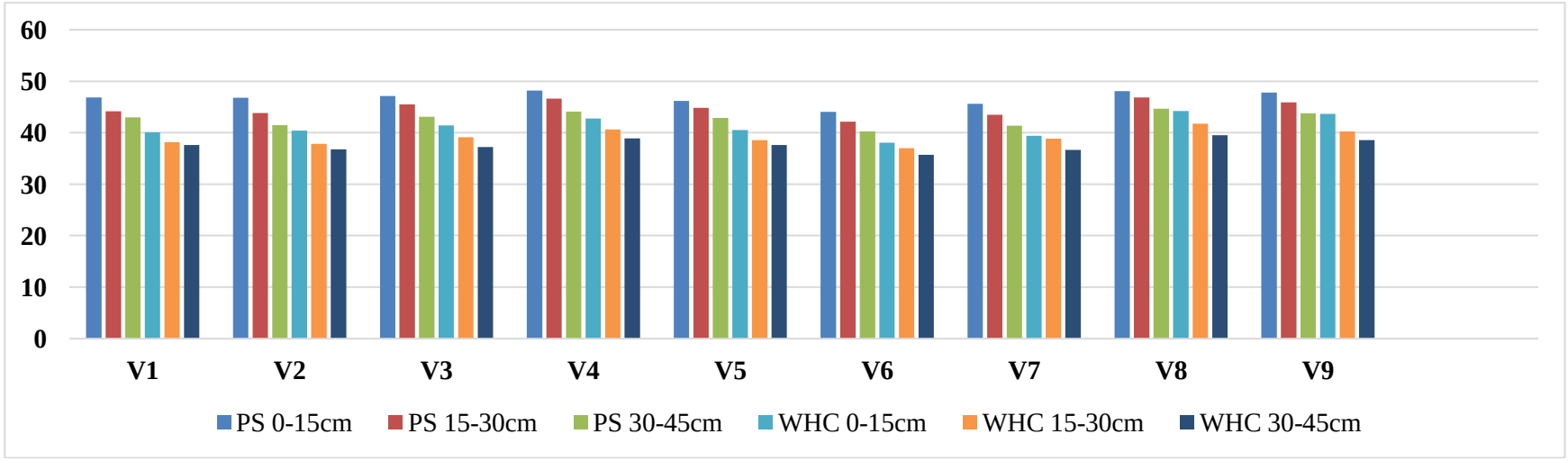

Fig. 2. Pore Space and Water Holding Capacity (%) of soil in different villages of West Godavari district at 0-15, 15-30 and 30-45 cm depth

Table 3. Soil pH and EC (dS m^{-1}) of soil in different villages of West Godavari district at 0-15, 15-30 and 30-45 cm depth

Villages	Soil pH			Soil EC (dS m^{-1})		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Denduluru (B1)						
V1	8.23	8.35	8.50	0.26	0.28	0.33
V2	7.55	7.45	7.92	0.24	0.24	0.30
V3	8.75	8.85	8.92	0.31	0.34	0.37
Chodimella (B2)						
V4	8.44	8.42	8.65	0.23	0.26	0.30
V5	8.00	8.20	8.52	0.21	0.24	0.27
V6	8.23	8.12	8.46	0.18	0.21	0.23
Palagudem (B3)						
V7	8.35	8.62	8.82	0.20	0.22	0.25
V8	8.20	8.61	8.22	0.21	0.24	0.26
V9	7.25	7.68	7.82	0.24	0.28	0.34
	F-test	**S.Em. (±)**	**C.D @5%**	**F-test**	**S.Em. (±)**	**C.D @5%**
Depth (0-15cm)	S	0.063842	0.189684	S	0.003715	0.011039
Depth (15-30cm)	S	0.139786	0.415326	S	0.444299	0.012774
Depth (30-45cm)	S	0.097931	0.290969	S	0.003779	0.011228

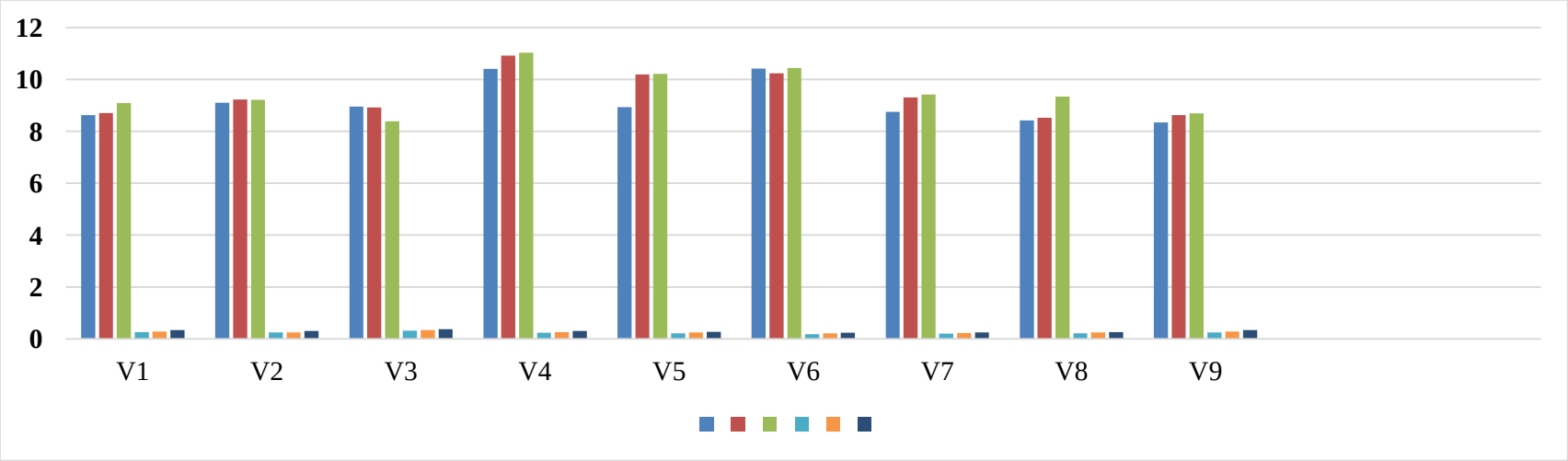

Fig. 3. Soil pH and EC (dS m^{-1}) of soil in different villages of West Godavari district at 0-15, 15-30 and 30-45 cm depth

Table 4. Soil OC (%) and Available Nitrogen (kg ha^{-1}) of soil in different villages of West Godavari district at 0-15,15-30 and 30-45 cm depth

Villages	Organic Carbon (%)			Nitrogen (kg ha^{-1})		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Denduluru (B1)						
V1	0.35	0.33	0.30	244.00	238.00	231.00
V2	0.33	0.31	0.29	256.00	249.00	242.00
V3	0.35	0.31	0.28	235.00	227.00	216.00
Chodimella (B2)						
V4	0.47	0.43	0.40	290.00	277.00	270.00
V5	0.50	0.47	0.44	277.00	265.00	259.00
V6	0.55	0.52	0.49	323.00	294.00	287.00
Palagudem (B3)						
V7	0.47	0.44	0.43	305.00	290.00	277.00
V8	0.44	0.41	0.37	317.00	303.00	283.00
V9	0.49	0.47	0.43	298.00	287.00	275.00
	F-test	**S.Em. (±)**	**C.D @5%**	**F-test**	**S.Em. (±)**	**C.D @5%**
Depth (0-15cm)	S	0.00867	0.025761	S	4.349374	12.92265
Depth (15-30cm)	S	0.005416	0.016093	S	2.71607	8.069859
Depth (30-45cm)	S	0.005281	0.015692	S	3.420792	10.1637

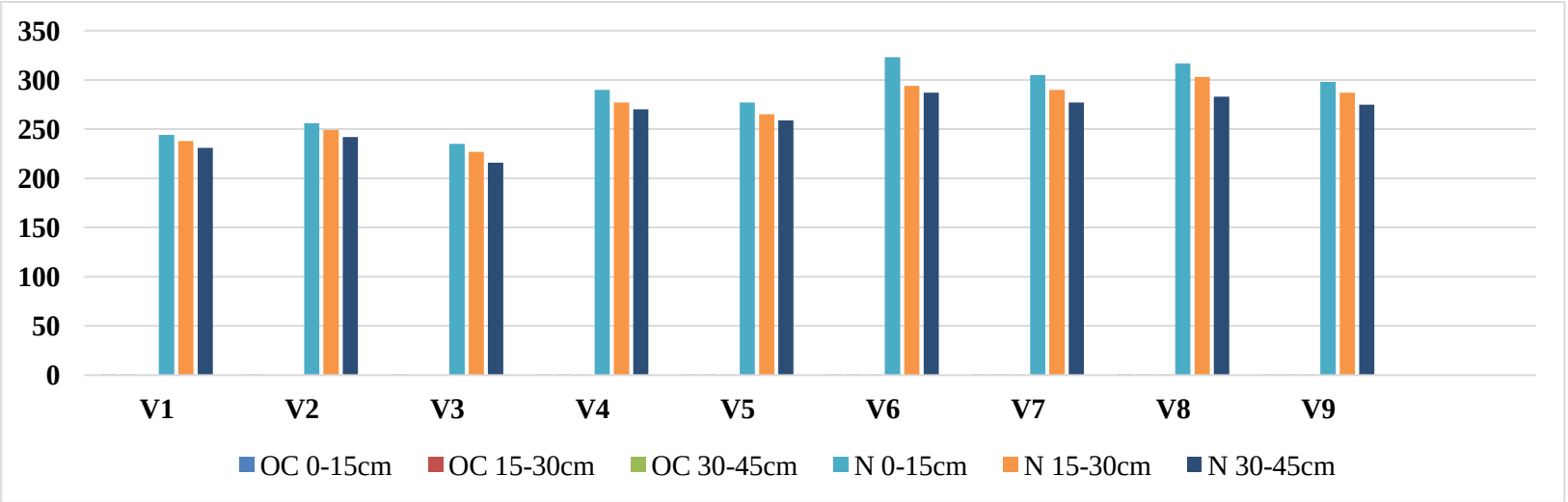

Fig. 4. Soil OC (%) and Available Nitrogen (kg ha^{-1}) of soil in different villages of West Godavari district at 0-15,15-30 and 30-45 cm depth

Table 5. Available Phosphorus and Potassium (kg ha^{-1}) of soil in different villages of West Godavari district at 0-15cm, 15-30cm and 30-45cm depth

Villages	Phosphorus (kg ha^{-1})			Potassium (kg ha^{-1})		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Denduluru (B1)						
V1	18.46	16.44	14.05	213.00	198.00	173.00
V2	20.78	17.56	15.34	185.00	179.00	153.00
V3	19.88	15.23	14.15	168.00	147.00	137.00
Chodimella (B2)						
V4	23.73	20.50	18.28	199.00	183.00	177.00
V5	21.93	17.70	15.47	203.00	185.00	176.00
V6	25.71	21.49	19.26	236.00	209.00	193.00
Palagudem (B3)						
V7	20.30	19.07	16.85	227.00	197.00	173.00
V8	18.94	17.71	14.49	213.00	210.00	193.00
V9	19.98	17.74	15.06	231.00	220.00	199.00
	F-test	**S.Em. (±)**	**C.D @5%**	**F-test**	**S.Em. (±)**	**C.D @5%**
Depth (0-15cm)	S	0.409358	1.216344	S	0.238521	0.708682
Depth (15-30cm)	S	0.294934	0.876294	S	2.674644	7.946776
Depth (30-45cm)	S	0.238521	0.708682	S	2.980573	8.855736

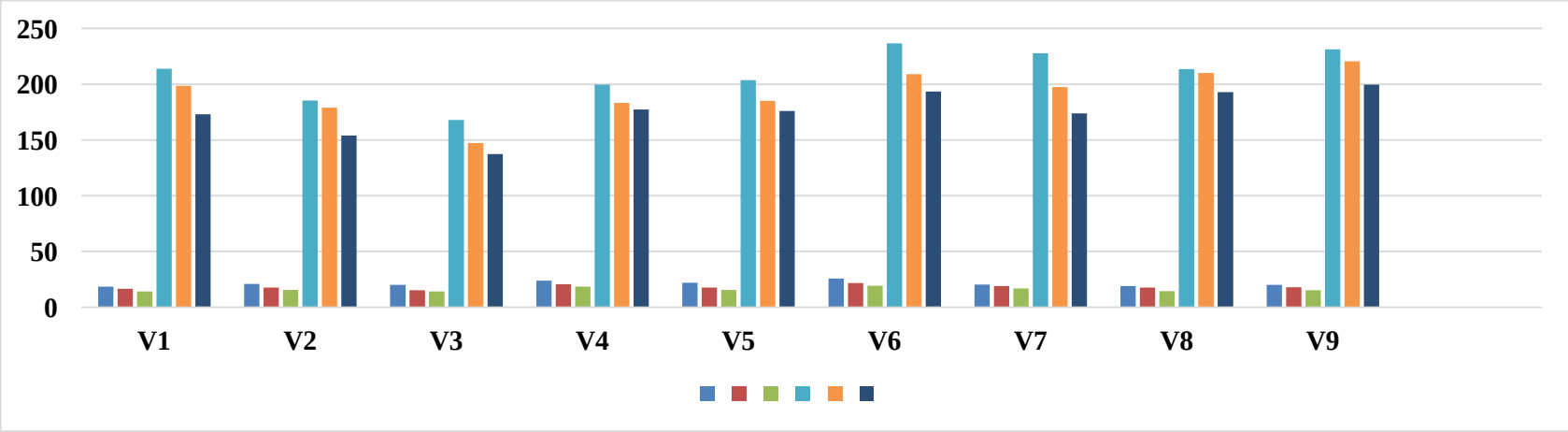

Fig. 5. Available Phosphorus and Potassium (kg ha^{-1}) of soil in different villages of West Godavari district at 0-15, 15-30 and 30-45 cm depth

Table 6. Exchangeable Calcium and Magnesium (meq 100g^{-1}) of soil in different villages of West Godavari district at 0-15,15-30 and 30-45 cm depth

Villages	Exchangeable Calcium (meq 100g^{-1})			Exchangeable Magnesium (meq 100g^{-1})		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Denduluru (B1)						
V1	4.82	4.76	3.34	1.74	1.46	1.36
V2	5.25	4.24	3.78	1.92	1.64	1.62
V3	5.16	4.32	3.82	1.54	1.72	1.56
Chodimella (B2)						
V4	5.66	5.42	4.98	2.24	1.96	1.84
V5	5.45	5.16	5.01	2.74	2.54	2.22
V6	5.54	5.20	4.86	2.53	2.26	2.02
Palagudem (B3)						
V7	5.32	4.95	4.94	2.34	2.20	2.36
V8	5.12	5.84	4.62	2.20	2.12	2.00
V9	4.98	4.84	4.45	2.09	2.24	1.98
	F-test	**S.Em. (±)**	**C.D @5%**	**F-test**	**S.Em. (±)**	**C.D @5%**
Depth (0-15cm)	S	0.084378	0.250699	S	0.035215	0.10463
Depth (15-30cm)	S	0.073463	0.218271	S	0.032873	0.09767
Depth (30-45cm)	S	0.003902	0.189863	S	0.026126	0.077623

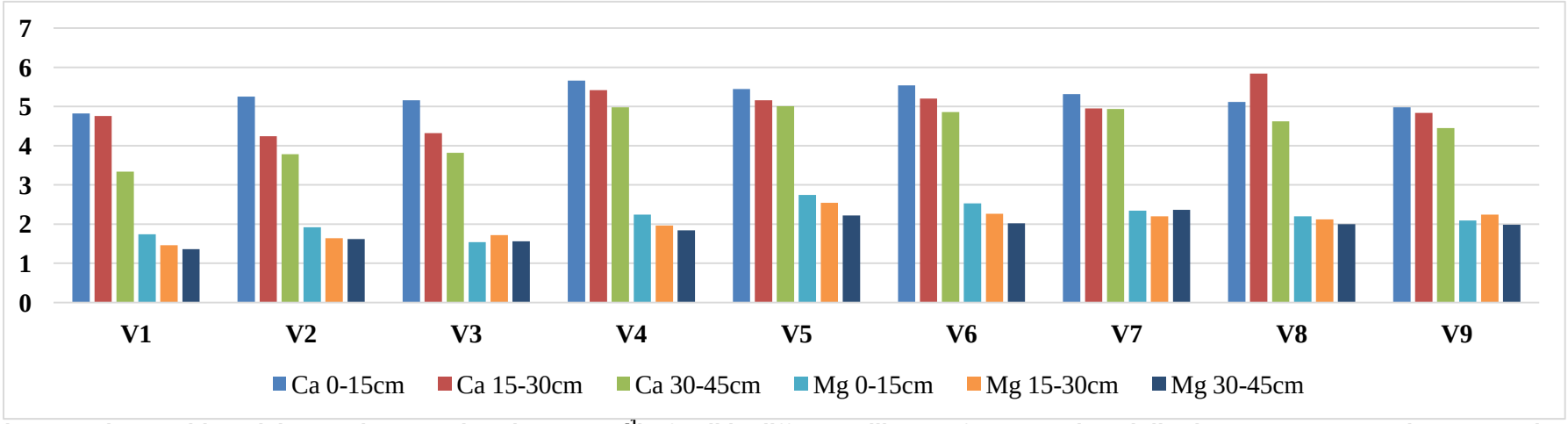

Fig. 6. Exchangeable Calcium and Magnesium (meq 100g^{-1}) of soil in different villages of West Godavari district at 0-15,15-30 and 30-45 cm depth

Chemical properties: The pH value ranges from 7.25 to 8.92 (Table 3). The highest pH value was observed in the (B_1V_3) Denduluru village. Due to high rainfall which caused leaching of bases similar findings Kumari et al*.,* The lowest pH value weas observed in the (B_3V_9) Palagudem village these results are similar to SriLakshmi et al*.,* [16] with an increase in organic matter the soil recovers its natural buffer capacity this means an increase in pH in acid soils. The Electrical Conductivity ranged from 0.18 to 0.37 dS m^{-1} (Table 3). (B_2V_6) Chodimella village with the lowest EC content, where the village with the greatest EC content was (B_1V_3) Denduluru and the soil was found to be normal. Organic Carbon (%) ranged from 0.28 to 0.55% (Table 4). The organic carbon range was low to medium range. The lowest Organic Carbon was observed in (B_1V_3) Denduluru and (B_2V_6) Chodimella village highest Organic Carbon. this is due to the addition of plant residues and farmyard manures to surface horizons than lower horizons**.** The amount of Available Nitrogen is low to medium.

The Nitrogen of soil ranged from 216.00 to 323.00 kg ha^{-1} (Table 4). The lowest Nitrogen content was observed in (B_1V_3) Denduluru village due to replenishment of soil Nitrogen through organics and or inorganics to avoid soil mining for Nitrogen, where highest Nitrogen content in soil was observed in (B_2V_6) Chodimella village Patel et al., [17]. The amount of Available Phosphorus is high. Because of excessive use of phosphatic fertilizers. The Phosphorus ranged from 14.05 to 25.71 kg ha^{-1} (Table 5). The lowest Phosphorus content was observed in (B_1V_1) Denduluru village whereas highest Phosphorus content was reported (B_2V_6) Wani et al*.,* [18] Available Potassium content of soil ranged from 137.00 to 236.00 kg ha^{-1} (Table 5). The lowest Potassium content was observed in (B_1V_3) Denduluru village whereas highest Potassium content was observed (B_2V_6). All the sites have low to medium potassium content Dinesh et al., [19] Exchangeable Calcium content of soil ranged from 3.34 to 5.84 meq $100g^{-1}$(Table 6). The lowest Calcium content was observed in (B_1V_1) Denduluru village whereas highest Calcium content was observed (B_3V_8). Exchangeable Magnesium content of soil ranged from 1.36 to 2.74 meq $100g^{-1}$(Table 6). The lowest Magnesium content was observed in (B_1V_1) whereas highest Magnesium content observed (B_2V_5) Calcium and Magnesium are low in the soil. Calcium and magnesium both increases the soil pH as its availability increases in soil Malvath et al*.,* [20].

4. CONCLUSION

It is concluded that both the red soils and black soils were moderately to strongly alkaline in reaction and non-saline. On the soil complex the dominant cation is calcium. The physical properties of both surficial and sub-surficial soils are normal as the bulk density value is normal. The Water Holding Capacity is high. The overall fertility status of the soils was low, medium and high in nitrogen, phosphorus and potassium respectively. As the soils were calcareous and strongly alkaline, there is need for application of any acid forming amendment improves and organic materials to alleviate the nutrient deficiency and improve productivity of soils.

ACKNOWLEDGEMENT

I would like to express my sincere thanks to my Advisor Dr. Narendra Swaroop and Associate Professor, department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute, SHUATS, Prayagraj, for his diligent guidance and constructive suggestions at every step during my work. I thank him for his creative criticism and valuable suggestions for improving the quality of this work. I also extend my gratitude to all the teaching and non- teaching staff of our department because without them I would not be able to complete my work.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Aasim M, Thomas T, Swaroop N, Singh AK. Assessment of soil health parameters from different blocks of Kota district, Rajasthan. The Pharma Innovation Journal. 2021;10(10):690-5.
2. Tewari G, Khati D, Rana L, Yadav P, Pande C, Bhatt S, Kumar V, Joshi N, Joshi PK. Assessment of Physicochemical Properties of Soils from Different Land Use Systems in Uttarakhand, India. Journal of Chemical Engineering and Chemistry Research. 2016;3(11):1114-8.
3. Das S, Mipun BS. Spatial distribution of soil physical properties in west Tripura

district, Tripura. Indian Journal F Research. 2020;10(1):39-40.
4. Anonymous. Munsell colour chart. Munsell colour company inc. 2241 N. calveri street, Baltimore, Marytanel 21212, USA; 1971.
5. Bouyoucos GJ. The hydrometer as a new method for the mechanical analysis of soils. Soil Science. 1927;23:343-353.
6. Jackson ML. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi; 1958.
7. Wilcox LV. Electrical conductivity, Amer. Water Works Assoc. J. 1950;42:775-776.
8. Walkley A. Critical examination of rapid method for determining organic carbon in soils, effect of variation in digestion conditions and of inorganic soil constituents, Soil Sci. 1947;632:251.
9. Subbiah BV, Asija CL. A rapid procedure for the estimation of available nitrogen in soils. Current Sci. 1956;25:259-260.
10. Olsen SR, Cole CV, Watnahe FS, Dean LA. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. U.S. Deptt. Agr. Circ. 1954;939.
11. Toth SJ, Prince AL. Estimation of cation exchange capacity and exchangeable Ca, K and Na content of soil by flame photometer technique. Soil Sci. 1949;67: 439-445.
12. Cheng KL, Bray RH. Determination of Calcium and Magnesium in soil and plant material. Soil Sci. 1951;72:449-458.
13. Bindu AH, Hasan A, Thomas T, David AA, Singh AK. Assessment of Physico-Chemical Properties of Soil from Different Blocks of Prakasam District, Andhra Pradesh, India. International Journal of Plant & Soil Science. 2022;34(19):340-9.
14. Ahad T, Kanth TA, Nabi S. Soil Bulk Density as Related to Texture, Organic Matter Content and Porosity in Kandi Soils of District Kupwara (Kashmir Valley), India. International Journal of Scientific Research. 2015;4(1):198-200.
15. Lalitha Kumari B, Rojarani M, Sudhakar P, Hanumasri M, Satyasree KPNV. Analisation of soil water quality in and around the saltpans of Prakasam (Dt.) A.P. International Journal of Recent scientific Research. 2013;4 (3):198-201.
16. Srilakshmi M, Thomas T, Rao PS. Assessment of soil physico-chemical properties of near by coastal area of paddy soils of Praksam district, Andhra Pradesh. International Journal of chemical studies.2019;7(3):1605-1608.
17. Patel KP. Analysis of soil quality using Physico- chemical parameters of shehra Taluka District, Panchmahal, Gujarat. Indian journal of Applied Research. 2015;5(9):466-468.
18. Wani SA, Najar GR, Padder BA, Akhter F, Chand S. Altitudinal and depth-wise variation of soil physico-chemical properties and available nutrients of pear orchards in Jammu & Kashmir, India. Chem. Sci. Rev. Lett. 2017;6(23):1638-1645.
19. Dinesh K, Sushil L, Binita T, Bandhu R, Baral, Parbati A. An assessment of soil fertility status of national maize research program, Rampur, Chitwan, Nepal Imperial Journal of Interdisciplinary Research (IJ IR). 2016;(5):2454-1362.
20. Malavath RN, Thurpu SR. Soil fertility status of some turmeric growing soils of Nizamabad district of Telangana in relation to root-knot nematodes, Journal of Pharmacognosy and Phytochemistry. 2019;8(1):926-929.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/101362