

Original Research Article

Assessment of Physico-chemical properties of soil from different blocks of West Godavari district, Andhra Pradesh

ABSTRACT

The study of nutrient status in West Godavari District of Andhra Pradesh. 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. Results show that the soil samples of the areas of Eluru division were found to be mildly alkaline and non-saline. 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 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 7.25 to 8.92 and EC is 0.18 to 0.37 % respectively while soil Organic Carbon varied from 0.28 to 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 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 % ($\text{Meq } 100\text{g}^{-1}$) and 1.36 to 2.74 % ($\text{Meq } 100\text{g}^{-1}$) respectively.

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).

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) (Griffiths *et al.*, 2010).

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. 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 (Das *et al.*, 2020). 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

2.1 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.

2.2 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.

2.3 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.

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Table 1: Procedure used for Physico-chemical analysis of soil**A. Physical analysis**

S. No.	Parameters	Scientist
1	Soil Textural Class (Sand, Silt, Clay)	Bouyoucos, (1927)
2	Bulk Density (Mg m^{-3})	Muthuvel <i>et al.</i> , (1992)
3	Particle Density (Mg m^{-3})	
4	Pore Space (%)	
5	Water Holding Capacity (%)	

B. Chemical analysis

S. No.	Parameters	Scientist
1	Soil pH	Jackson, (1958)
2	Electrical Conductivity (dS m^{-1})	Wilcox, (1950)
3	Organic Carbon (%)	Walkley and Black, (1947)
4	Available Nitrogen (kg ha^{-1})	Subbiah and Asija, (1956)
5	Available Phosphorus (kg ha^{-1})	Olsen <i>et al.</i> , (1954)
6	Available Potassium (kg ha^{-1})	Toth and Prince, (1949)
7	Exchangeable Ca and Mg ($\text{Meq } 100\text{g}^{-1}$)	Cheng and Bray, (1951)

3. Result and Discussion**3.1 Physical properties**

The Soil Textural class was identified Sandy Loam. 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} . Bulk density was found to increase with the increase soil depth in some sites due to increase in compaction in the subsurface comparatively. The Particle Density varied from 2.44 to 2.57 Mg m^{-3} . The particle density did not change with increases in depth in the sites.

The Pore Space (%) ranged from 40.24 to 48.12%. The pore space was found to decrease with increase in depth attributed to increase in compaction in the subsurface. The Water Holding Capacity (%) ranged from 35.73 to 44.24%. 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.

Table 2: Bulk density and Particle density (Mg m^{-3}) of soil in different villages of West Godavari district at 0-15cm, 15-30cm 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)						
V ₁	1.42	1.43	1.44	2.48	2.50	2.51
V ₂	1.41	1.43	1.45	2.52	2.53	2.55
V ₃	1.44	1.45	1.46	2.53	2.55	2.56
Chodimella (B₂)						
V ₄	1.32	1.34	1.35	2.52	2.54	2.55
V ₅	1.33	1.35	1.37	2.51	2.52	2.56
V ₆	1.31	1.34	1.37	2.44	2.47	2.52
Palagudem (B₃)						
V ₇	1.42	1.45	1.46	2.52	2.55	2.56
V ₈	1.39	1.43	1.47	2.49	2.53	2.55
V ₉	1.39	1.44	1.48	2.54	2.55	2.57
	F-test	S.Em. (\pm)	C.D @5%	F-test	S.Em. (\pm)	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	-

Table 3: Pore Space and Water Holding Capacity (%) of soil in different villages of West Godavari district at 0-15cm, 15-30cm and 30-45cm 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)						
V ₁	46.87	44.15	42.98	40.08	38.15	37.63
V ₂	46.80	43.83	41.48	40.41	37.83	36.75
V ₃	47.16	45.49	43.09	41.73	39.12	37.23
Chodimella (B₂)						
V ₄	48.21	46.62	44.42	42.76	40.62	38.92
V ₅	46.18	44.82	42.86	40.51	38.54	37.61
V ₆	44.07	42.13	40.24	38.04	37.02	35.73
Palagudem (B₃)						
V ₇	45.62	43.48	41.36	39.42	38.82	36.67
V ₈	48.09	46.83	44.69	44.24	41.76	39.54
V ₉	47.81	45.88	43.75	43.64	40.26	38.56
	F-test	S.Em. (\pm)	C.D @5%	F-test	S.Em. (\pm)	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

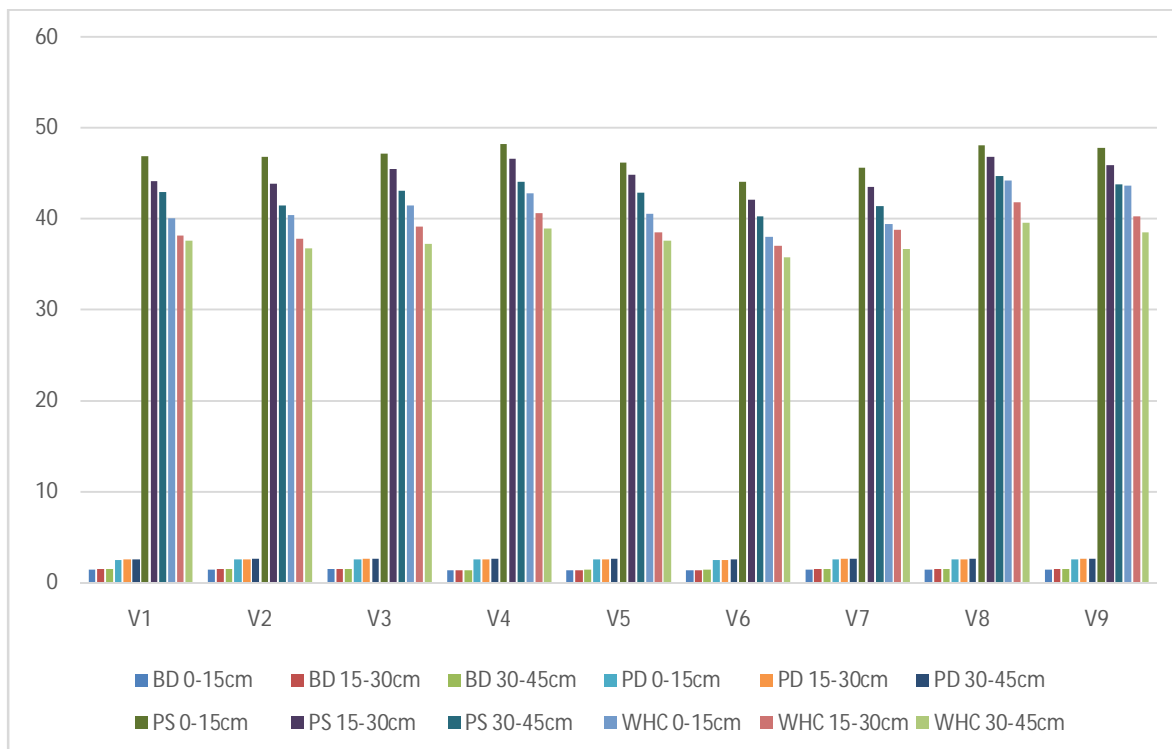


Fig.1: Bulk density, Particle density, Pore space and Water holding capacity of soil in different villages of West Godavari district at 0-15cm, 15-30cm and 30-45cm depth

3.2 Chemical properties

The pH value ranged from 7.25 to 8.92. The Electrical Conductivity ranged from 0.18 to 0.37 dS m⁻¹ and the soil was found to be normal. The value of total Organic Carbon (%) varied from 0.28 to 0.55%. The organic carbon content decreased with increased depth, and this is due to the addition of plant residues and farmyard manures to surface horizons than lower horizons. The available Nitrogen content of soil ranged from 216.00 to 323.00 kg ha⁻¹ and nitrogen content was low in all blocks. The available Phosphorus content of soil ranged from 14.05 to 25.71 kg ha⁻¹. All the sites have low to medium phosphorus content. Available Potassium content of soil ranged from 137.00 to 1236.00 kg ha⁻¹. All the sites have low to medium potassium content. Exchangeable Calcium content of soil ranged from 3.34 to 5.84 Meq 100g⁻¹. Exchangeable Magnesium content of soil ranged from 1.36 to 2.74 Meq 100g⁻¹. Calcium and Magnesium are low in the soil.

Calcium and magnesium both increases the soil pH as its availability increases in soil.

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Table 4: Soil pH and EC (dS m⁻¹) of soil in different villages of West Godavari district at 0-15cm, 15-30cm 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)						
V ₁	8.23	8.35	8.50	0.26	0.28	0.33
V ₂	7.55	7.45	7.92	0.24	0.24	0.30
V ₃	8.75	8.85	8.92	0.31	0.34	0.37
Chodimella (B₂)						
V ₄	8.44	8.42	8.65	0.23	0.26	0.30
V ₅	8.00	8.20	8.52	0.21	0.24	0.27
V ₆	8.23	8.12	8.46	0.18	0.21	0.23
Palagudem (B₃)						
V ₇	8.35	8.62	8.82	0.20	0.22	0.25
V ₈	8.20	8.61	8.22	0.21	0.24	0.26
V ₉	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

Table 5: Soil OC and Available Nitrogen of soil in different villages of West Godavari district at 0-15cm,15-30cm and 30-45cm 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)						
V ₁	0.35	0.33	0.30	244.00	238.00	231.00
V ₂	0.33	0.31	0.29	256.00	249.00	242.00
V ₃	0.35	0.31	0.28	235.00	227.00	216.00
Chodimella (B₂)						
V ₄	0.47	0.43	0.40	290.00	277.00	270.00
V ₅	0.50	0.47	0.44	277.00	265.00	259.00
V ₆	0.55	0.52	0.49	323.00	294.00	287.00
Palagudem (B₃)						
V ₇	0.47	0.44	0.43	305.00	290.00	277.00
V ₈	0.44	0.41	0.37	317.00	303.00	283.00
V ₉	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

Table 6: Available Phosphorus and Potassium (kg ha⁻¹) of soil in different villages of West Godavari district at 0-15cm, 15-30cm and 30-45 cm 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)						
V ₁	18.46	16.44	14.05	213.00	198.00	173.00
V ₂	20.78	17.56	15.34	185.00	179.00	153.00
V ₃	19.88	15.23	14.15	168.00	147.00	137.00
Chodimella (B₂)						
V ₄	23.73	20.50	18.28	199.00	183.00	177.00
V ₅	21.93	17.70	15.47	203.00	185.00	176.00
V ₆	25.71	21.49	19.26	236.00	209.00	193.00
Palagudem (B₃)						
V ₇	20.30	19.07	16.85	227.00	197.00	173.00
V ₈	18.94	17.71	14.49	213.00	210.00	193.00
V ₉	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

Table 7: Exchangeable Calcium and Magnesium of soil in different villages of West Godavari district at 0-15cm, 15-30cm 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)						
V ₁	4.82	4.76	3.34	1.74	1.46	1.36
V ₂	5.25	4.24	3.78	1.92	1.64	1.62
V ₃	5.16	4.32	3.82	1.54	1.72	1.56
Chodimella (B₂)						
V ₄	5.66	5.42	4.98	2.24	1.96	1.84
V ₅	5.45	5.16	5.01	2.74	2.54	2.22
V ₆	5.54	5.20	4.86	2.53	2.26	2.02
Palagudem (B₃)						
V ₇	5.32	4.95	4.94	2.34	2.20	2.36
V ₈	5.12	5.84	4.62	2.20	2.12	2.00
V ₉	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

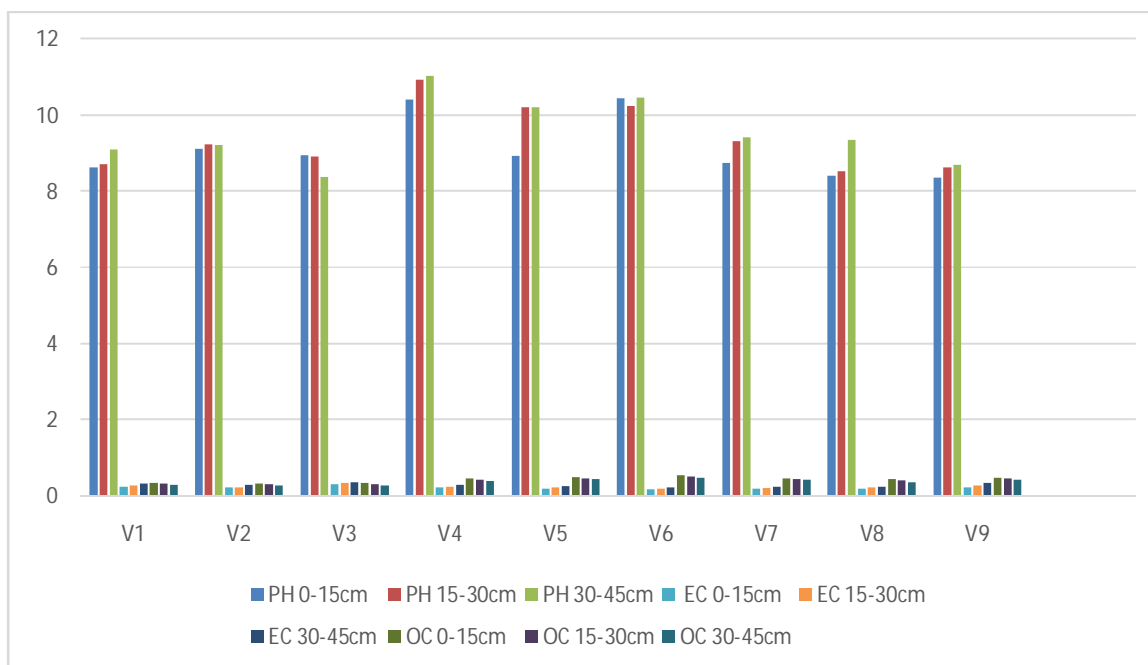


Fig.2: Soil pH, EC and Organic Carbon of soil in different villages of West Godavari district at 0-15cm, 15-30cm and 30-45 cm depth

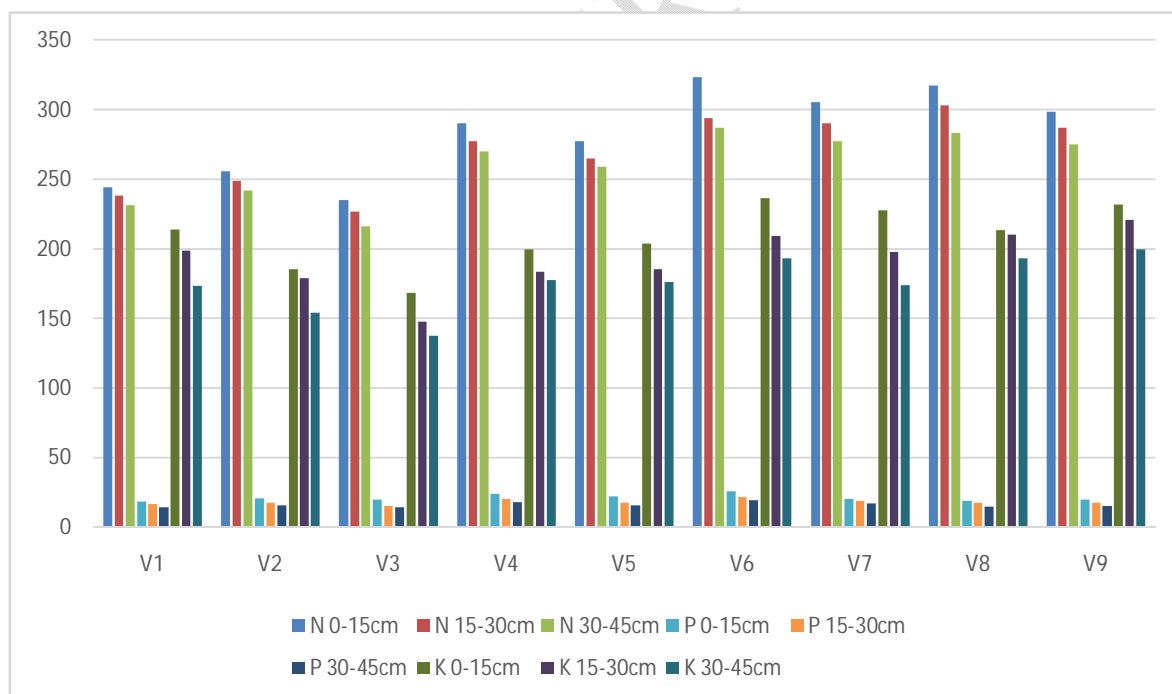


Fig.3: Available Nitrogen, Phosphorus and Potassium of soil in different villages of West Godavari district at 0-15cm, 15-30cm and 30-45 cm depth

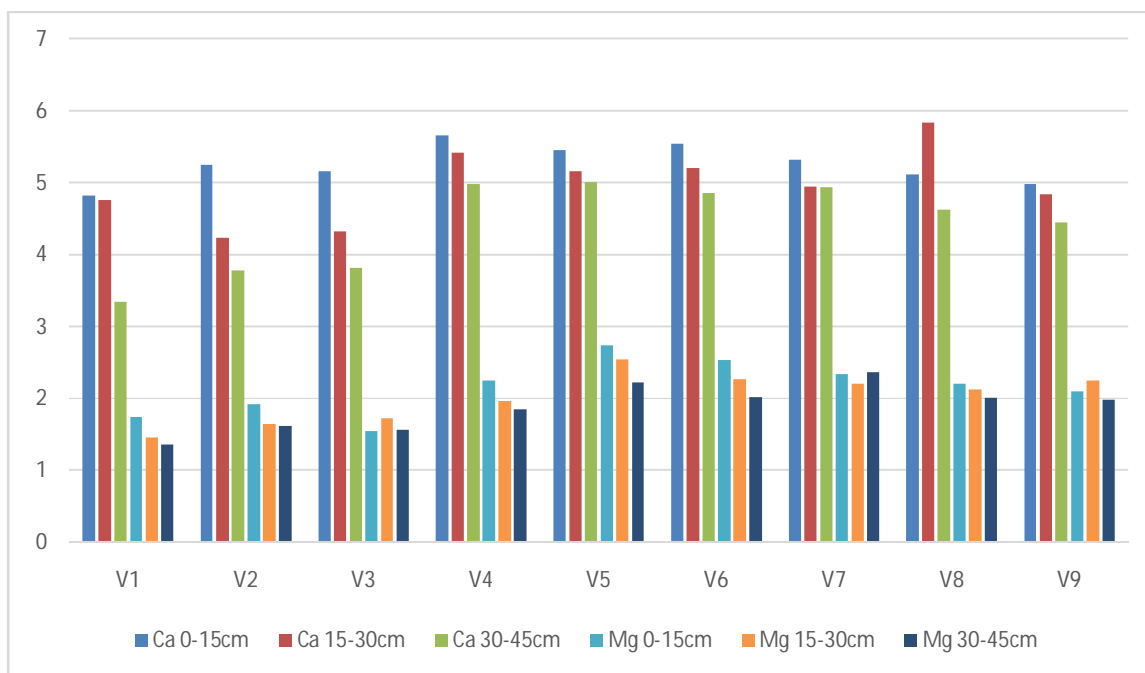


Fig.4: Exchangeable Calcium and Magnesium of soil in different villages of West Godavari district at 0-15cm, 15-30cm and 30-45 cm depth

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.

References

- Anonymous (1971). Munsell colour chart. Munsell colour company inc. 2241 N. calveri street, Baltimore, Marytanel 21212, USA.
- Bouyoucos, G. L. (1927). The hydrometer as a new method for the mechanical analysis of soils. Soil Sci., 23: 343- 353.
- Black *et al.*, (1965) Methods of Soil Analysis. Part I And II. American Society of Agronomy, Inc., Madison, Wisconsin, U. S. A., 1-2: 1572.

- Chaudhari, P. R., Dodha, V. A., Vidya, D. A., Chkravarty, M., and Maity, S. (2013). Soil Bulk Density as related to Soil Texture, Organic Matter Content and available total Nutrients of Coimbatore Soil. *International Journal of Scientific and Research Publications*, **3**(2).
- Department of Agriculture, Andhra Pradesh (1989) Soil survey report of soil correlator, Andhra Pradesh. Government Press, Hyderabad.
- Das, S. and Mipun, B.S. (2021) Spatial distribution of soil physical properties in west Tripura district, Tripura. *Indian Journal F Research*. 10(1):39-40.
- Dhaliwal, S. S., Naresh, R. K., Mandal, A., Walia, M. K., Gupta R. K. and Singh, R. (2019). Effect of manures and fertilizers on soil physical properties, build-up of macro and micro nutrients and uptake in soil under different cropping systems. *Journal of Plant Nutrition*, **42**(20): 2873-2900.
- Jackson, M. L. (1958). The pH was determined in 1:2 soil water suspensions using digital pH meter. *Soil Chemical Analysis, Prentice Hall, Inc. Englewood. cliffe. N.J.*
- Joshi, P. C., Pandey, P., and Kaushal, B. R. (2013) Analysis of some physico-chemical parameters of soil from a protected forest in Uttarakhand. *Nature and Science*, **11**(1): 136-140.
- Muthuvel, P., Udayasoorian, C., Natesan, R., and Ramaswami, P. R. (1992). Introduction of Soil Analysis. Tamil Nadu Agricultural University, Coimbatore.
- Olsen. S.R., Cole. C.V., Watanabe. F.S. and Dean. L.A. (1954) Estimation of Available Phosphorus in Soils by Extraction with Sodium Bicarbonate. U.S. Department of Agriculture, Circular No. 939.
- Parmar, M. K., and Negi, R. S. (2017). Study was undertaken in Takoli Gad watershed, Uttarakhand. *International Journal of Applied and Pure Science and Agriculture (IJAPSA)*, 03.
- Patel, K. P. (2015). Analysis of soil quality using Physico- chemical parameters of shehra Taluka District, Panchmahal, Gujarat. *Indian journal of Applied Research*, **5**(9): 466-468.
- Tale, S., and Ingole, S. (2015). Worked on the role of Physico- chemical properties in soil quality *Chemical Science Review and Letter*, **4**(13): 57-66.
- Subbiah, B. V. and Asija, G. L. (1956) A rapid procedure for the estimation of available nitrogen in Soils. *Current Science*, 25: 259-260.
- Toth, S. J., and Prince, A. L. (1949) Estimate of Cation Exchange capacity and exchangeable Ca, K, Na, Content of soil by flame photometer technique. *Soil Sci.*, 67: 439-445.
- Upadhyay, M., Nadeemashaban, and Rishapaul, M. (2014) Physico chemical properties of soil

Kusmunda area District Korba (Chhattisgarh), *Indian Journal of Pharmaceutical Science and Research*, **4**(3):139-143.

Upreti, B. M., Tewari, L., Tewari, A., and Joshi, N. (2016) Physio-chemical characterization of soil collected from sacred and non-sacred forests of Uttarakhand: A Comparative study. *Journal of Chemical Engineering and Chemistry Research*, **3**(11): 989-992.

Walkley, A., and Black (1947) A critical examination of a Rapid method for determining organic carbon in soils: Effect of variations in digestion conditions and of Organic soil constituents. *Soil Sci.*, 63: 251- 263.

Wilcox *et al.*, (1950) Electrical conductivity, *Amer. Water Works Assoc. J.*, 42: 775-776.

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