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Assessment of Physico-Chemical Properties of Soil from Different Blocks of Prakasam District, Andhra Pradesh, 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

The present research topic entitled "Assessment of Physico-Chemical parameters of soil from different blocks of Prakasam district, Andhra Pradesh" was carried out at the Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj. Department of Soil Science and Agricultural Chemistry (U.P.). During the year 2021-2022. In the present study Physico-Chemical analysis of soil in three blocks from nine in each hamlet, a single farmer's land was chosen for sampling, and samples were taken at three depths: 0-15 cm, 15-30 cm, and 30-45 cm, of a total 27 samples collected and analysed using conventional laboratory techniques. Bulk Density ranged 1.29 -1.46 Mg m^{-3}, Particle Density ranged 2.42-2.55 Mg m^{-3}, Percent of Pore Space varied 42.68-48.00%, Water Holding Capacity varied 40.00-46.50%, and Specific Gravity varied 2.27-2.66. The pH ranged 6.42-9.04, EC ranged 0.16-0.35 dS m^{-1}, Organic Carbon varied 0.26-0.53% and Available Nitrogen varied from low to medium 225-321 kg ha^{-1} Available Phosphorus varied from medium to high range 12.03-23.69 kg ha^{-1}. And Potassium was found to be medium range 135.62-234.65 kg ha^{-1}. It suggests that still improvement can be done by improving cropping pattern.

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1. INTRODUCTION

Soil is a dynamic, 3-dimensional natural body of the landscape developed from the weathering of rocks through various pedogenic processes, composed of mineral and organic materials, processing a defined set of physical, chemical, and biological qualities, having a variable depth covering the earth's surface, and providing a medium for terrestrial plant growth [1]. Soil is a dynamic natural body formed by pedogenic processes such as rock weathering, and it is made up of mineral and organic ingredients with specific chemical, physical, and biological properties [2,3]. Physical, mineralogical, and biological properties that vary in depth over the earth's surface and provide a growing medium for plants [4]. The rate of soil deterioration is influenced by land use patterns, soil types, terrain, and climate variables. Inappropriate land use is one of these variables that accelerates the deterioration of soil physicochemical and biological qualities [5].

Soil porosity is the percentage of total soil volume taken up by pore space. The amount of water that a specific soil can hold for crop usage is known as its water holding capacity [6,7]. The pH of a soil determines its acidity or basicity. The EC measures the quantity of salts in soil. Organic Carbon is a component of soil organic matter that can be measured [8].

Nitrogen (N) it plays a fundamental role in energy metabolism and protein synthesis and plant cannot complete its life cycle in absence of that particular nutrient. Cell membranes, proteins and nucleic acids all include Phosphorus (P). Potassium (K) it is a mineral that is required in the growing parts of the plants in large amounts.

1.1 Study Area

Prakasam District is located between the longitudes of $14^0$57' and $16^0$17' in the north and 78.43' and 80.25' in the east. The district has 102 kilometres of coastline that passes across eleven coastal mandals. Average Rainfall: 616 mm summer average temperature: 33.72°C. Average Winter Temperature: 24.08 ^{0}C. The crops grown in this region are rice, cotton, chickpea, tobacco, sorghum. The soils are diverse, with red soils accounting for 51.3 percent, black soils for 40.8 percent, sandy loam soils for 5.9%, and sandy soils for 2%.

2. MATERIALS AND METHODS

2.1 Soil Sampling

In Prakasam district covers 56 mandals, in that 3 mandals are covered in this study i.e., Podili, Darsi, Kurichedu. Nine villages in the district were chosen at random for sampling. Each farmer's field included three separate locations that indicated three different profile depths: 0-15 cm, 15-30 cm and 30-45 cm. A total of 27 samples were taken, with 9 representing a single farmer's land. At sampling site, soil samples were collected separately by a random selection from field with help of khurpi, meter scale, spade, and digging bar following the collection of samples, the soil samples were air dried in the shade to avoid further chemical reactions. After the samples have dried, all undesired items such as roots, stones, and other foreign objects were removed. Large clods were crushed by wooden mallet. Grinding was followed by sieving for which 2.0 mm sieve was used. Physical and chemical attributes were marked and sieved samples were stored in airtight polybags. Completely Randomized Design was used as the experiment design in the analysis (CRD) [9].

2.2 Analysis of Physico-chemical Properties

The hydrometer method was used to analyse the texture of soil particles less than 2 mm [10]. The graduated 100 ml measuring cylinder method was used to determine Bulk density, Particle density, Pore Space, and Water Holding Capacity [11]. The relative density bottle or pycnometer method, as written out by black, 1965 to determine the specific gravity of soil. A digital pH metre was used to determine the pH, and the 1:2 soil water suspension method [12]. A digital EC metre was used to calculate the EC, and the 1:2 soil-water suspension method [13]. The wet oxidation method was used to determine Organic Carbon (Walkley and Black, 1965). The alkaline Potassium permanganate technique was used to determine available Nitrogen [14]. A colorimetric approach was used to determine available Phosphorus [15]. The flame photometer method was used to determine the amount of accessible Potassium [16].

3. RESULTS AND DISCUSSION

3.1 Soil Physical Properties

The experimental results of the present investigation entitled "Assessment of Physico-Chemical properties of soil from different blocks of prakasam district Andhra Pradesh, India." The colour (Dry method) of soil samples is shown Brown, Dark brown, Yellowish red, red, yellowish brown, reddish brown, Light olive brown, Dark reddish brown, Dark red and in (Wet method) colour of soil samples was shown Dark brown, very dark, yellowish brown, Brown, very dark greyish brown, Yellowish red, Red, Dark yellowish-brown, reddish-brown these results are similar to Chahat Verma et al., [1]. The Soil Texture was sandy clay loam, sand content varied from 46- 84%, silt 10-24% and clay 22.6-31% as reported by Das et al., [17]. Bulk density ranged 1.29-1.46 Mg m^{-3}. (P_2V_1) Kothapalli village reported lowest bulk density and (K_1V_3) Bodanampadu village reported highest Bulk density as reported by Ahad et al., [18] and the range of Particle density Mg m^{-3} varied 2.42-2.55 Mg m^{-3}. (P_2V_3) Akkacheruvu village reported lowest Particle density and (D_2V_3) Chalivendram village reported highest Particle density these results are similar to Chaudhari et al., [19]. The range of Pore Space varied 42.68-48.00%. (K_1V_1) Avulamanda village reported low porosity and (P_2V_1) Kothapalli village reported high porosity similar results showed by Chaudari et al., [20] and the range of Water Retaining Capacity varied 40.00-46.50%. The lowest Water Holding Capacity was observed in (K_1V_1) Avulamanda village highest Water Holding Capacity was observed in the (D_3V_3) Chalivendram village as recorded by Das et al., [17]. Specific Gravity ranges from 2.27 -2.66. In (P_2V_3) Mallawaram village the highest Specific Gravity value was found. The lowest Specific Gravity value was observed in (K_1V_2) Alavalapadu village as shown by Chaudari et al., [20].

3.2 Soil Chemical Properties

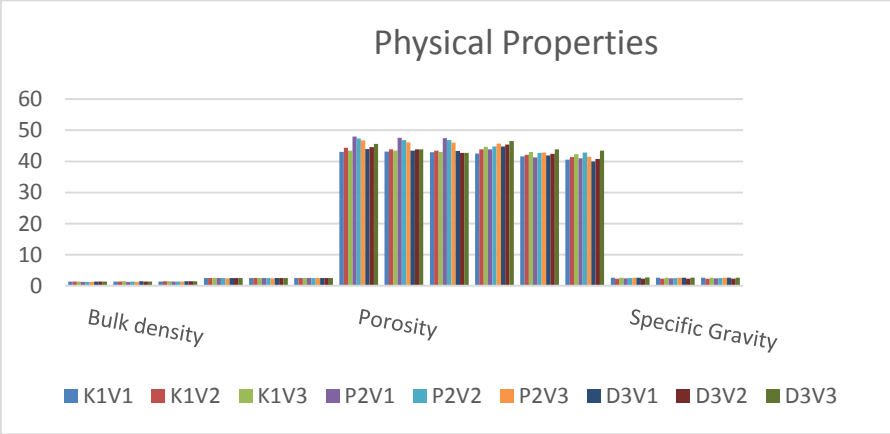
The pH of the soil samples is somewhat acidic to strongly alkaline in nature, with values ranging from 6.42 to 9.04. The highest pH value was observed in the (P_2V_1) Kothapalli village. Due to high rainfall which caused leaching of bases similar findings Basavaraja et al., [21]. The lowest pH value was observed in the (D_3V_3) Chalivendram village these results are similar to Srilakshmi et al., [22] 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 in the soil samples had a range of 0.16 to 0.35 dS m^{-1}. The village with the lowest EC content was (P_2V_3) Mallawaram, whereas the village with the greatest EC content was (K_1V_3) Bodanampadu. The results observed 100% of the soil samples are in permissible range suitable for most of the crops as recorded by [21] Organic Carbon levels ranged 0.26 - 0.53%. The results concluded that Organic Carbon range was low to medium range. The lowest Organic Carbon was observed in (K_1V_2) Alavalapadu and (K_1V_3) Bodanampadu villages whereas highest Organic Carbon reported in (P_2V_3) Mallawaram village Deshmukh et al., [23]. Organic Amendments Alleviate Salinity Effects on Soil Microorganisms and Mineralisation Processes in Aerobic and Anaerobic Paddy Rice Soils. Sea-water level rise leads to increased saltwater intrusion causing soil salinity on arable land with negative effects on soil microbial processes. The amount of available Nitrogen is low to medium. The Nitrogen varied 225.00-321.00kg ha^{-1}. The lowest Nitrogen content was reported in (K_1V_3) Bodanampadu village due to replenishment of soil Nitrogen through organics and or in organics to avoid soil mining for Nitrogen similar findings Kumar et al., [24] whereas highest Nitrogen content in soil was observed in (P_2V_3) Mallawaram village Patel et al., [25]. The amount of available Phosphorus is high. Because of excessive use of phosphatic fertilizers similar findings wagh et al., [26]. The Phosphorus ranged from 12.03- 23.69 kg ha^{-1}. The lowest Phosphorus content was observed in (K_1V_1) Avulamanda village whereas highest Phosphorus was reported in (P_2V_3) Mallawaram village. Supriya et al., [27]. The Potassium content is in medium range 135.62-234.65 kg ha^{-1}. The lowest Potassium content was observed in (K_1V_3) Bodanampadu village whereas highest Potassium content was reported in (D_3V_3) Chalivendram village Dinesh et al., [28].

3.3 Assessment of Correlation Matrix between Physico-chemical Parameters of Soil in Podili, Darsi, and Kurichedu Blocks of Prakasam district, Andhra Pradesh

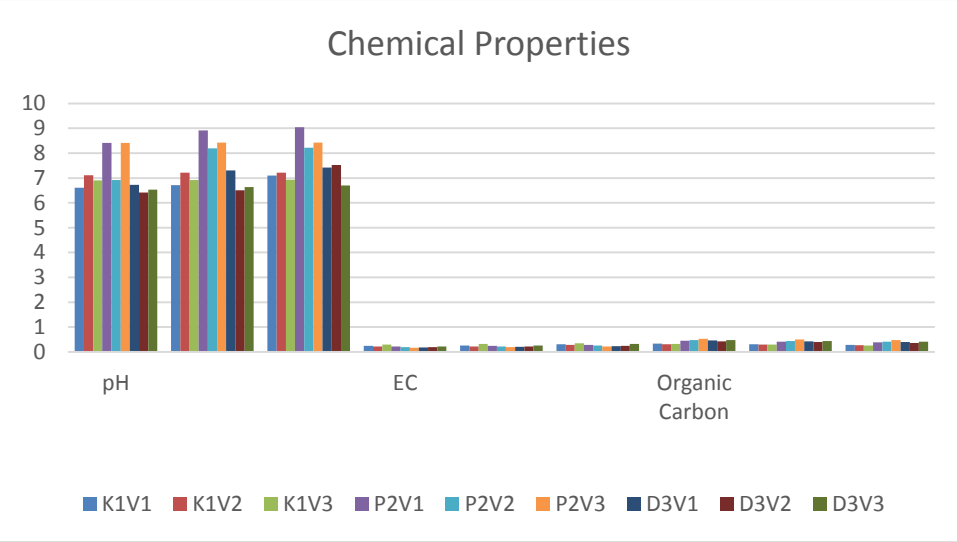
The Bulk density of the soil has a favorable correlation with EC (r=0.57) and Particle density (r=0.54). The Particle density of the soil has a substantial positive relationship with EC (r=0.57).

Table 1. Physical properties

Sample No.	Bulk density(Mg m^{-3})			Particle density(Mg m-3)			Porosity (%)			Water Holding Capacity(%)			Specific Gravity		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
K_1V_1	1.4	1.41	1.42	2.46	2.48	2.49	43.08	43.14	42.97	42.52	41.55	40.55	2.62	2.59	2.56
K_1V_2	1.39	1.41	1.43	2.5	2.51	2.53	44.4	43.82	43.47	43.85	42.09	41.38	2.33	2.3	2.27
K_1V_3	1.42	1.43	1.44	2.51	2.53	2.54	43.42	43.47	43.08	44.71	43.05	42.36	2.64	2.61	2.58
P_2V_1	1.3	1.32	1.33	2.5	2.52	2.53	48	47.61	47.43	43.85	41.28	40.94	2.43	2.39	2.36
P_2V_2	1.31	1.33	1.35	2.49	2.5	2.54	47.38	46.8	46.85	44.76	42.77	42.83	2.54	2.51	2.48
P_2V_3	1.29	1.32	1.35	2.42	2.45	2.5	46.69	46.12	46	45.66	42.85	41.5	2.65	2.62	2.59
D_3V_1	1.4	1.43	1.44	2.5	2.53	2.54	44	43.47	43.3	44.82	41.88	40	2.64	2.61	2.57
D_3V_2	1.37	1.41	1.45	2.47	2.51	2.53	44.53	43.82	42.68	45.45	42.45	40.75	2.35	2.31	2.28
D_3V_3	1.37	1.42	1.46	2.52	2.53	2.55	45.63	43.87	42.74	46.5	43.88	43.42	2.66	2.63	2.58
	F-test	S.Ed. (+)	C.D.@5 %	F-test	S.Ed. (+)	C.D.@5 %	F-test	S.Ed. (+)	C.D.@5 %	F-test	S.Ed. (+)	C.D.@5 %	F-test	S.Ed. (+)	C.D.@5 %
Due to depth	NS	0.023	-	NS	0.02	-	S	0.48	0.03	S	1.62	0.008	S	0.03	4.05
Due to site	NS	0.047	-	S	0.024	0.008	S	1.75	8.3	S	0.92	0.009	S	0.13	1.61



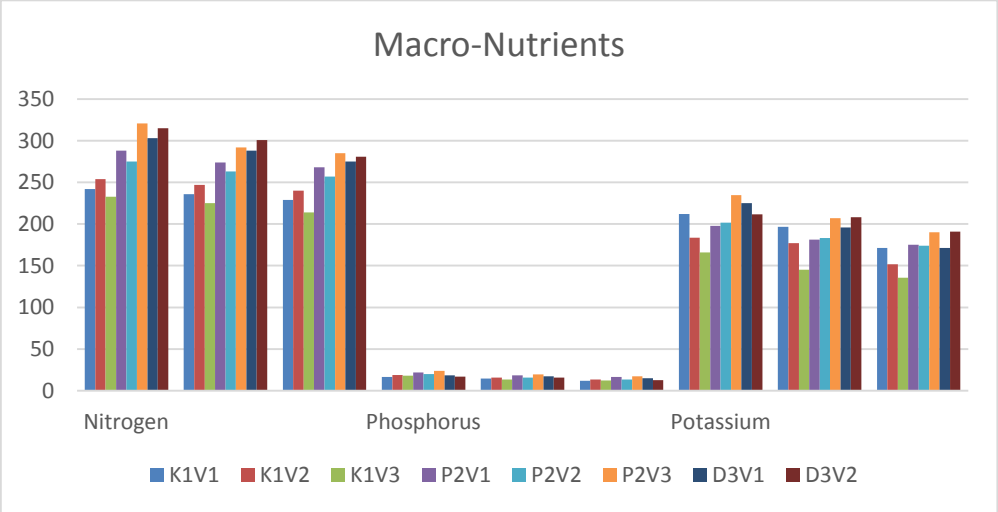
Graph 1. Physical properties



Graph 2. Chemical properties

Table 2. Chemical properties

Sample No.	pH			EC (dS m^{-1})			Organic Carbon (%)			Nitrogen (kg ha^{-1})			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	0-15 cm	15-30 cm	30-45 cm	0-15	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
K_1V_1	6.61	6.71	7.1	0.24	0.26	0.31	0.33	0.31	0.28	242	236	229	16.44	14.42	12.03	211.98	196.65	171.14
K_1V_2	7.11	7.21	7.22	0.22	0.22	0.28	0.31	0.29	0.27	254	247	240	18.76	15.54	13.32	183.45	177.04	151.87
K_1V_3	6.91	6.92	6.93	0.29	0.32	0.35	0.32	0.29	0.26	233	225	214	17.86	13.24	12.13	166.05	145.23	135.62
P_2V_1	8.41	8.92	9.04	0.21	0.24	0.28	0.45	0.41	0.38	288	274	268	21.71	18.48	16.26	197.75	181.16	175.34
P_2V_2	6.92	8.2	8.22	0.19	0.22	0.25	0.48	0.44	0.41	275	263	257	19.9	15.68	13.45	201.75	183.19	174.09
P_2V_3	8.41	8.42	8.43	0.16	0.19	0.21	0.53	0.5	0.47	321	292	285	23.69	19.47	17.24	234.65	207.02	190.31
D_3V_1	6.73	7.31	7.42	0.18	0.2	0.23	0.46	0.42	0.4	303	288	275	18.28	17.05	14.83	225.07	195.94	171.18
D_3V_2	6.42	6.51	7.53	0.19	0.22	0.24	0.42	0.39	0.36	315	301	281	16.92	15.69	12.47	211.63	208.13	191
D_3V_3	6.53	6.63	6.7	0.22	0.26	0.32	0.47	0.44	0.41	296	285	273	17.96	15.72	13.04	229.34	218.65	197.46
	F-test	S.Ed. (+)	C.D.@5 %	F-test	S.Ed. (+)	C.D.@5 %	F-test	S.Ed. (+)	C.D.@5 %	F-test	S.Ed. (+)	C.D.@5 %	F-test	S.Ed (+)	C.D.@5 %	F-test	S.Ed. (+)	C.D.@5 %
Due to depth	NS	-	0.2	S	0.0318	0.0003	S	0.029	6.47	S	11.42	0.0005	S	2.6	1.22	S	16.87	0.0004
Due to site	S	0.77	0.00002	S	0.0405	0.0001	S	0.07	6.06	S	27.71	1.52	S	1.97	3.92	S	20.62	6.36



Graph 3. Macro-Nutrients

Table 3. Assessment of Correlation matrix between Physico-Chemical parameters of soil in Podili, Darsi, Kurichedu blocks of Prakasam district, Andhra Pradesh

	BD	PD	Pore Space	WHC	pH	EC	OC	N	P	K
BD	1									
PD	0.539974	1								
Pore Space	-0.94785	-0.24431	1							
WHC	-0.32227	-0.35443	0.238802	1						
pH	-0.66521	-0.09712	0.73099	-0.31162	1					
EC	0.574248	0.574722	-0.45261	-0.36275	-0.2019	1				
OC	0.050378	-0.30799	-0.17965	-0.03664	-0.18955	-0.01194	1			
N	-0.43378	-0.31825	0.389864	0.415196	0.167054	-0.78004	-0.1782	1		
P	-0.74963	-0.62115	0.633423	0.570559	0.330571	-0.74506	0.014125	0.601483	1	
K	-0.35797	-0.53731	0.217634	0.550546	-0.11654	-0.719	0.185651	0.800264	0.597168	1
Cu	-0.69761	-0.41161	0.642401	0.108254	0.533759	-0.17054	0.106234	-0.23101	0.453336	-0.1869
Zn	-0.00449	0.284649	0.109891	0.507185	-0.2087	0.24597	-0.0312	-0.16437	0.196064	-0.0482
Fe	-0.08815	-0.22544	0.023726	0.458806	-0.13331	-0.33685	-0.13479	0.698995	0.243964	0.631673

The soil Pore Space is favorably linked with pH (r=0.73), Nitrogen (r=0.39), and Phosphorus (r=0.63). The capacity of the soil to hold water is positively associated with Nitrogen (r=0.42), Phosphorus(r=0.57), Potassium(r=0.55). The Nitrogen is positively significantly correlated with Phosphorus(r=0.60), Potassium(r=0.80). The Phosphorus is positively significantly correlated with Potassium(r=0.60).

4. CONCLUSION

The soil analysis results were interpreted using the literature which help farmers and add the deficient nutrients. According to the soil test results of Kurichedu, Darsi, Podili blocks clearly states that the soil is in slightly Acidic to strongly alkaline in condition. 100% of soil samples are in permissible limit of EC suitable for most of crops. Most of the soil samples showed low-medium Organic Carbon content this is due to low and high temperature and less decomposition of organic matter in the soil. More than 50% are low to medium in Nitrogen, Phosphorus is in high whereas Potassium is in medium range. Based on results Soil and Health Card has prepared given to farmers. It suggests that still improvement can be done by improving cropping pattern, decomposition of organic waste, mulching and tillage practices with the knowledge and experience gained through study may be developed in future to help the farmers regarding the quality produce, high yields through soil conservation and maintain better environment protection.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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