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Assessment of physical properties of soil from different blocks of coastal areas, of Bapatla district of Andhra Pradesh, India

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ABSTRACT

A study was carried out to examine the physical characteristics of soils from various blocks in the coastal regions of Bapatla district, Andhra Pradesh. For this purpose, the surface soil samples were collected from six different villages of three different blocks of coastal areas, a total of 30 soil samples were collected and analysed for their physical parameters by using standard laboratory techniques. The results showed that the soil texture in Nizampatnam, Cherukupalle and Vetapalem blocks varied from sandy loam, sandy clay loam to loamy sand. The bulk density ranged from 1.22 to 1.43 g cm^{-3}, particle density from 2.40 to 2.68 g cm^{-3}, pore space ranged from 42.80 to 49.81 per cent and water holding capacity ranged from 10.4 to 32.8 per cent. These results suggest that the farmers should adopt appropriate soil management techniques such as crop rotation and conservation tillage, to maintain the soil physical characteristics and to ensure the sustainability of agricultural practices for the long term soil health.

Key words: *Soil density, Soil physical properties, Soil porosity, Soil texture, and Water holding capacity*

Soil is a critical natural resource for the existence of life on earth and its evaluation is required to determine soil productivity and long-term sustainability of the ecosystem. One of today's biggest challenges is providing basic necessities from an ever-shrinking, non-renewable soil resource. For the planned development of soil resources and to sustain their productivity and management, precise scientific knowledge on their features, potentials, limitations and management is essential to meet the demands for the future. Soil and water are the greatest natural resources gifted to mankind. India depends upon agriculture and it becomes more important to study analyse and effectively manage soil. Soil being the basic media for the plants to stand and grow and water becomes the lifeline to the plants. In view of this, a greater importance has been attached for management of soil and water by analysis for various characteristics to contribute increased productivity in modern agriculture.

Andhra Pradesh is a South Eastern coastline state of India. It is the seventh largest state in terms of land area, with a total area of 162,975 km^2 . Agriculture and allied activities employ 60 per cent of the population. Rice is the main food crop and staple diet of the state. It exports a variety of agricultural goods and is recognised as the Rice Bowl of India. This time is a need to study the coastal soils for proper management. Thus, the present study was planned to analyse the soil for its physical state and constituents present in soil and determined by using standard methods.

MATERIAL AND METHODS

Bapatla district is in the state of Andhra Pradesh, India. Bapatla is located at approximately 15.9048° N and 80.4670° E. Major soils in Bapatla District are black cotton soil covering about 70 per cent of the area and sandy loam covering about 30 per cent. The proposed research includes 3 blocks of Bapatla district i.e., Vetapalem block, Nizampatnam block and Cherukupalle block (Table 1).

RESULTS AND DISCUSSION

soil texture under investigation varies from sandy loam to sandy clay loam and loamy sand across different villages (Table 2). The sand content ranged

Table 1. Methods followed for analysis of soils of Bapatla District

PARAMETER	METHOD	REFERENCE
Bulk density	Undisturbed core sample	Blake, 1965
Particle density	Pycnometer method	Vadyunina and Korchagina, 1986
Water holding capacity	Keen-Raczkowski box (Gravimetric method)	Keen and Raczkowski., 1921
Porosity	Calculation using bulk density and particle density	Danielson and Sutherland, 1986
Soil texture	Bouycous hydrometer method	Bouycous, 1962

from 54.7 to 85.6 per cent. silt from 5.9 to 25.2 per cent and clay from 8.1 to 22.8 per cent. In Nizampatnam, all villages (V1, V2 and V3) exhibited sandy loam texture due to higher sand content ranging between 63.4 to 68.3 per cent. Village (V2) reported the lowest sand content (63.4 per cent) and highest silt content (21.2 per cent). In Cherukupalle, the texture varied between sandy clay loam and sandy loam. V1 and V2 had a sandy clay loam texture due to higher clay content (21.5 and 22.8 per cent), while V3 showed a sandy loam texture with 16.4 per cent clay. In Vetapalem, all villages (V1, V2 and V3) were characterized by loamy sand due to their dominant sand fraction, which ranged from 78.2 to 85.6 per cent and relatively low clay content (8.1 to 10.6 per cent).

Bulk Density and Particle Density

The bulk density (BD) of the soils in the studied area varied from 1.22 to 1.43 g cm^{-3} across the three locations (Table 3). In Nizampatnam, the bulk density ranged from 1.27 to 1.39 g cm^{-3}, with mean values between 1.31 and 1.34 g cm^{-3}. V3 exhibited the highest bulk density (1.34 g cm^{-3}) compared to V1 and V2. Similarly, in Cherukupalle, the bulk density ranged from 1.26 to 1.40 g cm^{-3}, with mean values between 1.32 and 1.35 g cm^{-3}. The highest bulk density was found in V1. In Vetapalem, bulk density values were relatively higher ranged from 1.22 to 1.43 g $cm^{-3}$and mean values between 1.37 and 1.41 g cm^{-3}.

The particle density which indicates the density of soil particles varied from 2.40 to 2.71 in the study area (Table 3). In Nizampatnam, particle density ranged from 2.47 to 2.61 g cm^{-3} with mean values between 2.48 and 2.59 g cm^{-3}. V2 region exhibited the highest particle density (2.59 g cm^{-3}), suggesting higher mineral content. In Cherukupalle, particle density ranged from 2.43 to 2.56 g cm^{-3}, with mean values between 2.44 and 2.55 g cm^{-3}. V3 showed the highest particle density (2.55 g cm^{-3}). In Vetapalem, particle density was comparatively higher, ranging from 2.40 to 2.71 g cm^{-3} with mean values between 2.61 and 2.68 g cm^{-3} particularly in V3. This elevated particle density typically indicates a lower organic matter content, which can negatively impact soil structure and limit nutrient availability (Brady & Weil., 2008).

Pore Space and Water holding Capacity

Pore space, which refers to the volume of soil occupied by air and water, varied from **42.80 per cent to 49.81 per cent** (Table 3) in the study area. In Nizampatnam, pore space ranged from 44.40 per cent to 49.38 per cent with mean values between 45.68 and 48.06 per cent. Village V2 had the highest pore space. In Cherukupalle, pore space ranged from 43.50 to 49.61 per cent, with mean values between 45.43 and 48.21 per cent. V3 exhibited the highest pore space. In Vetapalem, pore space ranged from 42.80 to 49.81 per cent, with mean values between 47.39 and 47.92 per cent.

. The water holding capacity, which is essential for determining the soil's ability to retain moisture, varied significantly across the regions (Table 3). In Nizampatnam, the water holding capacity ranged from 14.8 per cent to 21.6 per cent, with mean values between 18.6. **and 19.7 per cent.** In **Cherukupalle**, water holding capacity varied from **18.9 to 32.8 per cent** with mean values between **23.8 and 30.2 per cent**. The highest water holding capacity was recorded in **V1 (30.2 per cent)**, indicating good moisture retention, which is advantageous for crop cultivation in the study area. In **Vetapalem**, water holding capacity ranged from **10.4 to 16.5 per cent** with mean values between **13.4 and 14.7 per cent**. The lowest water holding capacity was found in **V3 (13.4 per cent)** with a higher sand content, which leads to rapid drainage and require frequent irrigation to maintain adequate soil moisture. Rawls *et al*.,(2003) emphasize that water holding capacity is

Table 2.Soil Texture Analysis of Bapatla District, Andhra Pradesh

Location	Village	Sand (per cent)	Silt (per cent)	Clay (per cent)	Textural Class
Nizampatnam	V1	68.3	12.3	19.4	Sandy loam
Nizampatnam	V2	63.4	21.2	15.4	Sandy loam
Nizampatnam	V3	65	18.1	16.9	Sandy loam
Cherukupalle	V1	54.7	23.8	21.5	Sandy clay loam
Cherukupalle	V2	58.4	19.8	22.8	Sandy clay loam
Cherukupalle	V3	58.4	25.2	16.4	Sandy loam
Vetapalem	V1	85.6	5.9	8.5	Loamy sand
Vetapalem	V2	82.7	6.7	10.6	Loamy sand

Table 3. Physical properties of soil in Bapatla District of Andhra Pradesh

Location	Village	BD Range (g cm^{-3})	BD Mean (g cm^{-3})	PD Range (g cm^{-3})	PD Mean (g cm^{-3})	Pore space Range (per cent)	Pore space Mean (per cent)	Water holding capacity Range (per cent)	Water holding capacity Mean (per cent)
Nizampatnam	V1	1.27-1.35	1.31	2.48-2.51	2.49	46.21-48.80	47.23	14.8-21.6	19.7
Nizampatnam	V2	1.28-1.39	1.33	2.58-2.61	2.59	46.74- 49.38	48.06	16.2-20.5	18.6
Nizampatnam	V3	1.31-1.39	1.34	2.47-2.50	2.48	44.40-46.97	45.68	17.6-19.5	19.2
Cherukupalle	V1	1.32-1.40	1.35	2.51-2.54	2.52	44.89-47.42	46.32	25.7-32.8	30.2
Cherukupalle	V2	1.26-1.39	1.32	2.43-2.46	2.44	43.50-48.15	45.43	26.6-31.8	29.2
Cherukupalle	V3	1.28-1.37	1.32	2.54-2.56	2.55	46.49-49.61	48.21	18.9-28.0	23.8
Vetapalem	V1	1.26-1.39	1.37	2.40-2.64	2.61	42.80-47.70	47.51	11.8-15.7	14.7
Vetapalem	V2	1.22-1.40	1.38	2.48-2.67	2.65	44.23-49.81	47.92	11.5-14.6	13.6

primarily influenced by soil texture, structure and organic matter content. Soils with a higher proportion of clay and organic matter tend to retain more water whereas sandy soils drain quickly, requiring more frequent irrigation.

CONCLUSION

Based on the experimental results, it can be concluded that the soil physical characteristics across the villages of Nizampatnam, Cherukupalle and Vetapalem indicate that bulk density, particle density, pore space and water holding capacity are well within the acceptable range for agricultural practices. The soils of Cherukupalle, with their higher water retention and pore space, are particularly well suited for crops requiring more moisture, while the sandyloam soils of Nizampatnam offer balanced drainage and moderate water retention. Vetapalem loamy sand soils, although well-drained, may require interventions such as irrigation or organic amendments to enhance water retention. Overall,the soils in these region are favorable for agriculture, but practicing soil management techniques like mulching, crop rotation, organic amendments and conservation tillage will help to maintain soil physical properties and ensure long-term agricultural sustainability.

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