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"Soil Quality Assessment Based on Physico-Chemical Parameters of White Soil from Sonhat Block, District Koriya"

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ABSTRACT :

The present study investigates the physico-chemical properties of white soil collected from the Sonhat Block in Koriya District, Chhattisgarh, with the objective of assessing its overall soil quality and suitability for agricultural practices. Soil samples were collected from selected locations and analyzed for key parameters including pH, electrical conductivity (EC), organic carbon content, texture (sand, silt, clay composition), bulk density, water holding capacity, and essential nutrients such as nitrogen (N), phosphorus (P), potassium (K), zinc (Zn), iron (Fe), copper (Cu), and manganese (Mn). The results indicate that the white soil of this region exhibits moderately acidic to neutral pH levels and low electrical conductivity, suggesting minimal salinity. Organic carbon and macronutrient contents were found to be low to moderate, implying a need for organic matter enrichment. The soil texture was predominantly silty loam to sandy loam, with moderate porosity and water retention capacity. Overall, the study highlights the potential and limitations of white soil in the Sonhat Block, providing valuable insights for improving soil management practices and enhancing agricultural productivity in the region.

Keywords*:* Soil Physicochemical Properties, Surface and Subsurface Soil, Kudargarh Region, Organic Carbon, Soil Acidity (pH), Electrical Conductivity (EC).

Introduction:

Soil is one of the most vital natural resources, playing a crucial role in supporting life on Earth by providing the foundation for agriculture, vegetation, and ecological balance. The productivity and sustainability of any ecosystem depend significantly on the physical and chemical characteristics of its soil. Among various soil types, *white soil*—often recognized by its light coloration due to the presence of minerals like silica and lower organic content—presents unique properties that directly influence its fertility and suitability for cultivation.

The Sonhat Block, located in the Koriya District of Chhattisgarh, is an ecologically and agriculturally important area. It features diverse soil types, among which white soil is commonly found in certain pockets. Understanding the physico-chemical properties of this soil is essential for developing site-specific land use strategies, improving crop productivity, and ensuring long-term soil health. Parameters such as soil pH, electrical conductivity, organic carbon, texture, macro- and micronutrient content are critical indicators of soil quality.

This study aims to evaluate the quality of white soil in the Sonhat Block by analyzing its key physico-chemical parameters. By establishing a baseline of soil health, this research provides valuable insights for farmers, researchers, and policymakers to formulate appropriate soil management practices and recommend suitable crops for the region. Such assessments are also instrumental in identifying areas needing soil amendment or conservation interventions

Literature Review

1. Soil quality is a key determinant of agricultural productivity and environmental health. The physico-chemical properties of soil provide critical information about its fertility, structure, and potential for supporting plant growth. Numerous studies have emphasized the importance of evaluating these properties to ensure sustainable land use and improve soil management practices.
2. According to Brady and Weil (2017), soil texture, pH, organic matter content, and nutrient availability are among the most significant indicators of soil health. These parameters influence the soil's water retention capacity, aeration, microbial activity, and nutrient dynamics. Understanding these properties is essential, especially in regions where agricultural practices heavily depend on soil quality.
3. Research conducted by Sharma et al. (2020) in the Central Indian region demonstrated that soils with sandy to loamy textures often suffer from nutrient deficiencies and poor water-holding capacity. Their study emphasized the need for organic matter enrichment and micronutrient supplementation in such soils to improve crop productivity. Similarly, Singh and Gupta (2018) observed that soils with lower organic carbon and imbalanced nutrient profiles often require integrated nutrient management strategies to sustain long-term fertility.
4. In the context of Chhattisgarh, several researchers have examined the variability of soil types and their implications for agriculture. A study by Verma and Tiwari (2019) focused on the soils of the Surguja and Koriya districts, revealing that white soils typically possess low organic carbon and macronutrient levels. The study suggested that these soils, while cultivable, require amendments such as compost and biofertilizers to enhance their productivity.
5. Furthermore, the influence of soil pH on nutrient availability has been well documented. As noted by Lal (2015), acidic to neutral pH levels can significantly affect the solubility of essential nutrients, impacting plant uptake and yield. This is particularly relevant in regions like Sonhat, where soil pH varies depending on local geology and land use patterns.
6. The role of micronutrients such as zinc, iron, and manganese in soil fertility has also been widely studied. According to Rao and Reddy (2016), deficiencies in these elements can lead to reduced crop vigor and quality. Their findings support the necessity of regular soil testing to identify and correct such imbalances.
7. In summary, existing literature underlines the importance of comprehensive soil quality assessments, especially in areas with distinct soil types like white soil. These studies provide a foundation for understanding the limitations and potentials of the soils in Sonhat Block and guide appropriate management strategies to enhance agricultural output.

4. Materials and Methods

Study Area

The study was conducted in the **Sonhat Block**, located in the **Koriya District** of **Chhattisgarh, India**. The area is part of the northern region of the state and is characterized by undulating topography, mixed forest cover, and varied soil types including white soil. Geographically, the region lies between latitudes 23.5°N to 23.7°N and longitudes 82.7°E to 82.9°E. The climate is sub-tropical with an average annual rainfall of about 1200–1400 mm, primarily during the monsoon season (June to September) (Chhattisgarh State Climate Report, 2022).

Soil Sample Collection

White soil samples were collected from **five selected locations** within the Sonhat Block to ensure spatial representation. At each location, samples were taken from the **surface layer (0–15 cm depth)** using a stainless-steel auger following **random sampling techniques** (Jackson, 1973). Approximately **1 kg** of soil was collected from each site and stored in clean, labeled polythene bags. The samples were air-dried, ground with a wooden mortar, and sieved through a **2 mm mesh** for further analysis.

Analytical Methods

The physico-chemical properties of the soil samples were determined using standard laboratory procedures:

- **Soil pH** was measured using a digital pH meter in a 1:2.5 soil-to-water suspension (Black, 1965).
- **Electrical Conductivity (EC)** was measured with a conductivity meter in the same 1:2.5 soil-water extract (Richards, 1954).
- **Organic Carbon** content was estimated using the **Walkley and Black dichromate oxidation method** (Walkley & Black, 1934).
- **Soil texture (sand, silt, clay)** was analyzed by the **International Pipette Method** (Bouyoucos, 1962).
- **Bulk density and particle density** were measured using the **core method** and **pycnometer method** respectively (Blake & Hartge, 1986).
- **Water Holding Capacity (WHC)** was determined using the **gravimetric method** (Veihmeyer & Hendrickson, 1931).

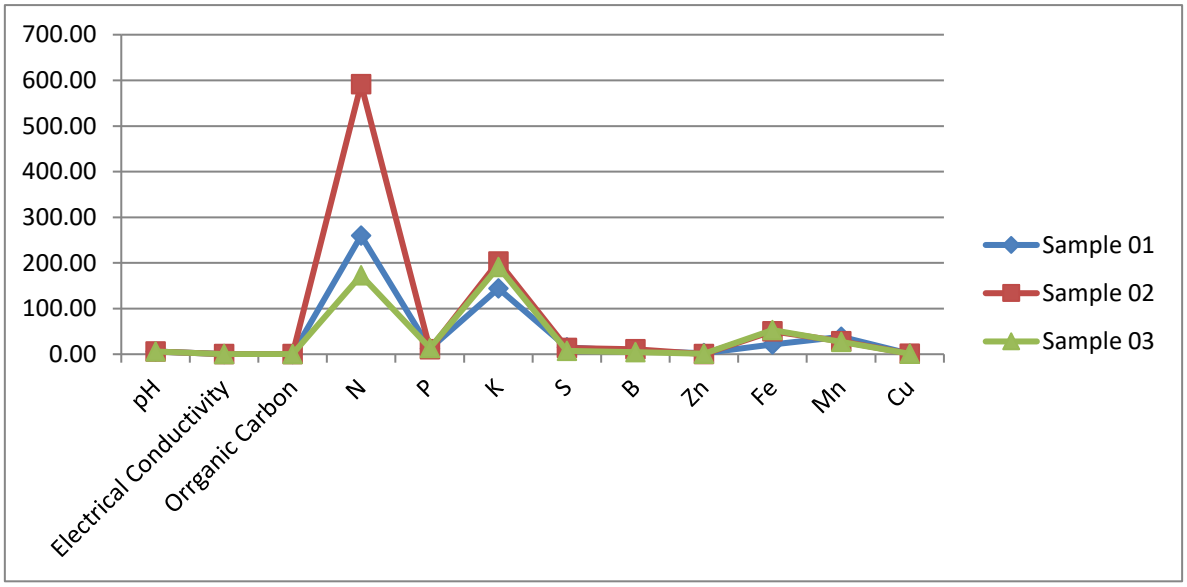
- **Macronutrients** (N, P, K) were measured using:
    - **Available nitrogen** by the **alkaline $KMnO_4$ method** (Subbiah & Asija, 1956),
    - **Available phosphorus** using **Olsen's method** (Olsen et al., 1954),
    - **Available potassium** with a **flame photometer** (Jackson, 1973).
- **Micronutrients** (Zn, Fe, Cu, Mn) were extracted using **DTPA (Diethylenetriaminepentaacetic acid)** and analyzed via **atomic absorption spectrophotometry (AAS)** (Lindsay & Norvell, 1978).

Results and Discussion

The analysis of physico-chemical properties of three white soil samples from Sonhat Block provides critical insights into soil fertility status, nutrient availability, and potential agricultural suitability. The parameters assessed include pH, electrical conductivity (EC), organic carbon (OC), macronutrients (N, P, K, S), and micronutrients (B, Zn, Fe, Mn, Cu). Results are interpreted with reference to standard soil fertility norms as outlined by Jackson (1973) and Tandon (2005).

pH and Electrical Conductivity (EC)

The soil pH ranged from **5.65 to 6.11**, indicating a **moderately acidic** to **slightly acidic** nature. Sample 01 (pH 5.65) was more acidic than the others, which may affect nutrient availability, especially phosphorus and micronutrients like Zn and Mn (Lal, 2015). EC values ranged from **0.16 to 0.65 dS/m**, well within the non-saline range, indicating no salinity issues and suitability for most crops (Richards, 1954).



Organic Carbon and Nitrogen

The **organic carbon** content ranged from **0.46% to 0.55%**, considered **low to medium** in fertility classification (Walkley & Black, 1934). Sample 01 had the highest organic carbon (0.55%), while Sample 03 had the lowest (0.46%). The **available nitrogen (N)** ranged from **173.15 to 591.49 kg/ha**, with Sample 02 showing a **very high nitrogen level** (591.49 kg/ha), while Sample 03 was **deficient** (173.15 kg/ha), indicating variability in organic matter mineralization or previous cropping patterns.

Phosphorus and Potassium

Available phosphorus (P) ranged between **10.80 and 13.44 kg/ha**, which is considered **medium** in all samples. Sample 03 had the highest P content (13.44 kg/ha), indicating phosphorus-sufficient soil under acidic pH, which often enhances availability (Olsen et al., 1954). Potassium (K) levels ranged from **144.26 to 203.17 kg/ha**, considered **moderate to high**, with Sample 02 showing the highest K (203.17 kg/ha), essential for crop quality and disease resistance (Brady & Weil, 2017).

Sulfur and Boron

Sulfur (S) content varied from **7.50 to 15.00 mg/kg**, with Sample 03 being **deficient**, while Sample 01 had an **adequate** level. Boron (B) ranged from **4.55 to 10.57 mg/kg**, where Sample 02 had a **very high level** (10.57 mg/kg), and Sample 03 was **below the optimum** (4.55 mg/kg), which may affect flowering and fruit development (Rao & Reddy, 2016).

Micronutrients (Zn, Fe, Mn, Cu)

- **Zinc (Zn):** Levels ranged from **0.35 to 2.56 mg/kg**. Sample 01 had a **sufficient level** (2.56 mg/kg), whereas Sample 02 had a **deficient value** (0.35 mg/kg), which may lead to stunted crop growth.
- **Iron (Fe):** All samples had **sufficient iron**, ranging from **21.68 to 53.06 mg/kg**, with Sample 03 showing the highest.
- **Manganese (Mn):** Levels ranged from **27.02 to 38.45 mg/kg**, indicating **sufficient availability** for all samples.
- **Copper (Cu):** Values ranged from **1.02 to 1.10 mg/kg**, all within the **adequate range**.

Conclusion:

- The present study on the *physico-chemical properties of white soil* from the Sonhat Block, District Koriya, Chhattisgarh, reveals significant *variability in soil quality* and nutrient status across the sampled locations. The *pH values* indicate that the soils are *moderately to slightly acidic*, which may influence the availability of essential nutrients, particularly phosphorus, zinc, and manganese (Lal, 2015). Despite the *non-saline nature* of the soils (EC < 1 dS/m), the *organic carbon content* was found to be *low to medium*, suggesting limited organic matter and potential nitrogen mineralization (Walkley & Black, 1934).
- Sample 02 demonstrated the *highest fertility potential*, with *elevated nitrogen (591.49 kg/ha)*, potassium (203.17 kg/ha), and micronutrient levels such as *boron and iron*, indicating better management or organic input history. In contrast, Sample 03 had the *lowest nutrient values* for nitrogen and sulfur, and moderate levels of other elements, reflecting either natural soil variability or degradation due to anthropogenic pressures.
- The observed *micronutrient levels*, particularly zinc deficiency in Sample 02 (0.35 mg/kg) and marginal boron deficiency in Sample 03 (4.55 mg/kg), underscore the need for *targeted micronutrient management* in the region to ensure optimal crop performance (Tandon, 2005). The findings suggest that while the white soils of Sonhat are *suitable for agriculture*, *site-specific nutrient amendments*, especially organic matter enrichment and micronutrient supplementation, are essential for *sustainable soil fertility* and *improved crop productivity*.

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