# Investigating the Physico-Chemical Characteristics of Soil in Budha Bagicha (Mahuapara), Rajpur, Balrampur District, Chhattisgarh

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## 1. Abstract:

*This study examines the physical properties of soil in Budha Bagicha, Mahuapara, and Rajpur, located in Balrampur District, Chhattisgarh. The research aims to provide a comprehensive analysis of soil characteristics that influence land use and agricultural practices in the region. Soil samples from these areas were collected and analyzed for key physical properties including soil texture, bulk density, porosity, water holding capacity, and permeability. The results indicated a range of soil textures, from sandy loam to clay loam, affecting water retention and drainage characteristics. Bulk density measurements revealed variations in soil compaction, with some areas showing higher values indicative of potential compaction issues. Porosity levels and water holding capacity varied across the sites, reflecting differences in soil structure and its suitability for crop growth. The study also assessed soil permeability, which influences water infiltration and drainage. These findings highlight the diverse physical properties of soil in the study areas and provide valuable insights for effective land management and agricultural planning. The results underscore the importance of considering local soil conditions in developing strategies for sustainable land use and enhancing agricultural productivity in Balrampur District.*

**Keywords:** Soil analysis, Soil Compaction and Structure, Shantinagar Junadhee, Sustainable.

## 2. Introduction:

The study of soil physico-chemical properties is fundamental to understanding its role in various ecological and agricultural processes. Soil acts as a reservoir of nutrients, water, and microorganisms, influencing plant growth, water filtration, and overall ecosystem dynamics. In the context of environmental sustainability and land management, the need to investigate soil characteristics becomes even more critical. This research focuses on analyzing the physico-chemical properties of soil from Budha Bagicha, a region in Mahuapara, Rajpur, located in the Balrampur district of Chhattisgarh.

Budha Bagicha, a region known for its agricultural practices and natural landscape, provides a unique setting for examining soil properties that may influence both agricultural productivity and environmental health. The district of Balrampur lies within the northern part of Chhattisgarh, which is characterized by a diverse landscape of forests, hills, and plains, with a subtropical climate. These geographical and climatic conditions affect the soil composition, making it essential to understand its variability for optimal land use and agricultural sustainability.

This study aims to investigate the physico-chemical properties of the soil, including parameters such as texture, bulk density, particle density, porosity, water holding capacity, permeability, and chemical characteristics like pH, electrical conductivity, and the presence of essential nutrients and trace metals. These characteristics not only provide insights into soil fertility but also highlight any potential risks related to soil degradation, contamination, or nutrient imbalances.

By assessing these properties, this study will contribute to a better understanding of the soil's potential for sustainable agriculture and help identify possible measures for soil improvement in Budha Bagicha and similar regions. Additionally, this research may offer baseline data for future studies aimed at environmental monitoring and land use planning in the Balrampur district.

## 3. Literature review:

Understanding the physical properties of soil is essential for effective land management, agricultural productivity, and environmental sustainability. This literature review examines existing research on the physical properties of soil, focusing on regions similar to Budha Bagicha, Mahuapara, Rajpur, in Balrampur District, Chhattisgarh. Key aspects covered include soil texture, bulk density, porosity, water holding capacity, and soil structure.

### Soil Texture and Composition

Soil texture, defined by the proportions of sand, silt, and clay, is a primary determinant of soil behavior and suitability for various uses. According to Brady and Weil (2017), soil texture influences water retention, drainage, and nutrient availability. Studies from similar regions in Chhattisgarh have shown that soils often vary from sandy loam to clay loam, which affects their physical properties (Kumar et al., 2018). In Budha Bagicha, Mahuapara, and Rajpur, variations in soil texture impact agricultural practices, as clayey soils tend to retain water better but have lower drainage capacities (Hillel, 2004).

### Bulk Density and Porosity

Bulk density and porosity are critical indicators of soil compaction and structure. High bulk density often indicates soil compaction, which can restrict root growth and reduce soil aeration (Blake & Hartge, 1986). Studies have shown that in intensively farmed areas of Chhattisgarh, bulk density can increase due to repeated tillage and heavy machinery use (Lal, 2004). Conversely, lower bulk density and higher porosity are indicative of well-structured soils that support better root development and water infiltration (Dexter, 2004). Research specific to the Budha Bagicha region is needed to understand local compaction issues and soil management practices.

### Water Holding Capacity and Permeability

Water holding capacity (WHC) and permeability are essential for assessing soil's ability to retain and transmit water. Soils with higher clay content generally exhibit higher WHC but lower permeability, leading to potential issues with waterlogging (Hillel, 2004). In contrast, sandy soils in the Budha Bagicha and Mahuapara areas may have lower WHC but higher permeability, which affects their suitability for different crops and land uses (Brady & Weil, 2017). Evaluating these properties helps in understanding irrigation needs and water management strategies in the region.

### pH and Soil Reaction

Soil pH affects nutrient availability, microbial activity, and soil health. In tropical and subtropical regions like Chhattisgarh, soils often have acidic to neutral pH levels, influencing the availability of essential nutrients (Rayment & Higginson, 1992). Research indicates that the pH of soils in Balrampur varies, with some areas showing more acidic conditions due to leaching and organic matter decomposition (Sparks et al., 1996). Understanding soil pH in Budha Bagicha and surrounding areas is crucial for implementing effective soil amendments and improving crop productivity.

**Soil Compaction and Structure**

Soil compaction impacts soil structure, aeration, and water movement. Compacted soils can lead to reduced root growth and lower crop yields. In similar agricultural settings, practices such as excessive tillage or heavy vehicle traffic contribute to soil compaction (Holland, 2004). Addressing compaction through practices such as reduced tillage and the use of cover crops can improve soil health and productivity in Budha Bagicha and neighboring areas (Dexter, 2004)

## 4.Material and method:

### 1. Study Area

The investigation was conducted in **Budha Bagicha (Mahuapara)**, located in the **Rajpur region** of **Balrampur District, Chhattisgarh**. The area is characterized by diverse terrain and soil types, making it an ideal location for studying soil physico-chemical properties. The region experiences a tropical climate with significant rainfall during the monsoon season and dry conditions during other parts of the year. The exact geographical coordinates of the sampling sites were recorded using GPS to ensure precise location tracking for future studies.

### 2. Soil Sampling

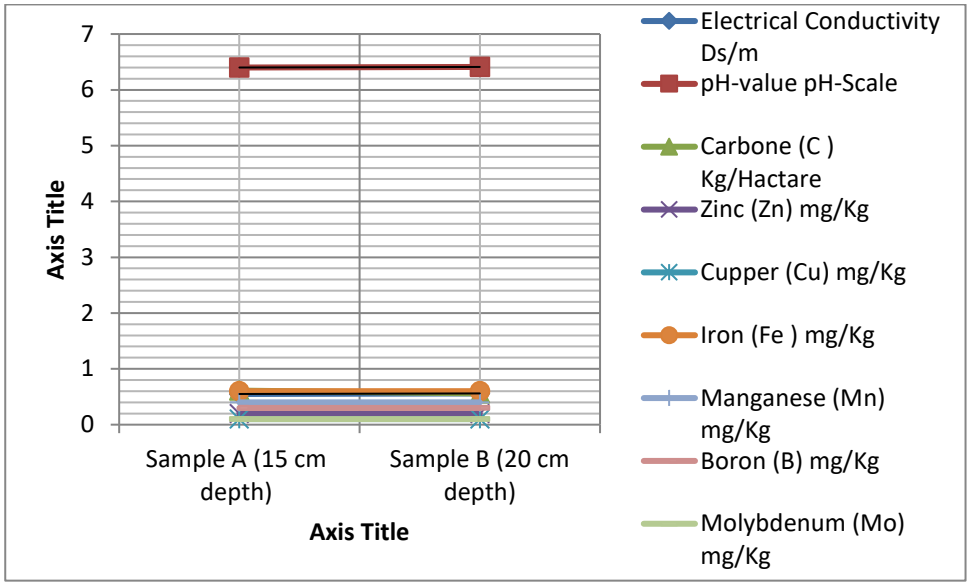
Soil samples were collected from selected sites within Budha Bagicha using a **systematic random sampling method**. Sampling points were distributed across the area, ensuring a representative collection of soil from various land use patterns, including agricultural fields, forest areas, and open land.

- **Sampling Depth**: Soil samples were taken at two depths—surface soil (0-15 cm) and sub-surface soil (15-30 cm)—to capture variation in soil properties with depth.
- **Sample Collection**: At each sampling point, approximately **1 kg of soil** was collected using a stainless-steel auger, ensuring no contamination from external sources. The collected samples were placed in labeled, sterile polyethylene bags and transported to the laboratory for further analysis.
- **Number of Samples**: A total of **3 soil samples** were collected from the study area, depending on the spatial variation observed in the landscape.

**Table 1: Physico-chemical properties of Soil.**

| S.No. | Physio-chemical properties | Unit | Value in Soil | | Level Description/ Critical Level |
|---|---|---|---|---|---|
| | | | **Sample A (15 cm depth)** | **Sample B (20 cm depth)** | |
| **01** | **Electrical Conductivity** | **Ds/m** | **0.55** | **0.56** | Less than 1.0-Normal |
| **02** | **pH-value** | **pH-Scale** | **6.40** | **6.41** | Neutral 7 |
| 03 | **Carbone (C )** | **Kg/Hactare** | **0.61** | **0.56** | Less than 0.50- Lower |
| **04** | **Zinc (Zn)** | **mg/Kg** | **0.2** | **0.2** | 0.6 |
| **05** | **Cupper (Cu)** | **mg/Kg** | **0.1** | **0.1** | 0.2 |
| **06** | **Iron (Fe )** | **mg/Kg** | **0.6** | **0.6** | 4.5 |
| **07** | **Manganese (Mn)** | **mg/Kg** | **0.4** | **0.4** | 3.5 |
| **08** | **Boron (B)** | **mg/Kg** | **0.3** | **0.3** | 0.5 |
| **09** | **Molybdenum (Mo)** | **mg/Kg** | **0.1** | **0.1** | 0.2 |

**5.Results and Discussion:**




**Graph 2: Physico-chemical properties of Soil.**

**1. Electrical Conductivity (EC)**

Both soil samples exhibit **normal EC values** below the critical level of **1.0 Ds/m**, indicating that the soil is non-saline. This is favorable for most crops, as salinity levels are low enough not to inhibit water uptake by plants. Thus, the soils are classified as **normal**, suitable for agricultural activities without concerns over salt stress.

**2. pH Value**

The pH values of both samples are slightly acidic (**6.40 and 6.41**), close to neutral. This pH range is beneficial for the availability of most essential nutrients. A slightly acidic to neutral pH is optimal for nutrient absorption, making the soil suitable for various crops. However, amendments may be required if specific crops that prefer more neutral pH are to be grown.

**3. Organic Carbon**

The **organic carbon content** of both soil samples is moderately above the critical level (**0.50 Kg/ha**). While these values (**0.61 and 0.56 Kg/ha**) suggest moderate organic matter content, the soils still require organic inputs like compost or green manure to maintain or improve fertility, especially over time.

**4. Zinc (Zn)**

The **zinc concentration** in both samples is **0.2 mg/kg**, which is below the critical level (**0.6 mg/kg**). Zinc is essential for various enzymatic functions and protein synthesis in plants. The deficiency of zinc could result in stunted growth, reduced crop yields, and poor quality. Zinc fertilizers should be applied to correct this deficiency.

**5. Copper (Cu)**

Copper levels are **0.1 mg/kg** in both samples, below the critical level of **0.2 mg/kg**. Copper is a crucial micronutrient involved in photosynthesis, respiration, and protein metabolism. The deficiency of copper could impair plant growth and development. Regular copper supplementation is necessary for maintaining crop productivity.

**6. Iron (Fe)**

Iron levels in both samples are low at **0.6 mg/kg**, far below the critical level of **4.5 mg/kg**. Iron is vital for chlorophyll synthesis and enzymatic reactions in plants. Iron deficiency, known as **chlorosis**, can result in yellowing of leaves and reduced photosynthetic efficiency. Soil amendments or iron chelates are recommended to address this severe deficiency.

**7. Manganese (Mn)**

The manganese content in both samples is **0.4 mg/kg**, which is significantly below the critical level (**3.5 mg/kg**). Manganese is crucial for photosynthesis, nitrogen assimilation, and enzyme activation in plants. Its deficiency can lead to interveinal chlorosis and poor growth. Supplementing the soil with manganese fertilizers is necessary to support optimal plant health.

**8. Boron (B)**

Boron concentrations in both samples are **0.3 mg/kg**, slightly below the critical level of **0.5 mg/kg**. Boron is necessary for cell wall formation and reproductive growth in plants. Insufficient boron levels can lead to reduced crop yields, poor fruit quality, and deformed growth. Boron fertilizers should be applied to prevent reproductive issues in crops.

**9. Molybdenum (Mo)**

The **molybdenum content** in both samples is **0.1 mg/kg**, which is below the critical level of **0.2 mg/kg**. Molybdenum is essential for nitrogen fixation in legumes and other enzymatic processes. Its deficiency could lead to poor nitrogen metabolism and reduced plant growth. Molybdenum supplementation is recommended to ensure nitrogen-fixing crops like legumes can thrive.

6.**Conclusion:**

The physico-chemical analysis of soil samples from **Budha Bagicha (Mahuapara), Rajpur, Balrampur District** reveals important insights into the soil's fertility and its suitability for agricultural practices. The key findings are as follows:

1. **Electrical Conductivity (EC)**: Both soil samples have EC values within the normal range (**<1.0 Ds/m**), indicating non-saline conditions suitable for crop growth.
2. **pH Value**: The soils are slightly acidic with pH values of **6.40 and 6.41**, close to neutral. This pH range is favorable for most crops but may need adjustment depending on the specific crop requirements.
3. **Organic Carbon (C)**: The organic carbon content is **moderately above the critical level** but still requires improvement through organic inputs to enhance soil fertility.
4. **Micronutrient Deficiencies**: Significant deficiencies in **zinc (Zn), copper (Cu), iron (Fe), manganese (Mn), boron (B), and molybdenum (Mo)** were identified, with concentrations below their critical levels. These deficiencies could lead to poor crop yields, reduced quality, and impaired plant growth if not addressed.
   - Zinc, copper, iron, and manganese are essential for enzymatic processes and chlorophyll synthesis.
   - Boron and molybdenum are crucial for reproductive growth and nitrogen fixation.
5. **Soil Management Recommendations**:
   - **Micronutrient fertilization** (especially zinc, copper, iron, manganese, boron, and molybdenum) is necessary to address nutrient deficiencies and ensure healthy plant development.
   - Application of **organic matter** such as compost or green manure can improve the organic carbon content, enhancing soil structure, moisture retention, and microbial activity.

- Monitoring and adjusting the pH where necessary could further improve nutrient availability and crop productivity.

In conclusion, while the soils of Budha Bagicha are generally non-saline and suitable for cultivation, the identified micronutrient deficiencies must be addressed through proper soil management and fertilization practices. Sustainable agricultural productivity in the region can be achieved by implementing corrective measures to enhance soil fertility.

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