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"EVALUATION OF THE PHYSICO-CHEMICAL CHARACTERISTICS OF SOIL IN THE CHANDO REGION, KUSMI BLOCK, BALRAMPUR DISTRICT, CHHATTISGARH"

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ABSTRACT:

The present study aims to evaluate the physico-chemical characteristics of soil in the Chando region of Kusmi Block, Balrampur District, Chhattisgarh, to assess its fertility status and agricultural suitability. Soil samples were collected from different locations following standard sampling procedures and analyzed for key parameters such as pH, electrical conductivity (EC), organic carbon, macronutrients (N, P, K), sulphur, and selected micronutrients. The results indicate that soil properties vary across sampling sites due to differences in land use and environmental conditions. The pH of the soil ranged from slightly acidic to neutral, which is generally favorable for nutrient availability. Electrical conductivity values were low, indicating non-saline soil conditions. Nutrient analysis revealed moderate to adequate levels of essential elements, supporting crop growth. The study highlights the importance of regular soil assessment to maintain soil health, optimize fertilizer application, and promote sustainable agricultural practices in the region.

KEYWORDS: Soil Physico-Chemical Properties, NPK Nutrient Status, Soil pH and Electrical Conductivity.

INTRODUCTION:

Soil is a fundamental natural resource that supports plant growth, sustains ecosystems, and plays a vital role in agricultural productivity. The physico-chemical characteristics of soil, including parameters such as pH, electrical conductivity (EC), organic carbon, and nutrient content, are critical indicators of soil health and fertility. These properties influence nutrient availability, water retention, microbial activity, and ultimately crop yield. Therefore, a detailed assessment of soil characteristics is essential for effective land management and sustainable agriculture.

In recent years, increasing population pressure and intensive agricultural practices have significantly altered soil properties in many regions. The excessive use of chemical fertilizers, deforestation, and improper land use have led to nutrient imbalances and soil degradation. As a result, evaluating soil quality has become increasingly important to ensure long-term agricultural productivity and environmental sustainability. The analysis of both macronutrients such as nitrogen (N), phosphorus (P), potassium (K), and sulphur (S), along with micronutrients like zinc (Zn), iron (Fe), manganese (Mn), and copper (Cu), provides a comprehensive understanding of soil fertility status.

The Chando region in Kusmi Block of Balrampur District, Chhattisgarh, is characterized by diverse land use patterns, including agricultural land, forest areas, and rural settlements. The region largely depends on agriculture for livelihood, making soil quality a key factor in determining crop productivity. However, limited scientific studies have been conducted to evaluate the soil properties of this area. Variations in topography, climatic conditions, and agricultural practices may lead to significant differences in soil characteristics across different locations within the region.

The present study aims to evaluate the physico-chemical properties of soil samples collected from the Chando region. Important parameters such as pH, electrical conductivity, organic carbon, and nutrient content are analyzed to assess soil fertility and suitability for agricultural purposes. The findings of this study will help in identifying nutrient deficiencies or excesses and provide valuable information for improving soil management practices.

Literature review:

Soil is a complex natural system whose physico-chemical properties play a fundamental role in determining soil fertility, productivity, and environmental sustainability (Patel et al., 2022). Parameters such as pH, electrical conductivity (EC), organic matter, and nutrient content are widely used to assess soil quality and its suitability for agricultural purposes (Patel et al., 2022).

Soil pH is considered one of the most important factors influencing nutrient availability, microbial activity, and overall soil health (Dasgupta & Brahmaprakash, 2021) . Variations in pH can significantly affect the solubility and mobility of both macro and micronutrients in soil systems (Dasgupta & Brahmaprakash, 2021) .

Electrical conductivity (EC) is an important indicator of soluble salt concentration in soil and helps in determining salinity status, which directly affects plant growth (Patel et al., 2022) . Low EC values generally indicate non-saline soils, whereas high EC values may cause osmotic stress and reduced crop productivity (Patel et al., 2022) .

Micronutrients such as zinc (Zn), iron (Fe), manganese (Mn), and copper (Cu) are essential for plant growth, although required in small quantities (Sagwal et al., 2023) . These elements are involved in vital physiological processes including enzyme activation, chlorophyll formation, and metabolic reactions in plants (Sagwal et al., 2023) .

The availability of micronutrients is strongly influenced by soil physico-chemical properties, particularly pH, organic matter content, and moisture conditions (Sagwal et al., 2023) . In acidic soils, micronutrients like iron and manganese are more available, whereas zinc deficiency is common in alkaline soils (Sagwal et al., 2023) .

Studies conducted in different regions of India have reported significant spatial variability in soil physico-chemical properties due to differences in land use, climate, and management practices (Manivikas et al., 2022).

Depth-wise variation in soil properties is also observed, with higher nutrient concentrations generally found in surface layers compared to subsurface layers (Manivikas et al., 2022).

Land use patterns such as agriculture, forestry, and urbanization significantly influence soil characteristics and nutrient dynamics (Kumar et al., 2025). Intensive cultivation and improper fertilizer use can lead to nutrient imbalance, soil degradation, and decline in soil quality over time (Kumar et al., 2025).

Soil physico-chemical properties also regulate microbial diversity and activity, which in turn affect nutrient cycling and soil ecosystem functioning (Dasgupta & Brahmaprakash, 2021). Healthy soil microbial communities contribute to improved soil structure, nutrient availability, and sustainable agricultural productivity (Dasgupta & Brahmaprakash, 2021).

The application of fertilizers and organic amendments has been shown to significantly alter soil properties and nutrient availability (Dhaliwal et al., 2019). Balanced nutrient management practices are therefore essential to maintain soil fertility and prevent environmental degradation (Dhaliwal et al., 2019).

MATERIALS AND METHODS:

Soil Sampling:

Following standard sampling procedures, soil samples were collected from a depth of 15–30 cm using a soil auger. The samples were air-dried, ground, and sieved through a 2 mm sieve to remove debris and stones. Subsequently, the sample was quartered, and one portion was sieved through a 0.5 mm sieve. This portion was then quartered again, and one part was sieved through a 0.02 mm sieve.

Materials Used:

Standard laboratory equipment and chemicals were utilized, including a pH meter, electrical conductivity meter, weighing balance, oven, glassware, and reagents necessary for nutrient analysis.

Analytical Methods:

The soil pH value was determined using a digital pH meter in a 1:2.5 soil-water suspension. Electrical Conductivity (EC) was measured using a conductivity meter. Organic carbon was assessed using the 'Walkley and Black method.' Available nitrogen was determined using the 'Alkaline Permanganate method.' Available phosphorus was analyzed using the 'Olsen method.' Available potassium was assessed using a flame photometer. Micronutrients such as zinc, iron, copper, and manganese were analyzed using standard extraction methods.

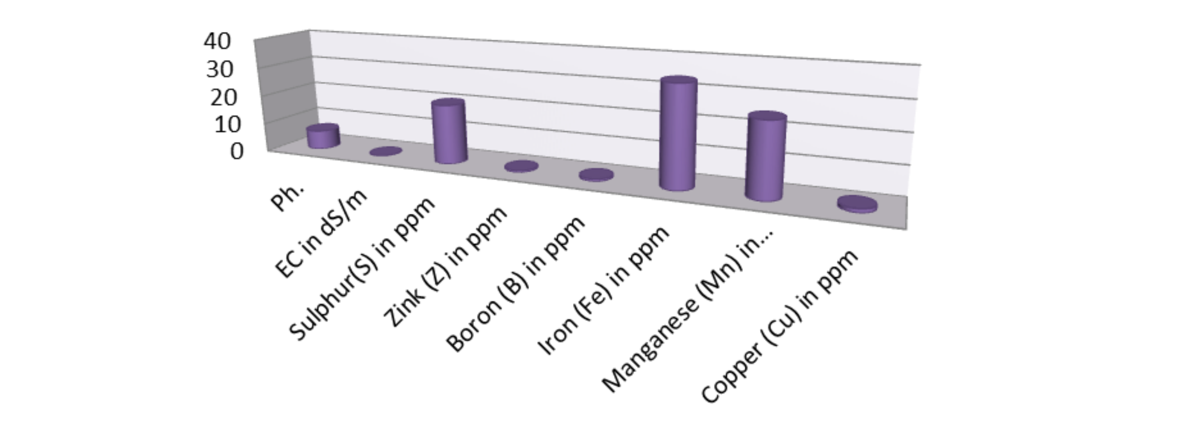
Data Analysis:

Observations derived from the analysis of the soil samples are as follows:

Table 1: Physico-chemical properties of soil sample taken from Chando village.

Ph.	EC in dS/m	Sulphur(S) in ppm	Zink (Z) in ppm	Boron (B) in ppm	Iron (Fe) in ppm	Manganese (Mn) in ppm	Copper (Cu) in ppm
4.7	0.12	24.9	0.74	0.8	32.4	18.9	1.24

RESULTS AND DISCUSSION:



Graph: 1: All Physico-chemical properties of soil sample.

The soil sample exhibited a pH of 4.7, indicating strongly acidic conditions, which can significantly influence nutrient availability and microbial activity (Brady & Weil, 2016). Strongly acidic soils tend to increase the solubility of micronutrients like iron and manganese while reducing the availability of essential macronutrients (Havlin et al., 2014).

The electrical conductivity (0.12 dS/m) indicates that the soil is non-saline and free from harmful salt accumulation, making it suitable for most crops (Richards, 1954). Low EC values reflect minimal soluble salt concentration, which is beneficial for maintaining soil health and plant growth (Gupta & Gupta, 2013).

The sulphur content (24.9 ppm) falls within the adequate range, supporting protein synthesis and enzymatic functions in plants (Tandon, 2013).Sufficient sulphur availability enhances crop yield and improves the quality of agricultural produce (Scherer, 2001).

Zinc concentration (0.74 ppm) is within the adequate range, indicating sufficient availability for plant metabolic activities and enzyme functioning (Alloway, 2008). Zinc plays an essential role in growth regulation and auxin synthesis in plants (Marschner, 2012).

Boron content (0.8 ppm) is within the optimal range, supporting cell wall development and reproductive growth in plants (Gupta, 1993). Adequate boron levels are important for proper flowering, fruiting, and seed formation (Shorrocks, 1997).

Iron concentration (32.4 ppm) is relatively high, which is typical in acidic soils and beneficial for chlorophyll synthesis and plant respiration (Lindsay & Norvell, 1978). However, excessive iron availability in strongly acidic conditions may sometimes lead to toxicity in sensitive crops (Fageria et al., 2002).

Manganese content (18.9 ppm) is also sufficient and supports important physiological processes such as photosynthesis and nitrogen metabolism (Marschner, 2012). Higher manganese availability is commonly associated with low pH soils (Kabata-Pendias, 2011).

Copper concentration (1.24 ppm) is within the normal permissible range, indicating no immediate risk of toxicity to plants or soil microorganisms (Kabata-Pendias, 2011). Adequate copper levels contribute to enzyme activation and overall plant metabolic functions (Alloway, 2013).

CONCLUSION:

The analysis of the soil sample indicates that the soil is **strongly acidic** with a pH of 4.7, which significantly affects nutrient availability and may require pH correction for optimal crop growth. The electrical conductivity (0.12 dS/m) confirms that the soil is **non-saline**, making it suitable for agricultural use without salinity-related issues.

The sulphur content (24.9 ppm) is within the **adequate range**, supporting essential plant metabolic activities. Micronutrients such as zinc (0.74 ppm), boron (0.8 ppm), iron (32.4 ppm), and manganese (18.9 ppm) are present in **sufficient quantities**, indicating good micronutrient status and favorable conditions for plant growth. Copper (1.24 ppm) is also within the **safe and permissible limit**, posing no toxicity risk.

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