



Physicochemical Characterization Of Ranipokhar Pond Soil, Vaishali (Bihar, India): Influence Of Soil Texture, Colour And Macro- And Micronutrient Dynamics

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Abstract

Soil physicochemical properties significantly influence nutrient availability, microbial activity, and overall ecosystem productivity. The present study investigates the physicochemical characteristics of soil collected from the Ranipokhar pond ecosystem located in Vaishali district, Bihar, India. Soil samples were analyzed for texture, colour, pH, electrical conductivity (EC), organic carbon (OC), and essential macro- and micronutrients including nitrogen (N), phosphorus (P), potassium (K), sulfur (S), iron (Fe), zinc (Zn), manganese (Mn), and copper (Cu). Standard analytical techniques such as the Walkley–Black method for organic carbon, Kjeldahl method for nitrogen, Olsen method for phosphorus, and flame photometry for potassium were applied. Soil texture was determined using the hydrometer method and soil colour was classified using the Munsell Soil Colour Chart. The study revealed that the soils around Ranipokhar pond ranged from sandy loam to clay loam with brown to greyish coloration, indicating moderate organic matter accumulation. The soil pH was found to be slightly alkaline while electrical conductivity remained within acceptable limits for agricultural productivity. Macronutrient analysis indicated moderate to high nitrogen and potassium content, whereas phosphorus was present in moderate levels. Micronutrient assessment showed adequate iron and manganese concentrations but comparatively lower zinc availability in some samples. The findings provide baseline information on soil fertility status and nutrient dynamics in the Ranipokhar ecosystem, which may assist in sustainable land-use planning and environmental monitoring in the Vaishali region.

Keywords: organic carbon, Soil fertility, Macronutrient, electrical conductivity

1. Introduction

Soil is a dynamic natural resource that plays a crucial role in supporting terrestrial ecosystems, agriculture, and environmental sustainability. The physicochemical characteristics of soil determine nutrient availability, microbial activity, water retention capacity, and plant growth potential.

Understanding these properties is therefore essential for evaluating soil fertility and environmental health **Kassouri et al., 2020.**

Physicochemical parameters such as soil pH, electrical conductivity, organic carbon, and nutrient concentrations are widely used as indicators of soil quality. Soil pH affects the solubility and availability of nutrients and influences microbial metabolism. Electrical conductivity reflects salinity conditions within the soil environment, while organic carbon represents an important reservoir of nutrients and plays a vital role in maintaining soil structure and biological activity **Sharma et al., 2018.**

Macro-nutrients such as nitrogen, phosphorus, and potassium are required in large quantities for plant growth and metabolic processes. Nitrogen is essential for protein synthesis and vegetative growth, phosphorus plays a key role in energy transfer and root development, and potassium regulates enzyme activity and osmotic balance. In addition to these nutrients, micronutrients including iron, manganese, zinc, and copper are necessary for various physiological and biochemical functions in plants **Kekane et al., 2015.**

Soil texture and colour are important physical indicators that provide insights into soil composition and fertility. Soil texture influences water infiltration, drainage, and nutrient retention capacity, whereas soil colour often reflects organic matter content, mineral composition, and soil moisture conditions **de Oliveira et al., 2018.**

In rural regions of India, ponds represent important ecological resources that support agriculture, fisheries, and groundwater recharge. The soils surrounding these water bodies play a significant role in nutrient cycling and agricultural productivity. Despite their importance, limited scientific studies have been conducted on the physicochemical properties of soils associated with local pond ecosystems in Bihar **Manoj et al., 2015.**

Ranipokhar pond located in Vaishali district is an important freshwater resource used for irrigation and aquaculture. Assessing the physicochemical characteristics of soil around this pond can provide valuable information regarding soil fertility status and environmental sustainability.

Therefore, the objective of the present study is to evaluate the physicochemical characteristics of Ranipokhar pond soil with special emphasis on soil texture, colour, and macro- and micronutrient dynamics **Kumara et al., 2015.**

2. Materials and Methods

2.1 Study Area

The study area is Ranipokhar pond located in Hajipur region of Vaishali district, Bihar, India. The area experiences a subtropical climate characterized by hot summers, moderate rainfall during the monsoon season, and mild winters. Agricultural activities are widely practiced in the surrounding area **Kumar et al., 2020.**

2.2 Soil Sampling

Soil samples were collected from six different locations surrounding the pond at a depth of 0–20 cm using a stainless-steel auger. The collected samples were placed in sterile polyethylene bags and transported to the laboratory for analysis. Samples were air-dried, ground, and sieved through a 2-mm mesh before analysis **Fennemore et al., 2001**.

2.3 Determination of Soil Texture

Soil texture was determined using the hydrometer method, which measures the relative proportions of sand, silt, and clay particles **Wilson et al., 2020**.

2.4 Soil Colour Determination

Soil colour was determined using the Munsell Soil Colour Chart, which provides standardized colour classification based on hue, value, and chroma **Klink et al., 2023**.

2.5 Physicochemical Analysis

The following parameters were analyzed using standard soil analysis techniques: **Jones et al., 2018**.

Parameter	Method
pH	Digital pH meter
Electrical Conductivity	Conductivity meter
Organic Carbon	Walkley-Black method
Nitrogen	Kjeldahl method
Phosphorus	Olsen method
Potassium	Flame photometry
Micronutrients	Atomic Absorption Spectroscopy

3. Results and Discussion

The physicochemical characteristics of soil surrounding Ranipokhar pond revealed noticeable variation in soil texture, nutrient content, and physicochemical parameters **Bobadeet al., 2018**.

Table 1. Monthly Soil Texture Composition

Month	Sand (%)	Silt (%)	Clay (%)	Soil Texture
July	52	25	23	Sandy loam
Month	Sand (%)	Silt (%)	Clay (%)	Soil Texture
August	50	27	23	Loam
September	48	29	23	Loam
October	46	30	24	Clay loam
November	45	31	24	Clay loam
December	47	28	25	Clay loam

The results indicated that sandy loam and clay loam were the dominant soil textures in the study area. Clay fraction slightly increased during post-monsoon months due to sediment deposition.

Table 2. Soil Colour Variation Liu et al., 2020. Month Soil Colour Munsell Code

July	Dark Brown	10YR 3/3	August	Dark Brown	10YR 3/2	September	Brown	10YR 4/3
October	Brownish Grey	10YR 5/2	November	Greyish Brown	10YR 5/3	December	Brown	10YR 4/2

The brown to greyish soil colour suggests moderate organic matter content and mineral composition dominated by iron oxides.

Table 3. Physicochemical Properties of Soil Naga Raju et al., 2016.

Month	pH	EC (dS/m)	Organic Carbon (%)
July	7.2	0.35	0.75
August	7.3	0.36	0.74
September	7.4	0.38	0.72
October	7.5	0.40	0.70
Month	pH	EC (dS/m)	Organic Carbon (%)
November	7.4	0.39	0.69
December	7.4	0.37	0.68

The soil remained slightly alkaline throughout the study period, which is typical for alluvial soils of northern India.

Table 4. Macronutrient Concentration Leghi et al., 2020.

Month	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)	Sulfur (ppm)
July	260	42	320	14
August	255	40	315	13
September	248	39	310	13
October	240	37	305	12
November	238	36	300	12
December	232	35	298	11

Nitrogen and phosphorus levels gradually declined during post-monsoon months due to plant uptake and leaching.

Table 5. Micronutrient Concentration Coleet al., 2016. Month Fe (ppm) Zn (ppm) Mn (ppm) Cu

Month	Fe (ppm)	Zn (ppm)	Mn (ppm)	Cu (ppm)
July	6.8	0.92	3.5	0.75
August	6.6	0.90	3.4	0.74
September	6.4	0.87	3.3	0.73
October	6.2	0.85	3.2	0.72
November	6.1	0.83	3.1	0.71
December	6.0	0.82	3.0	0.70

Iron and manganese were found in adequate levels, while zinc showed slightly lower concentration.

Table 6. Statistical Summary of Soil Parameters Batjes et al., 2020. Parameter Minimum Maximum**Mean**

pH	7.2	7.5	7.37
Organic Carbon	0.68	0.75	0.71
Nitrogen	232	260	245
Phosphorus	35	42	38
Potassium	298	320	308

Overall results indicate moderate soil fertility and balanced nutrient availability around

Ranipokhar pond.

4. Conclusion

The present study provides a comprehensive assessment of the physicochemical properties of soil surrounding Ranipokhar pond in Vaishali district of Bihar. The soil texture ranged from sandy loam to clay loam with brown to greyish colour indicating moderate organic matter content. Soil pH remained slightly alkaline while electrical conductivity remained within acceptable limits for agricultural productivity.

Macronutrient analysis revealed adequate levels of nitrogen and potassium, whereas phosphorus was present in moderate concentrations. Micronutrient evaluation indicated sufficient iron and manganese but comparatively lower zinc concentrations in some samples.

The findings highlight the importance of periodic soil monitoring and nutrient management strategies for maintaining soil fertility and agricultural sustainability in the region.

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