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Assessment of physico-chemical parameters and macronutrient status of agricultural soils for sustainable resource management in Pauni Tehsil, Bhandara District, Maharashtra (Central India)

Sangita D Katre
Department of Chemistry, J. M. Patel Arts, Commerce Science College, Bhandara, Maharashtra, India

Abstract
In regions such as Pauni tehsil in Bhandara district of Maharashtra, agriculture forms the backbone of local livelihoods, making soil quality assessment vital. The physical and chemical characteristics of soil govern its fertility, crop yield potential, and long-term sustainability. Over time, continuous cultivation, improper fertilization, and environmental changes degrade soil nutrient balance. This study aims to evaluate the status of key macronutrients - nitrogen (N), phosphorus (P), and potassium (K) alongside other physico-chemical parameters, to understand soil health in the region. Such data is crucial for designing better land-use policies, nutrient management strategies, and for initiating future soil restoration and conservation programs. A total of 26 agricultural soil samples were collected during the year 2024. The findings provide insights into the current nutrient status of the region's soil and offer a foundation for sustainable agricultural practices. The study emphasizes the importance of soil health monitoring in effective land management, restoration, and conservation efforts.

Keywords: Pauni, Bhandara, soil analysis, ph, organic carbon, exchangeable cations

Introduction

Soil is a critical natural resource that directly influences agricultural productivity and ecosystem sustainability. Soil is one of the important and valuable resources of the nature. It also acts as a source and sink for atmospheric gases [1].

Sustaining Life and Ensuring Food Security, both directly and indirectly, hinges upon the health and productivity of our soil. An astonishing 95% of the food that sustains humanity originates from this vital resource, making the planning and execution of strategies to maintain its quality paramount to our very survival. Soil, far from being a simple, homogenous entity, is a complex natural body composed of distinct layers known as soil horizons. These horizons, varying in thickness, are made up of mineral constituents that differ significantly from the parent materials from which they were formed. These differences are evident in their morphological, physical, chemical, and mineralogical characteristics, shaped by the forces of weathering and erosion acting upon broken rock particles. In essence, soil constitutes the upper layer of the Earth's surface, a dynamic mixture of organic residues, clay, and rock particles, providing the essential foundation for plant growth. Consequently, soil quality is arguably the most critical environmental factor influencing agricultural activities, directly impacting the safety and quality of agricultural produce. The increasing global awareness of food security has propelled soil quality assessment to the forefront of critical issues. This assessment often involves analysing key indicators such as soil pH, electrical conductivity (EC), organic carbon content, nitrogen, potassium, and phosphorus levels, as well as soil texture, exchangeable cations, and water holding capacity. To maximize crop yields and ensure sustainable agricultural practices, periodic soil testing is absolutely essential. By analysing the physical and chemical properties of the soil, we can effectively gauge its ability to provide plants with necessary nutrients in readily available forms. Furthermore, this analysis allows us to identify and address factors that may be hindering the soil's efficiency, ultimately leading to improved food production while promoting an eco-friendly environment. In conclusion, understanding and actively managing soil quality is not just an agricultural imperative, but a fundamental responsibility for ensuring the long-term well-being and prosperity of our planet.

This study evaluates the physico-chemical characteristics and macronutrient content of agricultural soils in Pauni tehsil, located in Bhandara district of Maharashtra, Central India. The primary objective was to assess the levels of nitrogen (N), phosphorus (P), and potassium (K), which are essential for plant growth and soil fertility.

Materials and methods

1. Study area

The study area is situated in Pauni Tehsil, District - Bhandara, State-Maharashtra having a gross area of 662 km^2, including 653.62 km^2 rural area and 8.53 km^2 urban area. Pauni Tehsil is a rural area with significant natural features, such as the Wainganga River, the Indira Sagar Dam, and its proximity to the Umred-Karhandla wildlife sanctuary. The river Wainganga flows on the Northern side of the Pauni town. The Wainganga (Pranhita) River which is a principal tributary of the Godavari River, covers the 37 km stretch in the block along with National water reservoir named Indira Sagar Dam (Gosikhurd Project), having a total capacity of 930,000 acre-ft. The absolute location lies between 21.10^0 to 20.66^0 Latitude and 79.51^0 to 79.78^0 Longitude. Pauni is surrounded by Umred-Karhandla wildlife sanctuary, famous for tigers and other wild animals. It is bounded to the South-West by Umred district, to the North-West Ramtek district, to the east by Gondia district and to the South by Gadchiroli districts of Maharashtra State. Soils occur on gently sloping dissected stream bank are due to fluvial depositional activity of the stream/river, likely meaning fertile land along the riverbanks due to sediment deposition. This region seems to have a mix of environmental, hydrological, and ecological features that could support various studies, including agriculture.

1.1 Climate

Pauni tehsil lies in the Bhandara district of Maharashtra in central India. The region features a tropical climate, with agriculture predominantly dependent on monsoonal rainfall. The proximity of Pauni to the Wainganga River and its associated water resources can slightly moderate the temperature, particularly in areas closer to the river. This effect could lead to relatively cooler temperatures compared to more inland or dry areas. The study area experiences a climate characterized by hot summers, a generally dry period, and a monsoon season from June to September, with the majority of rainfall occurring during July and August. The south-west monsoon arrives in the second week of June, July being the rainiest month. High humidity levels are common during rainy season due to the consistent rainfall. The study area receives average 1227 mm of rainfall from southwest monsoon during June to October and annual minimum and maximum temperature lie between 6°C to 45°C.

The winter months are generally dry, with clear skies and pleasant weather. The region experiences cooler evenings and mornings, but the afternoons are usually warm. The winter season is characterized by cooler temperatures, making it more comfortable for outdoor activities. The humidity is high during the monsoon season but relatively low during the summer and winter months. The transition between seasons (from summer to monsoon and from monsoon to winter) can be quite noticeable, with temperatures dropping after the rains and then rising again as summer approaches.

1.2 Soil description and sampling

The soils in Pauni Tehsil, Maharashtra, are influenced by the region's tropical climate, river systems, and geological history. The area, situated along the Wainganga River and its tributaries, experiences fluvial (river-based) deposition, which plays a significant role in the soil formation. In Pauni taluka, Bhandara district, soils are varied, mainly residual and influenced by the Wainganga River, with alluvial soils predominating downstream. The soils are primarily residual, though alluvial soils predominate along the southern extremes of the Wainganga valley, downstream of Pauni. These soils arise out of the tropical sub-humid weathering of crystalline, metamorphic and igneous rocks. Common cultivable soil types of the district include Morand and Sihar, both of which are light and slightly acidic. Sihar is reddish yellow soil derived by oxidation crystalline rocks under tropical humid conditions. Sihar cracks very little in the hot weather and is suitable for rice cultivation. Morand soils are good for rabi crops like wheat and linseed, and kharif jowar.

The soil type varies, with black cotton soil and lateritic soils being common.

The soils in Pauni Tehsil are predominantly classified into the following types

a. Alluvial Soils

These soils are typically found along the riverbanks of the Wainganga River and its tributaries.

Alluvial soils are formed by the deposition of silt, sand, clay, and organic matter brought by the flowing water of the river. The texture can vary from sandy to clayey, but it is generally loamy, which is ideal for agriculture. Alluvial soils are fertile and well-drained, making them suitable for growing a variety of crops, especially during the monsoon season when water is readily available. These soils are typically light brown, grey, or pale yellow, depending on the mineral content and organic matter.

b. Black Soils (Regur Soils)

Black soils are found in the plateau regions and are widespread in many parts of Maharashtra, including areas of Pauni Tehsil. Black soils are formed from the weathering of basaltic rocks, which are abundant in Maharashtra. These soils are clayey and have a high moisture-retaining capacity, making them suitable for crops like cotton, groundnut, and sorghum. Black soils are generally rich in nutrients like lime, iron, and magnesium, which support crop growth. As the name suggests, these soils are typically black or dark brown due to the presence of iron and magnesium minerals.

c. Lateritic Soils

Lateritic soils are found in the hilly areas and elevated terrains of Pauni Tehsil. Lateritic soils form in regions with high rainfall and are rich in iron and aluminium, often resulting from the weathering of basalt or other parent rocks. These soils are typically coarse in texture, often reddish or yellowish in colour, and have low fertility, though they can be productive if properly managed with fertilizers. Lateritic soils are well-drained but require adequate moisture for cultivation.

The alluvial soils in the river valleys, along with the black soils, are generally more fertile and suitable for agriculture. Crops such as rice, maize, cotton, and pulses are commonly grown in these areas, especially during the monsoon season. Irrigation from the Wainganga River and the Indira Sagar Dam (Gosikhurd Project) enhances agricultural productivity, particularly in the dry season. The fertility of the soil in areas near the river is also improved by periodic flooding and deposition of nutrient-rich silt.

Erosion risks can occur in areas with steep slopes, especially around the hilly or dissected terrains. While the flatter, alluvial plains near the river are less prone to erosion, the sloped areas could experience erosion during heavy monsoon rains. In regions with black soils, water retention can sometimes cause issues like waterlogging, especially when there’s excessive rain during the monsoon. Drainage systems may be required to manage these soils effectively.

In lateritic soils, which are often poor in fertility, farmers might need to apply organic manure and chemical fertilizers to enhance soil productivity, especially for crops that are more sensitive to nutrient deficiencies. Continuous farming without proper soil management practices can lead to soil degradation, which is a concern in the region. Issues like nutrient depletion and declining organic matter content are common in areas that undergo intensive agricultural activity. Soil conservation techniques such as terracing, agroforestry, and water harvesting methods can help preserve soil fertility, prevent erosion, and maintain the health of the land in Pauni Tehsil.

A total of 26 soil samples were collected from cultivated fields across various villages of Pauni tehsil during the 2023–2024 period. Samples were taken from the topsoil layer (0–15 cm depth) using a standardized soil auger. The samples were air-dried, sieved (2 mm), and stored in clean polyethylene bags for analysis.

1.3 Physico-chemical analysis

The present study involves the analysis of 26 soil samples collected in 2023-24 from six different villages in the Pauni tehsil of Bhandara District. The samples of soils were collected separately in polythene bags as per the standard procedures recommended [2, 5] and laboratory manual prepared [3]. Soil samples were collected using a spade or khurpi, and V-shaped holes were dug to obtain a uniform 2 cm thick slice of soil from a depth of 0-15 cm. The soil was collected in plastic buckets. The samples were thoroughly mixed by rolling and turning them on a clean piece of cloth. They were then air-dried in the shade, and soil clods were crushed using a wooden pestle and mortar. The entire quantity was sieved through a 2 mm stainless steel sieve. Coarse material remaining after sieving was re-crushed and sieved again. Stones and organic residues were discarded. A total of twenty-six soil samples were finally collected, placed in clean polythene bags, and transported to the laboratory for further analysis.

Soil pH was measured using a pH meter, while Electrical Conductivity (EC) was determined with a conductivity meter[4] and is expressed in $dS \cdot m^{-1}$, indicating the amount of soluble salts present in the soil. Organic Carbon was estimated using the Walkley and Black rapid titration method[6]. Available Potassium was measured using a flame photometer by the neutral normal ammonium acetate method by Hanway and Heidel [7], and available Phosphorus was determined through spectrophotometry by Bray and Kurtz [8] and Olsen [9] method. Available Nitrogen was estimated using by the alkaline KMnO4 method by Subbiah and Asija [10] (1956). Exchangeable cations [11, 12] (Calcium and Magnesium) was measured using the EDTA complexometric titration method, based on ammonium acetate extracts of soil. At pH 10, all exchangeable Calcium and Magnesium form complexes with EDTA (Versene), producing a bright blue endpoint in the presence of Eriochrome Black T indicator. At pH 12, only Calcium forms a complex with EDTA in the presence of Murexide indicator. The initial orange-red colour changes to a red-violet endpoint. The amount of Magnesium was calculated by subtracting the Calcium content from the total (Calcium + Magnesium) value. Exchangeable Sodium and Potassium were also determined using a flame photometer. The percentage of Calcium Carbonate was measured by the Acid Neutralization method, a rapid titration technique [13]. The standard protocols [14, 15] as described below were followed for soil sample analysis.

Bulk density(gcm^{-1}): The bulk density of soil was determined by using the core method as given by the following formula –

$$\text{B.D. } (gcm^{-1}) = \frac{\text{Dry mass(gm) of soil}}{\text{Total volume } (cm^3) \text{ of soil}}$$

Soil texture: The distribution of different sized particles was determined by mechanical analysis (USDA System).

Results and Discussion

The soil pH of the Pauni block ranged from neutral to alkaline, varying between 6.0 and 8.80, with a mean value of 7.34 indicating favourable conditions for crop growth. Among the 26 soil samples analysed, 20 samples were neutral, while 6 were alkaline (Table 1). Electrical conductivity (EC) values were within acceptable limits, suggesting no salinity stress. The electrical conductivity (EC) ranged from 0.014 to 0.048 $dS\ m^{-1}$, with a mean of 0.017 $dS\ m^{-1}$. All the 26 samples, were classified as non-saline (Table 1). The organic carbon content essential for maintaining soil structure and nutrient-holding capacity, ranged from 0.10 % to 0.90 %, with a mean of 0.39 % which indicates low organic matter levels. Of the total samples, 19 soil samples were low, 4 were medium, and only 3 were high in organic carbon content (Table 1).

Table 1: Chemical characteristics of soils in Pauni Tehsil (Weighed means)

Village Name	pH	EC	OC	% $CaCO_3$	Available N $Kgha^{-1}$	Available P $Kgha^{-1}$	Available K $Kgha^{-1}$	CEC	Exchangeable bases			
									Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}
Khambadi	6.00	0.017	0.48	0	203.04	8.82	698.25	24.80	10.25	5	1.42	2.56
Khapri	6.43	0.015	0.81	0	342.63	11.06	647.01	23.40	8.75	5.75	0.84	2.37
Khapri	7.09	0.014	0.67	0	“	“	“	28.40	12.25	6.25	1.09	2.72
Khapri	7.38	0.015	0.50	0	“	“	“	31.20	13.25	7.25	1.27	2.89
Khapri	7.54	0.015	0.29	0	“	“	“	32.90	15.25	8	1.36	3.01
Khapri	7.64	0.015	0.14	0	“	“	“	9.10	2.75	1.5	0.42	1.01
Mangli	6.52	0.019	0.90	0	380.7	9.04	638.82	36.10	17.75	8.75	1.46	2.34
Mangli	7.10	0.016	0.77	0	“	“	“	36.90	18.50	8.75	1.53	2.39
Mangli	7.22	0.016	0.56	0	“	“	“	38.40	19.00	9.75	1.64	2.45
Mangli	7.33	0.017	0.31	0	“	“	“	37.20	18.00	9.75	1.61	2.37
Mangli	7.39	0.016	0.13	0	“	“	“	38.60	18.75	10.25	1.69	2.42
Nishti	6.95	0.015	0.64	5.72	270.72	13.4	584.22	16.80	16.80	3.5	0.64	2.14
Nishti	8.12	0.017	0.43	8.61	“	“	“	22.50	22.50	5	0.96	2.20
Nishti	8.63	0.020	0.28	9.37	“	“	“	23.80	23.80	5.25	1.04	2.31
Nishti	8.80	0.035	0.18	10.24	“	“	“	26.70	26.70	6	1.24	2.39
Nishti	8.75	0.048	0.10	10.36	“	“	“	25.40	25.40	5.25	1.13	2.33
Shivnala	7.27	0.015	0.42	0	177.66	8.90	212.94	11.90	4	2.25	0.61	0.78
Shivnala	7.46	0.015	0.31	0	“	“	“	12.80	4.25	2.5	0.68	0.82
Shivnala	7.30	0.014	0.24	0	“	“	“	13.60	4.50	2.75	0.70	0.89
Shivnala	7.15	0.014	0.26	0	“	“	“	52.10	25	15.5	2.61	4.05
Shivnala	7.03	0.015	0.24	0	“	“	“	54.20	26.25	16.25	2.58	4.24
Sirsala	6.54	0.013	0.57	0	241.11	10.78	159.37	4.10	1.25	0.5	0.16	0.21
Sirsala	7.25	0.016	0.43	0	“	“	“	6.30	1.75	1	0.26	0.28
Sirsala	7.33	0.017	0.31	0	“	“	“	5.10	1.50	0.75	0.22	0.23
Sirsala	7.29	0.017	0.22	0	“	“	“	5.20	1.25	1	0.23	0.23
Sirsala	7.28	0.017	0.13	0	“	“	“	5.90	1.75	0.75	0.25	0.27

The highest organic carbon content (0.90 %) was recorded in Mangli village. The generally low levels of organic carbon may be attributed to the inadequate application of organic matter following crop harvests. Available nitrogen content ranged from 177.66 to 380.7 kg ha^{-1}, with a mean of 269.31 kg ha^{-1}. The lowest nitrogen level (177.66 kg ha^{-1}) was found in Shivnala village, while the highest 380.7 kg ha^{-1}) was recorded in Mangli village. The low nitrogen levels may result from low soil organic carbon content as well as losses due to leaching, volatilization, microbial fixation, denitrification, and runoff [17, 18]. The available phosphorus content ranged from 8.82 to 13.4 kg ha^{-1}, with a mean of 10.33 kg ha^{-1}. Most soil samples were found to be in the low to medium category. The lowest value (8.82 kg ha^{-1}) was observed in Khambadi village, and the highest (13.4 kg ha^{-1}) in Nishti village. The available potassium content ranged from 159.37 to 698.25 kg ha^{-1}, with a mean of 490.10 kg ha^{-1}. The lowest potassium level (159.37 kg ha^{-1}) was recorded in Sirsala village, and the highest (698.25 kg ha^{-1}) in Khambadi village. These findings suggest variability in nutrient status across the study area, influenced by soil type, cropping pattern, and fertilizer application history. The extensive cultivation of rice and sugarcane in the area contributes to high potassium usage, particularly to enhance sugar content in cane. Initially, the soils were rich in potassium due to the parent material; however, continuous and excessive application has also influenced the current levels observed.

Khambadi soils

Khambadi soils are having fine loamy textural family. These soils are non-calcareous & are non-saline in nature, slightly acidic in reaction (6.00) and are medium (0.48 %) in organic carbon content. Clay complex is dominated by Ca^{2+} followed by Mg^{++} and indicating high CEC (24.80 cmol (+)/ kg soil) & percent base saturation. ESP observed in these soils is of none to slight hazard. These soils are well drained with rapid permeability.

These soils are low in available nitrogen (203.04 kg ha^{-1}) and high in available potassium (698.25 kg ha^{-1}) due to presence of montmorillonitic group of clay mineral. High CEC indicates greater number of total exchangeable cations leads to higher fertility status of soil. Higher values of CEC & PBS indicate that good inherent fertility. Deep tillage or soil cultivation to loosen compact soil layers, particularly the clay subsoil, has been suggested to improve drainage in the subsoil, thus reducing waterlogging. Addition of organic manures and gypsum at sub-surface will reduce sodicity which will help to improve soil structure and fertility.

Khapri soils

The soils are having fine loamy textural family. These soils are non-calcareous & are non-saline in nature, neutral to slightly alkaline in reaction (6.43 – 7.64) and are low very high in organic carbon content (0.14 -0.81 %). Clay complex is dominated by Ca^{2+} followed by Mg^{2+} ions, indicating high CEC (23.40 – 32.90 Cmol (+)/ kg soil). These soils are well drained soils. These soils are medium in available nitrogen (342.63 kg ha^{-1}) and medium in available phosphorous (11.06 kg ha^{-1}) and high in available Potassium (647.01 kg ha^{-1}). The presence of mixed group of clay minerals and a high value of CEC indicates that greater number of total exchangeable cations leads to higher fertility status of soil.

Mangli soils

The Mangli soils belong to the fine textural family. These soils are non-calcareous and non-saline in nature. They have a neutral to slightly alkaline pH (6.52 – 7.39) and exhibit very low to high (0.13 – 0.90 %) organic carbon content. Clay complex is dominated by Ca^{2+} followed by Mg^{2+} ions, indicating high CEC (36.10 – 38.60 Cmol (+)/ kg soil). The presence of mixed group of clay minerals, high value of cation exchange capacity indicates greater number of total exchangeable cations which leads to higher fertility status of soil.

These soils are moderately well-drained. These soils have medium levels of available nitrogen (380.7 kg ha-1), low in available phosphorous (9.04 kg ha-1) and high levels of available potassium (638.82 kg ha-1). The high values of CEC indicate that these soils can be easily managed for cultivation with proper management practices. Adding organic matter will improve soil structure, enhance fertility, and support better soil function. Proper nutrient management can further boost soil fertility and organic matter content.

Nishti soils

These soils belong to the fine loamy textural family, are calcareous (5.72-10.36 % $CaCO_3$) and non-saline in nature. They are neutral to alkaline in reaction (pH 6.95-8.80) and exhibit very low to medium organic carbon content (0.10-0.64 %). The clay complex is dominated by Ca^{2+} followed by Mg^{2+} ions, indicating high CEC (16.80 – 26.70 Cmol (+)/ kg soil). The high values of CEC indicate greater number of total exchangeable cation leading to higher fertility status of soils. These soils are moderately well-drained and have medium levels of available nitrogen (270.72 kg ha-1). They have medium levels of available phosphorous (13.4 kg ha-1) and high levels of available potassium (584.22 kg ha-1).

Shivnala soils

These soils are non-calcareous, non-saline in nature, neutral in reaction (pH 7.03 – 7.46). The Shivnala soils are well drained soils and are low in organic carbon content (0.24-0.42 %). Exchangeable sodium percentage is 5 %, which is low and is considered non-hazardous for most of the crops. The cation exchange capacity of this soil is 11.90-54.20 C mol (P+) Kg^{-1}. The clay complex is dominated by Ca^{2+} followed by Mg^{2+} ions, indicating medium to high CEC. The available nitrogen (177.66 kg ha-1) and available phosphorous (8.90 kg ha-1) is low and the available potassium is medium (212.94 kg ha-1) in these soils.

Sirsala soils

The soils are having loamy textural family and are well drained. These soils are non-calcareous & are non-saline in nature, neutral in reaction (6.54 – 7.33) and are very low to medium in organic carbon content (0.13 -0.57 %). Clay complex is dominated by Ca^{2+} followed by Mg^{2+} ions, indicating low CEC (4.1 – 5.9 Cmol (+)/ kg soil). These soils are medium in available nitrogen (241.11 kg ha^{-1}) and medium in available phosphorous (10.78 kg ha^{-1}) and low in available Potassium (159.37 kg ha^{-1}).

Table 2: Physical characteristics of soils in Pauni Tehsil

Village Name	Soil texture	Clay %	Sand %	Silt %	Bulk density
Khambadi	Clay loam	34	41	26	1.23
Khapri	Clay loam	33	37	30	1.34
Khapri	Clay loam	38	38	24	1.55
Khapri	Clay	40	38	22	1.50
Khapri	Clay	42	32	26	1.34
Khapri	Sandy loam	18	71	11	1.41
Mangli	Clay	44	44	26	1.53
Mangli	Clay	45	45	24	1.49
Mangli	Clay	46	46	25	1.47
Mangli	Clay	45	45	24	1.50
Mangli	Clay	46	46	25	1.61
Nishti	Sandy Clay Loam	27	47	26	1.51
Nishti	Clay Loam	32	43	25	1.35
Nishti	Clay Loam	33	38	29	1.47
Nishti	Clay Loam	37	39	24	1.58
Nishti	Clay Loam	36	39	25	1.53
Shivnala	Sandy Clay Loam	22	69	9	1.35
Shivnala	Sandy Clay Loam	23	68	9	1.30
Shivnala	Sandy Clay Loam	24	68	8	1.42
Shivnala	Clay	58	19	24	1.40
Shivnala	Clay	60	17	24	1.26
Sirsala	Loamy sand	9	89	2	1.45
Sirsala	Sandy loam	13	81	6	1.42
Sirsala	Loamy sand	11	85	4	1.42
Sirsala	Loamy sand	11	84	5	1.41
Sirsala	Loamy sand	12	83	5	1.46

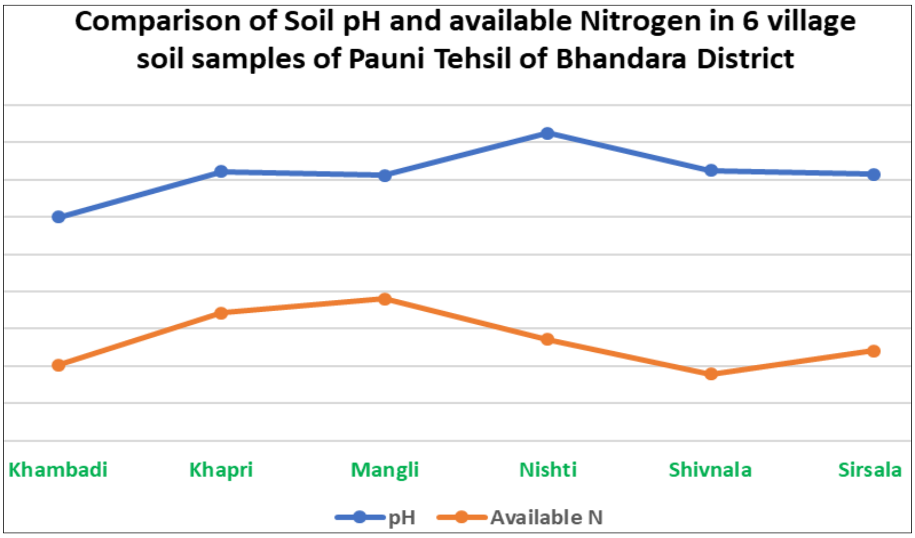

Fig 1: Comparison of Soil pH and available Nitrogen in 8 villages soil samples of Pauni Tehsil

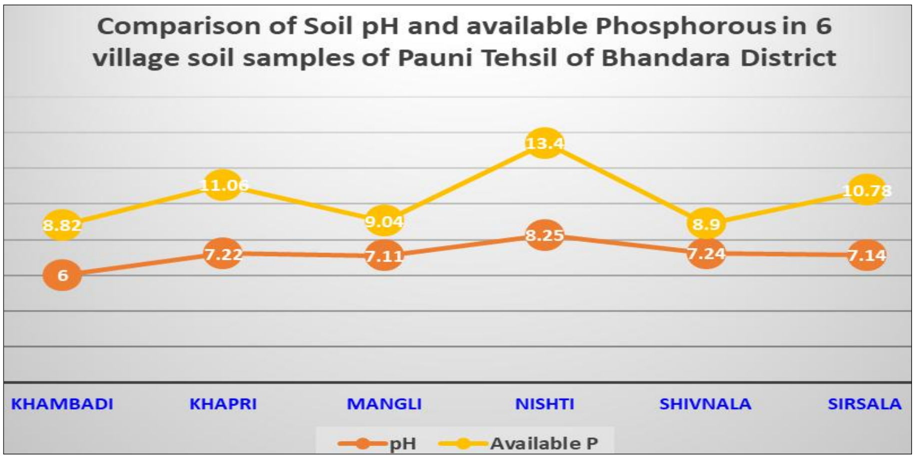

Fig 2: Comparison of Soil pH and available Phosphorous in soil samples of Pauni Tehsil

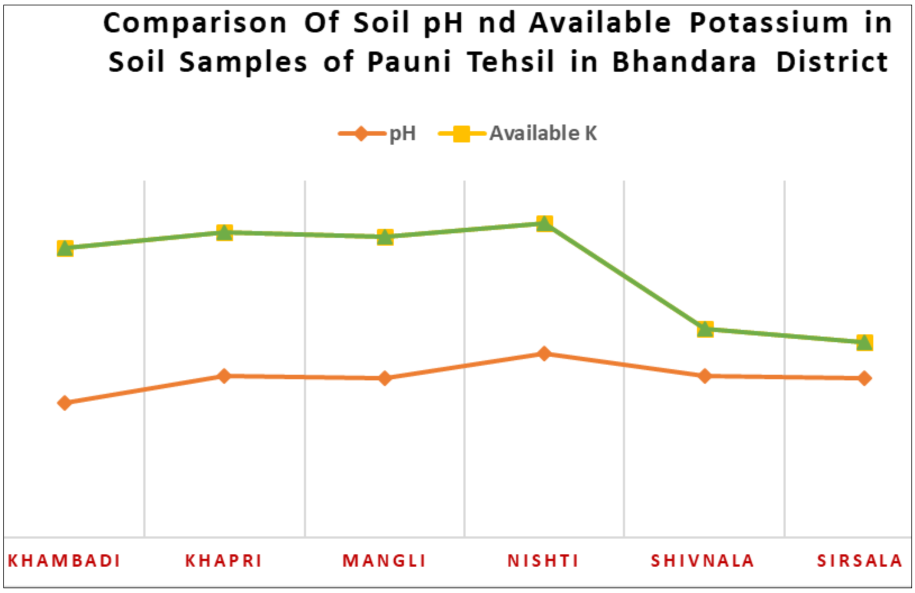

Fig 3: Comparison of Soil pH and available Potassium in soil samples of Pauni Tehsil

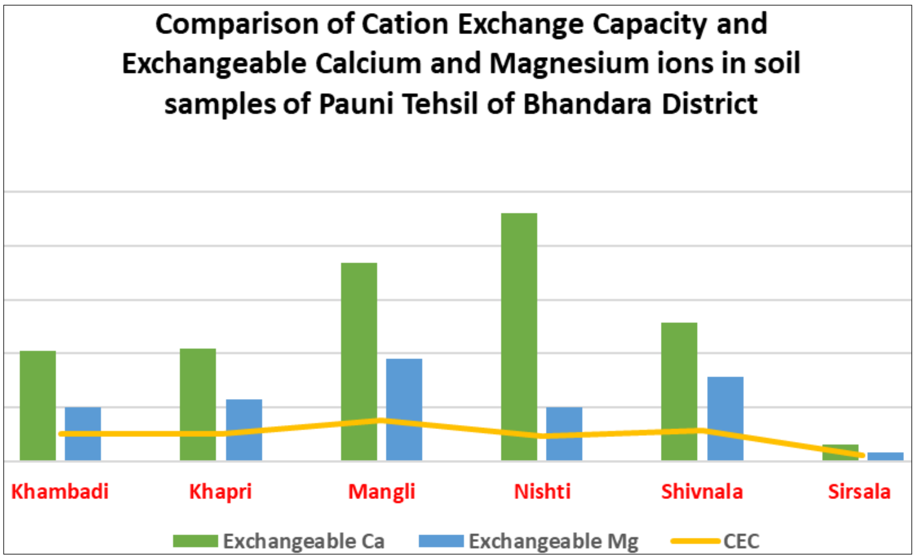

Fig 4: Comparison of CEC and Exchangeable Calcium & Magnesium in soil samples of Pauni Tehsil

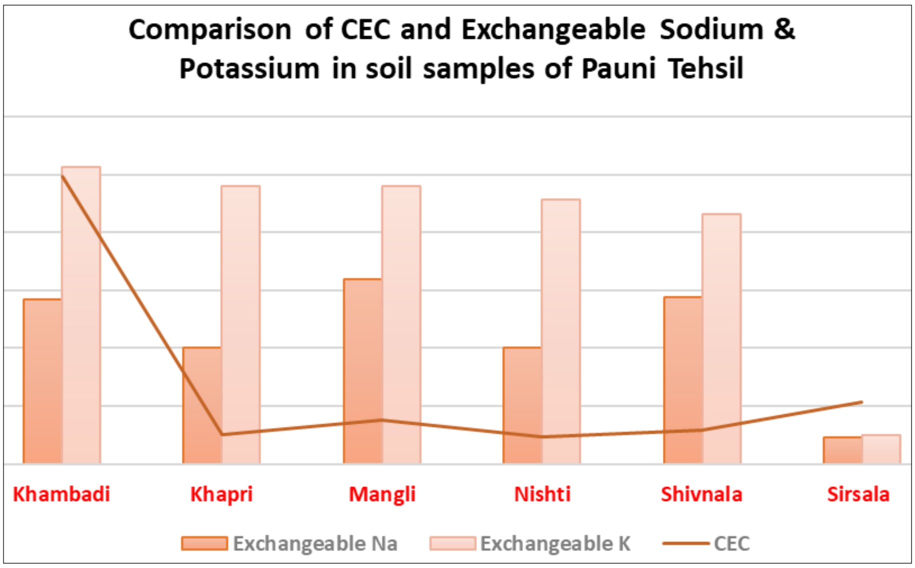

Figure 5: Comparison of CEC and Exchangeable Sodium & Potassium in soil samples of Pauni Tehsil

Conclusion

Pauni Tehsil has a variety of soil types that support a diverse range of agricultural practices. The alluvial soils and black soils are particularly fertile and well-suited for crop production, while lateritic soils are less fertile but can be used for certain types of cultivation with proper soil management. The proximity of the region to water bodies like the Wainganga River and the Gosikhurd Dam also supports irrigation, making it a key factor in agricultural activities in the region.

The soils in the majority of the Pauni block of Maharashtra, Central India, are neutral to slightly alkaline in reaction, non-saline with electrical conductivity values ranging from 0.014 to 0.048 dS m^{-1}, indicating they are free from soluble salts, and generally low to medium in organic carbon content. There was no significant variation in Exchangeable Sodium Percentage (ESP) across the soils of Pauni tehsil, all of which were classified as having none to slight sodicity hazard. Additionally, all soil samples were found to be non-calcareous except that of Nishti village samples. They exhibit marginal levels of available nitrogen, but low to medium in available phosphorus and medium to very high in potassium. The study reveals that while the soils of Pauni tehsil generally exhibit adequate potassium and moderate phosphorus levels, nitrogen remains a limiting factor for optimal crop production. Regular soil testing and tailored nutrient management plans are recommended for sustainable agriculture. The data can serve as a baseline for future soil fertility programs, conservation efforts, and the implementation of integrated soil nutrient management strategies in this region.

To improve soil fertility and crop productivity, it is essential to replenish deficient nutrients through a well-structured nutrient management plan. Enhancing soil health for future agricultural prospects requires the use of organic manures that are readily available to farmers, along with the incorporation of paddy straw residues, rather than burning them. This research provides critical baseline data on soil nutrient status across the entire Pauni block, and future studies can build upon these findings by focusing on crop-specific land suitability assessments.

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