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International

Journal

Of Modern Engineering Research (IJMER)

Evaluation and Availability of Nutrients in Soil Samples Collected from the Shahada Region

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ABSTRACT:

This research evaluates the soil fertility conditions in specific areas of Shahada Region, located in the Nandurbar District of Maharashtra. A total of ten soil samples were collected from various nearby villages and subjected to analysis for key physical and chemical properties. The findings indicate a deficiency of nitrogen (N), phosphorus (P), and both micro and macronutrients across all sampled profiles. Despite these deficiencies, the soils are classified as fertile, exhibiting a significant potential for production when subjected to balanced fertilization practices. It is recommended that nutrient content assessments be conducted annually, coinciding with the fresh siltation that occurs during the monsoon season in Nandurbar District, Maharashtra, India. The study provides detailed reports on the total and available contents of nitrogen (N), phosphorus (P), and potassium (K), as well as the total concentrations of iron (Fe), manganese (Mn), copper (Cu), and zinc (Zn) present in the soils.

Keywords: *ShahadaRegion, Physico-chemical parameters. Micro and Macra Nutrients.*

Date of Submission: 14-10-2024 Date of acceptance: 30-10-2024

I. INTRODUCTION:

Soil represents a fragile yet essential layer on the Earth's surface, playing a pivotal role in various processes that are fundamental to life. It provides a substrate for plant growth, acts as a reservoir for essential nutrients, and serves as a medium for biological activities that promote the decomposition and recycling of organic materials from both flora and fauna. Moreover, soil impacts air quality through its interactions with the atmosphere and functions as a system for water storage and purification as it filters through its layers. It integrates, transforms, stores, and filters materials relevant to its environmental and management contexts (Marathe and Sawant, 2016). Additionally, soil is a resource that encounters challenges due to changing environmental and management conditions. The limited nature of soil resources becomes apparent within human timeframes (Bafna and Thorat, 2008). The importance of soil to human civilization is highlighted by the histories of various ancient cultures, some of which faced collapse due to the degradation of the soils they depended upon (Haque et. al., 2007). Thus, effective soil management is crucial to ensure that soil continues to support environmental processes and alleviate pressures from agricultural practices. Achieving this balance necessitates aligning the output derived from soil with the inputs supplied to them (Wienhold et. al., 2004). Acidic soils, defined by a pH of 5.5 or lower, pose a significant limitation to agricultural productivity, particularly impacting the cultivation of staple grain crops. Therefore, this study investigates the soil fertility status of samples collected from the Shahada Region in the Nandurbar district. Gaining insight into the fundamental characteristics of soil is essential for establishing environmental relationships and formulating guidelines for effective soil resource management. The primary objective of soil surveys and mapping is to systematically catalog soil observations and knowledge. (Bafna and Thorat, 2009). Examining the physical and chemical characteristics of soil, along with the classification of soil series, is crucial for improving soil management practices aimed at increasing agricultural productivity. Research indicates that physical and chemical attributes of soil play a significant role in determining productivity rates, nutrient retention, moisture conservation, root growth, nutrient ion availability, and nitrogen fixation in the soils of Shahada Region, located in the Nandurbar district of Maharashtra, India.

II. MATERIAL AND METHODS:

The study area is in the Nandurbar district, which is found in the northwestern part of Maharashtra state. It is geographically situated between latitudes 21°00’00” and 22°00’30” N, and longitudes 73°31’00” and 74°45’30” E. The district covers an area of 5,034 square kilometres and is divided into six Regions (Kasetiya et. al., 2022). In terms of soil characteristics, a large portion of the district is dominated by Deccan traps, except for narrow alluvial strips along the banks of the Tapi River. The main soil types present in the district consist of coarse shallow, medium deep, and deep black soils. Furthermore, the presence of forested and pasture lands is a significant feature of the Nandurbar district (Ghodke et. al., 2016). The climate in this district is primarily hot and dry, with temperature fluctuations ranging from a low of 15.8 °C to a high of 40.7 °C. The district experiences an average annual rainfall between 767 and 801 mm (Lal et. al., 2003).

A research investigation was carried out in the irrigated area of Shahada Region, situated in the Nandurbar district, specifically in the villages of Mohida, Nandarkheda, Dondwade, Kavthal, Takarkheda, Temba, Aasane, Tarhadi and Pariwarda. This region is notable for its intensive cultivation of commercial crops, such as sugarcane, maize, wheat, cotton, and banana, which are cultivated in a rotational manner. The climatic conditions are characterized by an average annual rainfall of around 550 mm, with most of the rainfall occurring from June to September. Soil samples were collected randomly from various physiographic units within the area. The use of random sampling was necessitated by the difficulties associated with grid sampling in a landscape predominantly devoted to diverse crop cultivation. The collected soil samples were air-dried in a shaded environment, carefully crushed with wooden mallets, and subsequently sieved through a 2 mm mesh before being stored in clean polyethylene bags for further analysis. The analysis focused on parameters such as pH, electrical conductivity (EC), organic carbon (OC), and the primary nutrients nitrogen (N), phosphorus (P), and potassium (K), in addition to micronutrients including iron (Fe), copper (Cu), magnesium (Mg), and zinc (Zn), adhering to the methodologies established by Sharma et. al. (2005).

Soil pH and EC measurements were taken, and the available nitrogen was assessed based on the organic content of the soil. The nutrient availability (N, P, K) was classified into categories of low, medium, or high, as shown in Table 1. The main agricultural products in the region consist of key crops such as maize, wheat, cotton, and bananas. In addition, soybeans were grown in specific areas as secondary crops. While most vegetables were cultivated for family use, an increasing number of farmers have started to grow vegetables for commercial sale. To evaluate the socioeconomic conditions of the local community, a household survey was carried out, complemented by a soil survey that examined various land-use systems within Shahada Region. A total of ten soil samples, one from each land-use system, were collected and analysed for their nutrient composition. Topsoil samples, specifically from the 0 to 20 cm depth, were collected and analysed.

III. RESULTSANDDISCUSSION:

Selected chemical and physical properties of soil, along with micronutrient concentrations, have been employed as indicators to evaluate the soil fertility status in the lands of Shahada Region within the study area. The analysis conducted on ten soil samples collected from the villages of Mohida, Nandarkheda, Dondwade, Kavthal, Takarkheda, Temba, Aasane, Tarhadi, and Pariwarda revealed that all samples exhibited alkaline properties, with soil pH values ranging from 7.72 to 8.76 as shown in fig. 1 among the sampled soils, revealing a medium pH level characteristic of the Shahada Region. This medium pH is likely a consequence of the extensive application of chemical fertilizers and the leaching effects associated with irrigation practices in the area, which tend to create more acidic soil conditions. Conversely, the rainfed lands in Shahada Region did not display this trend. Electrical conductivity (EC) is recognized as a reliable measure of the total concentration of dissolved ions in aquatic ecosystems. Throughout the study, EC values fluctuated between 0.446 and 1.22 mhos cm^{-1}, or µmohs cm^{-1}, as shown in fig. 2 with the highest recorded values being 1.12 and 9.34 µmohs cm^{-1}. The concentration of organic matter in the topsoil of Shahada Region was determined to be moderate, with values ranging from 0.10% to 0.44% as shown in fig. 3. However, most soil samples were situated at the lower end of acceptable organic matter levels, with only a few classified as moderate. The field survey revealed that the use of farmyard manure, compost, and in situ manuring practices was more prevalent in sample seven, while sample three and nine showed lower levels. This variation highlights the relatively more favorable organic matter conditions found in Shahada Region. Nitrogen (N) is an essential macronutrient for agricultural crops, and analytical results indicated that nitrogen content across all soil samples was deficient.

The total nitrogen concentrations in the examined soils varied between 70.80 and 98.56 kg/ha as shown in fig. 4. Among the ten samples analysed, sample seven demonstrated the highest nitrogen level, whereas sample nine showed the lowest. This discrepancy can be linked to the increased use of farmyard manure (FYM) and compost, which has improved nitrogen availability. The irrigated lands in Shahada Region experience notable nitrogen losses due to leaching and runoff. In contrast, rain-fed regions experience significantly reduced leaching.

Table 1: Physicochemical characteristics and the presence of both macro and micro-nutrients in soil samples collected from the Shahada Region

Sr. No.	Sample Name	Mohida	Nandar kheda	Dondwade	Kavthal	Takar kheda	Temba	Kurhawad	Aasane	Tarhadi	Pariwarda
1	pH	7.90	8.10	7.72	8.18	8.72	8.76	8.26	8.38	7.84	7.92
2	EC	0.794	0.649	1.22	0.836	0.760	0.626	0.932	0.754	0.660	0.446
3	OC(%)	0.26	0.29	0.10	0.27	0.28	0.30	0.44	0.24	0.18	0.35
4	N Kg/ha	92.40	98.44	76.18	94.76	92.28	86.20	88.16	98.56	70.80	98.20
5	P Kg/ha	15.20	15.23	11.18	12.09	26.20	20.38	10.80	17.08	12.92	29.12
6	K Kg/ha	216.00	215.84	206.16	382.72	306.88	349.44	304.52	323.36	410.60	392.24
7	Feppm	9.25	9.30	9.34	8.67	7.14	9.86	9.04	6.80	9.08	9.55
8	Cuppm	3.90	2.80	1.14	3.39	2.78	2.76	2.46	1.67	1.66	2.99
9	Mnppm	10.10	6.80	9.88	13.28	14.96	12.96	11.18	8.87	13.69	12.29
10	Znppm	0.74	0.58	0.52	1.16	0.85	0.40	0.45	0.51	0.92	0.9

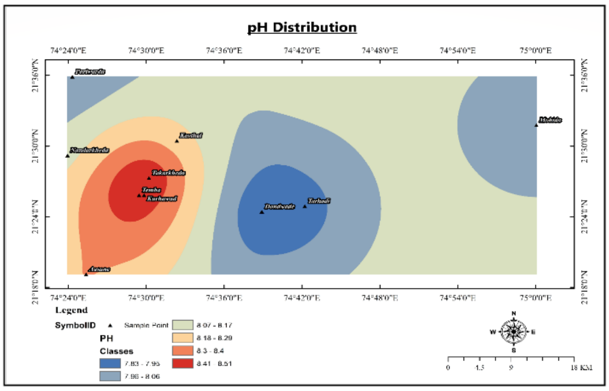

Fig. 1: Shows the pH distribution in the Soil of Shahada Region

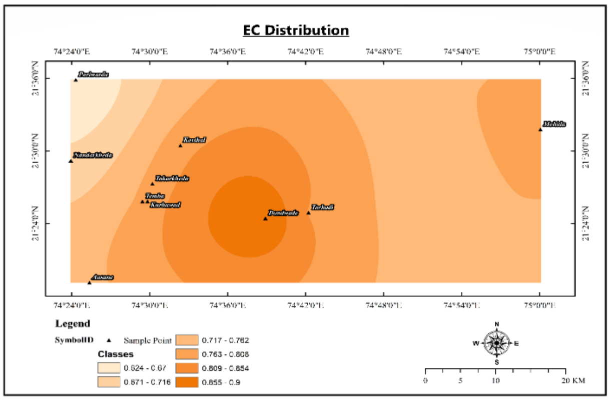

Fig. 2: Shows the E. Conductivity (EC) distribution in the Soil of Shahada Region

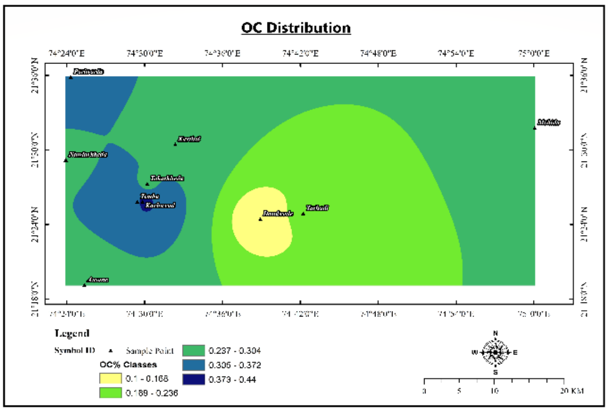

Fig. 3: Shows the Organic Carbon (OC) (%) distribution in the Soil of Shahada Region

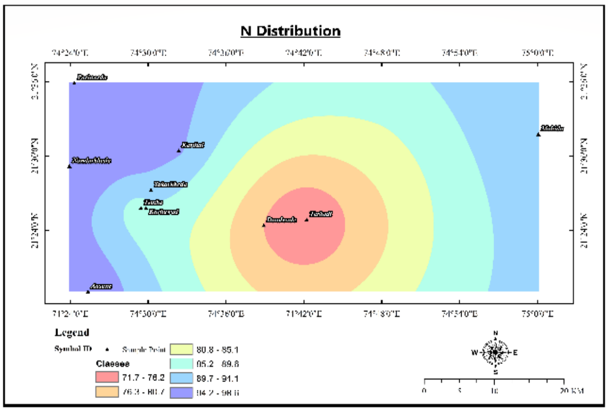

Fig. 4: Shows the Nitrogen (N) Kg/ha distribution in the Soil of Shahada Region

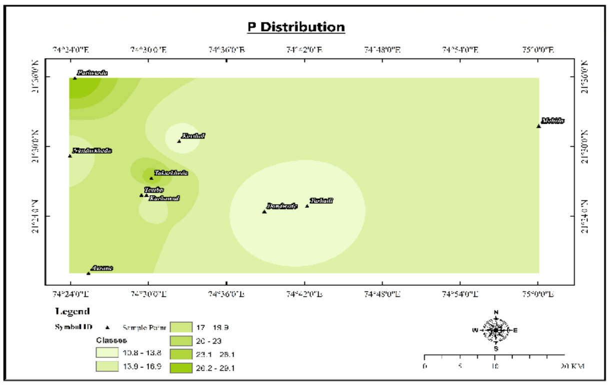

Fig. 5: Shows the Phosphorus (P) Kg/ha distribution in the Soil of Shahada Region

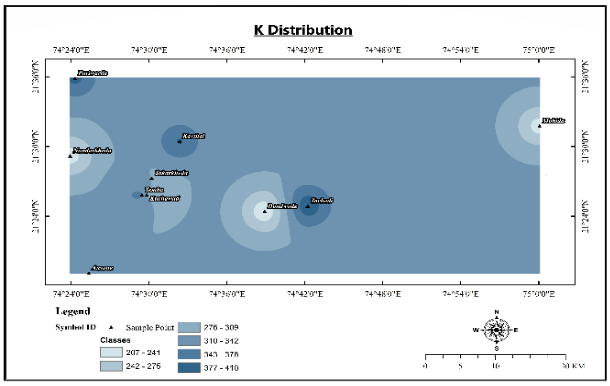

Fig. 6: Shows the Potassium (K) Kg/ha distribution in the Soil of Shahada Region

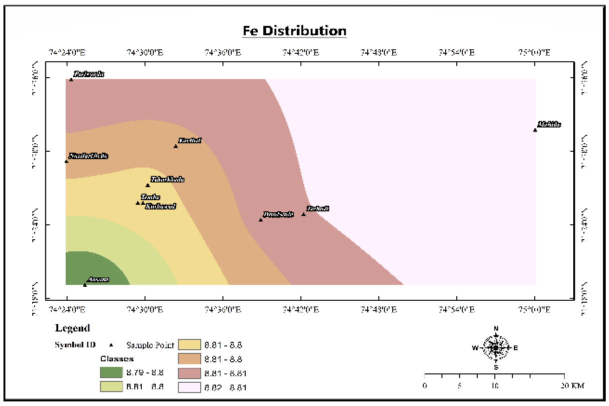

Fig. 7: Shows the Iron (Fe) Kg/ha distribution in the Soil of Shahada Region

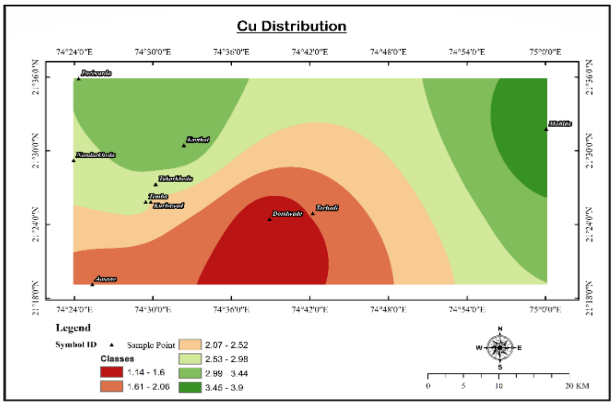

Fig. 8: Shows the Copper (Cu) Kg/ha distribution in the Soil of Shahada Region

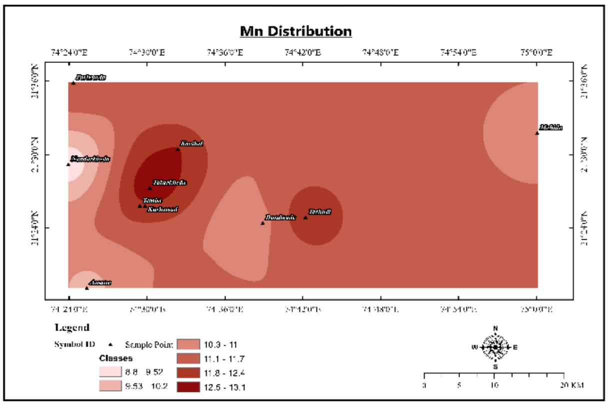

Fig. 9: Shows the Manganese (Mn) Kg/ha distribution in the Soil of Shahada Region

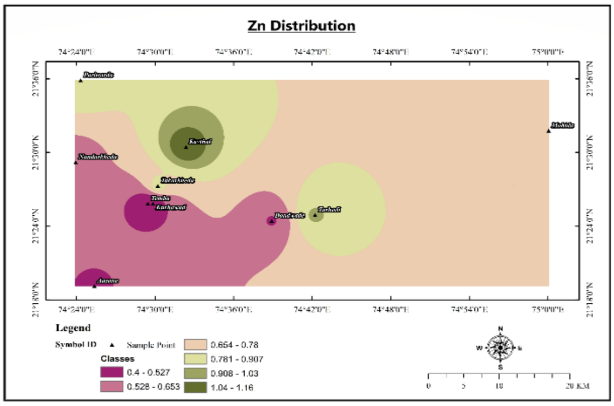

Fig. 10: Shows the Zinc (Zn) Kg/ha distribution in the Soil of Shahada Region

Phosphorus (P) is essential for agricultural productivity, playing a crucial role in crop maturation and root system development. Young seedlings particularly benefit from sufficient phosphorus availability. The phosphorus levels in the soil were assessed to be moderate, neither excessively high nor low. However, the factors influencing phosphorus availability to plants varied significantly across the region, with soil pH being a critical determinant. The phosphorus concentrations ranged from 10.80 to 29.12 kg/haas shown in fig. 5. Among the samples, sample ten had the highest phosphorus concentration at 29.12 kg/ha, while sample seven had the lowest at 10.80 kg/ha. The relatively high phosphorus levels in the soils of Shahada Region can be attributed to favourable pH conditions and substantial organic matter content, which together enhance soil quality and promote phosphorus availability. Potassium (K) is primarily found in the above-ground parts of plants. Therefore, returning crop residues to the soil aids in retaining a considerable amount of potassium. In the soil, potassium is a fundamental component of the mineral structure of various clay minerals, especially micas. However, in this mineralized form, potassium is not easily accessible to plant roots. The available potassium levels ranged from 206.16 to 410.60 kg/ha as shown in fig. 6, with sample nine showing the highest potassium concentration.

Soil analyses reveal that all samples exhibit elevated potassium levels, which can be attributed to the practice of returning crop residues to the soil and the increased use of organic fertilizers in the agricultural regions of Shahada Region. Although it lacks chlorophyll, potassium is essential for its synthesis. The iron concentration in the soil of Shahada Region ranges from 6.80 to 9.86 ppm as shown in fig. 7, with the lowest level found in sample number eight and the highest in sample number seven. Copper (Cu) is vital for plant growth, as it forms various compounds with amino acids and proteins within the plant system. The analysed samples show copper concentrations ranging from 1.14 to 3.90 parts per million (ppm) as shown in fig. 8. The lowest copper concentration was noted in sample number three, while the highest was recorded in sample number one, both sourced from Shahada Region. The manganese (Mn) distribution across varying soil depths did not reveal a distinct trend. The key determinants affecting Mn levels in the soil were found to be lime ($CaCO_3$) and clay content. In the Shahada Region, Mn concentrations ranged from 6.8 to 14.96 ppm as shown in fig. 9, with the lowest recorded in sample number two and the highest in sample number five. Zinc (Zn), an essential micronutrient for numerous plant enzymes, plays a vital role in enhancing water uptake in plants. The Zn concentrations varied between 0.40 and 1.16 ppm as shown in fig. 10, with the minimum observed in sample number six and the maximum in sample number four. The analysis of nutrient status suggests that the soils are classified as fertile, indicating a significant potential for production when appropriate fertilization strategies are implemented. It is imperative to conduct annual assessments of nutrient levels, particularly after the fresh siltation that occurs during the monsoon season.

The results indicate that most soil samples from Shahada Region in Nandurbar District possess medium levels of available phosphorus, whereas samples five, six and ten are categorized as high in phosphorus content. This increased phosphorus level may be a result of regular phosphatic fertilizer applications and the relatively low mobility of phosphate ions in the soil, leading to their accumulation. In soils with elevated phosphorus availability, there exists a heightened risk of zinc deficiency, underscoring the importance of judicious management of phosphatic fertilizer use. Furthermore, the micronutrients iron (Fe), copper (Cu), magnesium (Mg), and zinc (Zn) were found to be within the ranges respectively. A multitude of researchers have delved into the study of micronutrients within their respective fields, with significant contributions from various scholars, especially in the context of post-monsoon siltation. Noteworthy contributions to this area of research have been made by scholars such as Arunachalam et. al., (2013), Bafna and Thorat (2008, 2009), Deshmukh (2012), Doran et. al., (1996), Feller et. al., (2001), Fulpagare et. al., (2023), Ghodke et. al., (2016), Haque et. al., (2007), Kasetiya et. al., (2022), Lal et. al., (2003), Marathe and Sawant (2016), Parhad et. al., (2023), Sharma et. al., (2005), and Wienhold et. al., (2004).

IV. CONCLUSIONS:

The investigation indicates that the soils from ten samples gathered in the villages of Mohida, Nandarkheda, Dondwade, Kavthal, Takarkheda, Temba, Aasane, Tarhadi, and Pariwarda demonstrate alkaline characteristics. The soils in Shahada Region possess distinct morphological features and exhibit inadequate aggregate stability. The analyzed soil samples from this area presented a pH spectrum ranging from neutral to alkaline, were non-saline, and exhibited varying levels of calcium carbonate, from very low to high concentrations. In terms of nutrient availability, the soils were characterized by low available nitrogen, low to moderately high available phosphorus, and very high available potassium levels. Additionally, the organic carbon content varied significantly, showing a range from low to high. Notably, a significant negative correlation was observed between soil aggregate stability and soil electrical conductivity, with a significant level of five percent.

ACKNOWLEDGMENT:

Authors are gratefully acknowledged to the Director, School of Environmental and Earth Sciences. KBCNMU, Jalgaon for providing necessary laboratoryfacilities.

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