ISSN: **3107-6513**

# Evaluation of Soil Quality Index Based on Physico-Chemical Parameters in Gandhinagar Area of Ambikapur (C.G.)

Shailesh Kumar Dewangan[1], Dhaemendra Kumar Yadav[2].
Assistant Professor & HOD Department of Physics, Shri Sai Baba Aadarsh Mahavidyalaya, Ambikapur(C.G.).
[b]Students M.Sc.II[nd] Semester, Physics. Shri Sai Baba Aadarsh Mahavidyalaya, Ambikapur(C.G.).

**Abstract:**
*Soil quality assessment is essential for sustainable land use and agricultural productivity. The present study evaluates the Soil Quality Index (SQI) of soils collected from Gandhinagar area, Ambikapur (Chhattisgarh), based on selected physico-chemical parameters. Soil samples were collected from multiple sites and analyzed for pH, electrical conductivity (EC), organic carbon, macronutrients (nitrogen, phosphorus, potassium), and micronutrients such as zinc, iron, manganese, and copper using standard laboratory methods. The results indicate moderate variability in soil properties, with pH ranging from slightly acidic to neutral and EC values within permissible limits, suggesting non-saline conditions. Organic carbon and nutrient levels showed spatial variation, influencing overall soil fertility. The SQI was calculated using a weighted index approach, integrating key parameters to provide a comprehensive assessment of soil health. The findings reveal that soils in the study area are generally suitable for agriculture but require proper nutrient management practices to enhance productivity and sustainability.*

**Keywords:** Soil Analysis, Physico-Chemical Properties, pH, Electrical Conductivity (EC), Micronutrients.

## Introduction:

Soil is a fundamental natural resource that plays a vital role in sustaining terrestrial ecosystems and supporting agricultural productivity. It serves as a medium for plant growth, regulates water flow, and acts as a reservoir of essential nutrients. The quality of soil directly influences crop yield, environmental sustainability, and ecological balance. In recent years, increasing anthropogenic activities such as intensive agriculture, improper land use, and excessive use of chemical fertilizers have led to soil degradation, thereby affecting soil health and productivity. Therefore, evaluating soil quality has become crucial for effective land management and sustainable agricultural practices. Soil quality refers to the capacity of soil to function within natural or managed ecosystems to sustain plant and animal productivity, maintain environmental quality, and promote plant health. It is commonly assessed through a combination of physical, chemical, and biological properties. Among these, physico-chemical parameters such as pH, electrical conductivity (EC), organic carbon, macro-nutrients (nitrogen, phosphorus, potassium), and micro-nutrients (zinc, iron, manganese, copper) are widely used indicators due to their direct impact on soil fertility and crop growth. These parameters influence nutrient availability, microbial activity, and overall soil structure, making them essential for evaluating soil health.


The concept of Soil Quality Index (SQI) has been developed as an effective tool to integrate multiple soil parameters into a single quantitative value, providing a comprehensive assessment of soil condition. SQI simplifies complex soil data and helps in comparing soil quality across different locations and time periods. It also aids in identifying areas with nutrient deficiencies or degradation, thereby assisting policymakers, researchers, and farmers in making informed decisions regarding soil management and conservation.

The Gandhinagar area of Ambikapur, located in the Surguja district of Chhattisgarh, is an agriculturally important region where soil quality plays a significant role in determining crop productivity. However, variations in soil properties due to differences in land use patterns, cropping systems, and environmental factors necessitate a systematic evaluation of soil health in this region. Despite its importance, limited studies have been conducted to assess the integrated soil quality using a standardized index approach in this area.

Therefore, the present study aims to evaluate the Soil Quality Index of soils from Gandhinagar, Ambikapur, based on selected physico-chemical parameters. The study seeks to analyze the spatial variability of these parameters and to provide a comprehensive understanding of soil fertility status. The findings of this research will contribute to the development of sustainable soil management strategies and support agricultural planning in the region.

**Literature review:**

Soil quality has been widely recognized as a key factor influencing agricultural productivity, environmental sustainability, and ecosystem stability, making its evaluation an important area of research in soil science (Romaniuk et al., 2012) . Soil quality assessment involves the integration of various physical, chemical, and biological indicators to determine the functional capacity of soil within an ecosystem (Romaniuk et al., 2012) . Among these, physico-chemical parameters are most commonly used due to their direct influence on nutrient availability and plant growth (Gupta et al., 2022) .

Several studies have emphasized the importance of parameters such as pH, electrical conductivity (EC), organic matter, and essential nutrients in determining soil fertility and productivity (Gupta et al., 2022) . For instance, pH plays a crucial role in controlling nutrient solubility and microbial activity, while EC indicates the salinity status of soil (Selvaraju & Mahalakshmi, 2023) . Organic carbon is considered a key indicator of soil health as it affects soil structure, water retention, and biological activity (Selvaraju & Mahalakshmi, 2023) .

The concept of Soil Quality Index (SQI) has been developed to simplify the complex interactions of multiple soil parameters into a single value for better interpretation and comparison (Chandra

ISSN: 3107-6513

et al., 2017) . SQI integrates selected indicators such as pH, organic matter, phosphorus, potassium, and EC to classify soil into categories like good, moderate, or poor quality (Chandra et al., 2017) . This approach helps in identifying degraded soils and guiding appropriate management practices for sustainable land use (Chandra et al., 2017) .

Recent research has also highlighted the use of additive and weighted index methods for calculating SQI, which improve the accuracy and reliability of soil quality assessment (Abbas et al., 2024) . These methods involve assigning weights to different soil parameters based on their relative importance in influencing soil functions (Abbas et al., 2024) . Furthermore, studies have shown that spatial variability in soil properties can significantly affect SQI values, emphasizing the need for multi-site sampling and geospatial analysis (Abbas et al., 2024) .

In addition, advanced approaches have been proposed to enhance SQI by incorporating biological and morphological indicators along with physico-chemical properties, providing a more comprehensive evaluation of soil health (Zhang et al., 2024) . These integrated indices have shown strong correlations with crop yield and land-use patterns, highlighting their practical significance in agricultural planning (Zhang et al., 2024) .

Overall, existing literature demonstrates that the evaluation of soil quality using physico-chemical parameters and SQI is an effective method for assessing soil fertility and sustainability. However, region-specific studies are essential due to variations in soil characteristics influenced by local environmental conditions, land use, and management practices. Therefore, the present study focuses on evaluating the Soil Quality Index in the Gandhinagar area of Ambikapur to provide localized insights into soil health and support sustainable agricultural development.

## Materials and Methods:

### Soil Sampling

Soil samples were collected using standard and widely accepted procedures to maintain accuracy and reliability. Sampling was carried out at a depth of 15–30 cm, which corresponds to the active root zone of most crops, using a soil auger. The collected samples were air-dried at room temperature to remove excess moisture. After drying, the soil was gently crushed and passed through a 2 mm sieve to remove stones, plant roots, and other debris. The sieved soil was then thoroughly mixed to ensure uniformity and reduced using the quartering method to obtain a representative sample. A portion of this sample was further sieved through a 0.5 mm mesh and again reduced by quartering. Finally, a fine fraction suitable for detailed laboratory analysis was obtained by passing a part of the sample through a 0.02 mm sieve.

### Materials Used

The analysis was conducted using standard laboratory equipment and reagents. Instruments included a digital pH meter for determining soil acidity or alkalinity, an electrical conductivity meter for measuring salinity, an analytical balance for precise weighing, and an oven for drying samples. Laboratory glassware such as beakers, flasks, and pipettes were also used, along with specific chemical reagents required for analyzing different soil nutrients.

### Analytical Methods

Soil pH was measured using a digital pH meter in a soil-water suspension prepared in a 1:2.5 ratio. Electrical conductivity (EC) was determined with a conductivity meter to evaluate the concentration of soluble salts. Organic carbon content was estimated using the Walkley and Black wet oxidation method. Available nitrogen was analyzed by the Alkaline Permanganate method, while available phosphorus was determined using the Olsen method. Available potassium was measured with a flame photometer. Micronutrients such as zinc (Zn), iron (Fe),

copper (Cu), and manganese (Mn) were analyzed using standard extraction and determination techniques.

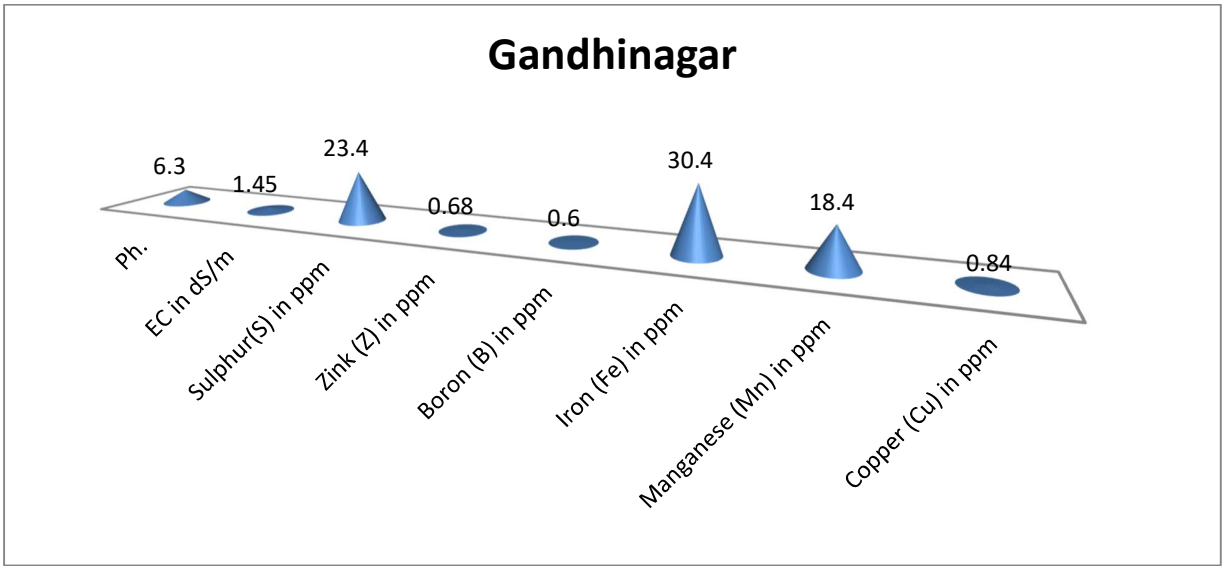
**Data Analysis**

The experimental data obtained from laboratory analyses were systematically recorded and interpreted to assess the physico-chemical characteristics and fertility status of the soil samples. The results derived from these analyses are presented and discussed in the following section.

**Table 1: Physico-chemical properties of soil sample taken from Gandhinagar.**

| 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 |
|---|---|---|---|---|---|---|---|
| 6.3 | 1.45 | 23.4 | 0.68 | 0.6 | 30.4 | 18.4 | 0.84 |

## Results and Discussion:




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

The physico-chemical analysis of the soil sample from Gandhinagar, Ambikapur reveals important information regarding soil fertility and suitability for agricultural use. The soil pH was recorded as **6.3**, indicating slightly acidic conditions. This pH range is generally considered favorable for most crops, as it enhances the availability of essential nutrients and supports microbial activity. Slight acidity also promotes better solubility of micronutrients such as iron and zinc. The electrical conductivity (EC) value was found to be **1.45 dS/m**, which indicates moderately saline soil conditions. While this level is not severely harmful, it may begin to affect sensitive crops and suggests the need for proper irrigation and soil management practices to prevent salinity buildup. The sulphur content (**23.4 ppm**) falls within the adequate range, indicating sufficient availability for plant growth. Sulphur is essential for protein synthesis and enzyme function, and its adequate presence supports healthy crop development.

Micronutrient analysis shows that zinc (**0.68 ppm**) is in the marginal to adequate range, suggesting that zinc supplementation may be beneficial for optimal crop yield. Boron content (**0.6 ppm**) is within the sufficient range, which is important for cell wall formation and reproductive growth in plants. Iron content (**30.4 ppm**) is relatively high and sufficient for plant requirements, ensuring proper chlorophyll formation and metabolic activities. Similarly,

ISSN: **3107-6513**

manganese (**18.4 ppm**) is present in adequate quantity, contributing to enzyme activation and photosynthesis. Copper concentration (**0.84 ppm**) is also within the acceptable range, supporting various physiological processes in plants, including lignin synthesis and respiration.

**Conclusion:**

The present study on the physico-chemical properties of soil from Gandhinagar, Ambikapur indicates that the soil is generally suitable for agricultural purposes with moderate fertility status. The soil pH (6.3) reflects slightly acidic conditions, which are favorable for nutrient availability and microbial activity. However, the electrical conductivity (1.45 dS/m) suggests moderate salinity, which may affect sensitive crops if not properly managed.

The sulphur content (23.4 ppm) is adequate, supporting essential plant metabolic functions. Micronutrients such as iron (30.4 ppm), manganese (18.4 ppm), and copper (0.84 ppm) are present in sufficient quantities, indicating no immediate deficiency concerns. Boron (0.6 ppm) is also within the optimal range for plant growth. However, zinc (0.68 ppm) is at a marginal level, which may limit crop productivity over time if not supplemented.

**References:**

1. Abbas, F., et al. (2024). Evaluation of soil quality through simple additive soil quality index (SQI). *Journal of the Saudi Society of Agricultural Sciences*.
2. Chandra, D. S., Asadi, S. S., & others. (2017). Empirical approach for estimation of soil quality index. *International Journal of Civil Engineering and Technology*.
3. Gupta, A., Chitranshi, S., Dwivedi, A., & Johri, S. (2022). Study of physico-chemical properties in industrial soils. *Agricultural Science Digest*.
4. Romaniuk, R., Giuffré, L., Costantini, A., Bartoloni, N., & Nannipieri, P. (2012). A comparison of indexing methods to evaluate soil quality. *Soil Research*.
5. Selvaraju, R., & Mahalakshmi, V. (2023). Soil quality assessment using physico-chemical parameters. *IRJIET*.
6. Zhang, Y., et al. (2024). A comprehensive soil quality index integrating multiple properties. *Soil & Tillage Research*.
7. Alloway, B. J. (2008). *Zinc in soils and crop nutrition*. International Zinc Association.
8. Brady, N. C., & Weil, R. R. (2016). *The nature and properties of soils* (15th ed.). Pearson.
9. Gupta, U. C. (2014). *Boron and its role in crop production*. CRC Press.
10. Kabata-Pendias, A. (2011). *Trace elements in soils and plants* (4th ed.). CRC Press.
11. Lindsay, W. L., & Norvell, W. A. (1978). Development of a DTPA soil test for zinc, iron, manganese, and copper. *Soil Science Society of America Journal*, 42(3), 421–428.
12. Marschner, P. (2012). *Marschner's mineral nutrition of higher plants* (3rd ed.). Academic Press. Richards, L. A. (1954). *Diagnosis and improvement of saline and alkali soils*. USDA.
13. Singh, M. V. (2015). Micronutrient deficiencies in Indian soils and field usable practices for their correction. *Indian Journal of Fertilisers*, 11(4), 94–112.
14. Tandon, H. L. S. (2013). *Methods of analysis of soils, plants, waters and fertilizers*. Fertiliser Development and Consultation Organisation.
15. Lindsay, W. L., & Norvell, W. A. (1978). Development of a DTPA soil test for zinc, iron, manganese, and copper. *Soil Science Society of America Journal, 42*(3), 421–428.
16. Richards, L. A. (1954). *Diagnosis and improvement of saline and alkali soils*. USDA Handbook 60.
17. Dewangan, S. K., Jaiswal, A., Shukla, N., Pandey, U., Kumar, A., & Kumari, N. (2022). Characterization of agriculture Soil of Gangapur area located in Latori, Surguja division of Chhattisgarh. International Journal of Science, Engineering And Technology, 11(1). Web-link. Researchget
18. Dewangan, S. K., Kumari, J., Tiwari, V., Kumari, L. (2022). Study the Physico-Chemical Properties of Red Soil of Duldula Area Located in Jashpur District, Surguja Division of Chhattisgarh, India. International

Journal of Scientific Research in Engineering and Management (IJSREM), 06(11), 1-5. Web-link , Researchget

19. Dewangan, S. K., Kumari, L., Minj, P., Kumari, J., & Sahu, R. (2023). The Effects of Soil pH on Soil Health and Environmental Sustainability: A Review. International Journal of Emerging Technologies and Innovative Research, 10(6), Web-link. Researchget
20. Dewangan, S. K., Kumari, L., Tiwari, V., Kumari, J. (2022). Study the Physio-Chemical Properties of Red Soil of Kandora Village of Jashpur District, Surguja Division of Chhattisgarh, India. International Journal of Innovative Research in Engineering (IJIRE), 3(6), 172-175. Web-link , Researchget
21. Dewangan, S. K., Minj, A. K., & Yadav, S. (2022). Study the Physico-Chemical Properties of Soil of Bouncing Land Jaljali Mainpat, Surguja Division of Chhattisgarh, India. International Journal of Creative Research Thoughts, 10(10), 312-315. Web-link , Researchget
22. Dewangan, S. K., Minj, P., Singh, P., Singh, P., Shivlochani. (2022). Analysis of the Physico-Chemical Properties of Red Soil Located in Koranga Mal Village of Jashpur District, Surguja Division of Chhattisgarh, India. International Advanced Research Journal in Science, Engineering and Technology, 9(11), 116-119. Web-link , Researchget
23. Dewangan, S. K., Sahu, K., Tirkey, G., Jaiswal, A., Keshri, A., Kumari, N., Kumar, N., Gautam, S. (2022). Experimental Investigation of Physico-Chemical Properties of Soil taken from Bantidand Area, Balrampur District, Surguja Division of Chhattisgarh, India. International Research Journal of Modernization in Engineering Technology and Science, 04(12), 751-755. Web-link. Researchget
24. Dewangan, S. K., Sahu, R., Haldar, R., & Kedia, S. (2022). Study the physico-chemical properties of black soil of girwani village of balrampur district, surguja division of chhattisgarh, india. Epra International Journal of Agriculture and Rural Economic Research (ARER), 10(11), 53-56. Web-link. Researchget
25. Dewangan, S. K., Sharma, G. K., & Srivasrava, S. K. (2022). Characterization of agriculture Soil of Gangapur area located in Latori, Surguja division of Chhattisgarh. International Journal of Science, Engineering And Technology, 11(1), 1-3. Web-link Researchget
26. Dewangan, S. K., Shrivastava, S. K., Kehri, D., Minj, A., & Yadav, V. (2023). A Review of the Study Impact of Micronutrients on Soil Physicochemical Properties and Environmental Sustainability. International Journal of Agriculture and Rural Economic Research (ARER), 11(6). Web-link. Researchget
27. Dewangan, S. K., Shrivastava, S. K., Soni, A. K., Yadav, R., Singh, D., Sharma, G. K., Yadav, M., & Sahu, K. (2023). Using the Soil Texture Triangle to Evaluate the Effect of Soil Texture on Water Flow: A Review. International Journal for Research in Applied Science & Engineering Technology (IJRASET), 11(6), 389-390. Web-link Researchget
28. Dewangan, S. K., Shrivastava, S. K., Soni, A. K., Yadav, R., Singh, D., Sharma, G. K., Yadav, M., & Sahu, K. (2023). Using the Soil Texture Triangle to Evaluate the Effect of Soil Texture on Water Flow: A Review. International Journal for Research in Applied Science & Engineering Technology (IJRASET), 11(6), 389-390. Web-link. Researchget
29. Dewangan, S. K., Singh, D., Haldar, R., & Tirkey, G. (2022). Study the Physio-Chemical Properties of Hair Wash Soil of Kardana Village of Jashpur District, Surguja Division of Chhattisgarh, India. International Journal of Novel Research and Development, 7(11), 13-17. Web-link , Researchget
30. Dewangan, S. K., Soni, A. K., & Sahu, K. (2022). Study the Physico-Chemical Properties of Rock Soil of Sangam River, Wadrafnagar, Surguja Division of Chhattisgarh, India. International Journal of Research and Analytical Reviews, 9(4), 119-121. Web-link . Researchget
31. Dewangan, S. K., Yadav, M. K., Tirkey, G. (2022). Study the Physico-Chemical Properties of Salt Soil of Talkeshwarpur Area Located in Balrampur District, Surguja Division of Chhattisgarh, India. International Research Journal of Modernization in Engineering Technology and Science, 4(11), 791-797. Web-link Researchget
32. Dewangan, S. K., Yadav, R., Haldar, R. (2022). Study the Physio-Chemical Properties of Clay Soil of Kandora Village of Jashpur District, Surguja Division of Chhattisgarh, India. EPRA International Journal of Research and Development (IJRD), 7(11), 87-91. Web-link Researchget
33. Dewangan, S. K., Yadav, V., Sahu, K. (2022). Study the Physio-Chemical Properties of Black Soil of Bahora Village of Jashpur District, Surguja Division of Chhattisgarh, India. International Research Journal of Modernization in Engineering Technology and Science, 04(11), 1962-1965. Web-link. Researchget
34. Dewangan, S.K., Kehri, D., Preeti . & Yadav, A.(2022). Study The Physico-Chemical Properties Of Brown Soil Of Gaura Village Of Surajpur District, Surguja Division Of Chhattisgarh, India. International Journal of Engineering Inventions,11(11),80-83. Web-link. Researchget

ISSN: **3107-6513**

35. Dewangana, S. K., Mahantb, M. (2023). Physical Characterization of Soil from BudhaBagicha Area, Balrampur, Chhattisgarh and its Comparative Study with Soils of Other Areas. International Journal of Science, Engineering and Technology, 11(6). Web-link. Researchget
36. Dewangana, S. K., Yadavb, N., & Preetic. (2023). A Study on the Physicochemical Properties of Soil of Butapani Area Located in Self-Flowing Water, Lundra Block, Surguja District, Chhattisgarh, India. EPRA International Journal of Research and Development (IJRD), 8(12). Web-link. Researchget
37. Lal, R. (2015). Restoring soil quality to mitigate soil degradation. Sustainability, 7(5), 5875-5895.
38. Prajapati, S., Singh, V., & Singh, S. (2019). Assessment of soil physicochemical properties in Korba district, Chhattisgarh. International Journal of Chemical Studies, 7(1), 281-286.
39. Singh, R., Kumar, A., & Sharma, S. (2015). Assessment of soil fertility and nutrient content in different locations of Chhattisgarh. Journal of Soil Science and Agricultural Engineering, 2(1), 32-37.