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Assessment and correlation of soil Physico-chemical properties with nutrient availability in Sendra block of VNMKV, Parbhani

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Abstract

Soil is a fundamental natural resource that supports agricultural productivity, environmental quality, and ecological sustainability. Accurate evaluation of soil properties is crucial for effective land-use planning and informed agricultural management. The present study was undertaken to assess the soil fertility status of the Sendra Block, VNMKV Parbhani through the integration of conventional soil analysis and geospatial techniques. A total of 80 surface soil samples were systematically collected and analyzed for key physico-chemical parameters and nutrient availability. The results indicated that the soils of the study area are predominantly dense in nature with textures ranging from clayey to clayey loam. The assessment of soil physical properties revealed that bulk density ranged from 1.32 to 1.62 Mg m^{-3} (mean: 1.47 Mg m^{-3}), particle density from 2.62 to 2.65 Mg m^{-3} (mean: 2.64 Mg m^{-3}), and porosity between 29.51% and 41.92% (mean: 34.64%), indicating moderate compaction with adequate pore space. The soil pH varied from 7.05 to 7.97 (mean: 7.69), classifying the soils as neutral to moderately alkaline. Electrical conductivity (EC) ranged from 0.14 to 0.43 dS m^{-1} (mean: 0.26 dS m^{-1}), suggesting non-saline conditions. Organic carbon content ranged from 0.16% to 0.57% (mean: 0.41%), reflecting low organic matter levels in Sendra Block. Calcium carbonate ranged between 5.21% and 13.7% (mean: 9.95%), categorizing the soils as moderately to strongly calcareous. Nutrient analysis indicated low nitrogen availability (108.17-190.34 kg ha^{-1} , mean: 123.69 kg ha^{-1}), low to medium phosphorus content (5.35-15.32 kg ha^{-1} , mean: 8.54 kg ha^{-1}), and high potassium levels (555.86 - 997.92 kg ha^{-1} , mean: 817.04 kg ha^{-1}). Sulphur ranged from 5.17 to 14.74 mg kg^{-1} (mean: 9.62 mg kg^{-1}), indicating a low to medium status. Among the micronutrients, iron ranged from 1.44 to 4.91 mg kg^{-1} (mean: 3.76 mg kg^{-1}), copper from 1.07 to 2.79 mg kg^{-1} , manganese from 7.43 to 15.16 mg kg^{-1} (mean: 12.44 mg kg^{-1}), zinc from 0.28 to 0.94 mg kg^{-1} (mean: 0.66 mg kg^{-1}), and boron from 0.34 to 0.84 mg kg^{-1} (mean: 0.54 mg kg^{-1}), reflecting medium to high availability across all 80 soil samples. Correlation analysis revealed significant relationships between phosphorus and pH ($r = 0.244$), sulphur and pH ($r = -0.269$), and zinc and calcium carbonate ($r = 0.227$).

Keywords: Sendra block, ecological sustainability, soil fertility, correlation analysis

Introduction

Soil is regarded as one of the most essential and irreplaceable natural resources as it underpins all forms of life (Das *et al.*, 2020)^[7]. For sustainable agricultural production it is crucial to thoroughly understand soil fertility in order to design and implement effective nutrient management strategies. The impact of soil management practices on fertility differs from one field to another field due to variations in local conditions across broader geographic regions. These variations influenced by a combination of physical, chemical, and biological factors, make soil test-based fertility management a practical method for improving crop productivity. Major indicators of soil fertility include essential macronutrients and secondary nutrients, organic matter, pH, micronutrients such as boron (B), iron (Fe), zinc (Zn), copper (Cu), manganese (Mn), as well as physical properties like texture, structure, and color (Brady and Weil, 2002)^[1]. An accurate understanding of these parameters is vital for formulating appropriate soil management practices that support effective crop planning.

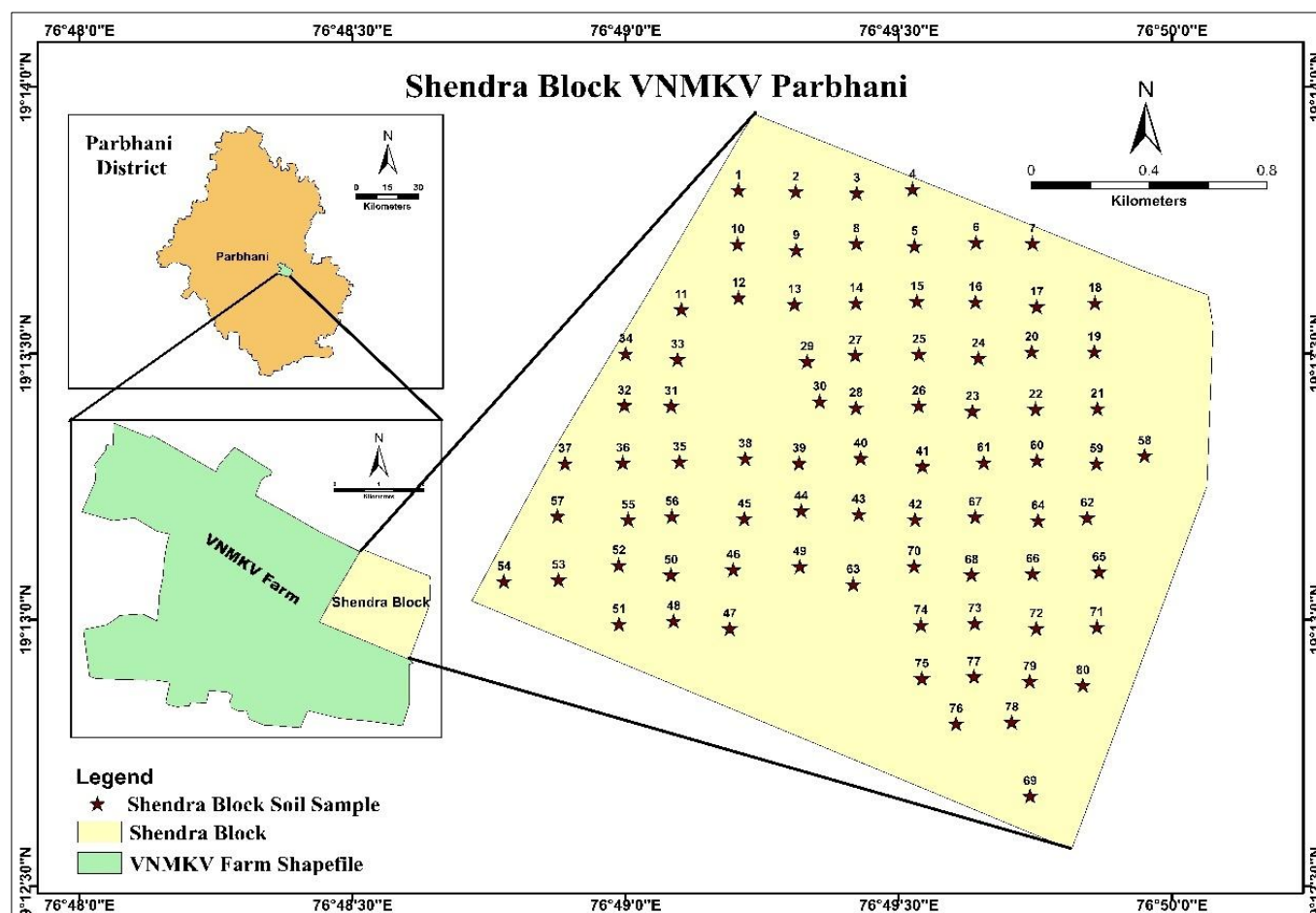
Understanding the physico-chemical properties of soil is fundamental to evaluating its fertility and optimizing nutrient management practices. Key parameters such as soil texture, pH, electrical conductivity (EC), organic carbon, and calcium carbonate content

critically influence nutrient availability, mobility, and retention. These properties interact dynamically with both macro and micronutrients, thereby affecting their solubility, transformation and uptake by plants. Assessment of these parameters provides essential insights into the soil's nutrient supplying capacity under varying environmental and management conditions. Soil pH governs nutrient speciation and bioavailability, whereas organic carbon enhances soil structure, microbial activity, and the retention of nutrients such as nitrogen and phosphorus. Likewise, electrical conductivity reflects the concentration of soluble salts which can either facilitate or inhibit nutrient absorption depending on their magnitude. Establishing correlations between physico-chemical characteristics and nutrient concentrations enables the identification of limiting factors and nutrient imbalances within the soil system. Such relationships form the basis for precision nutrient management and the sustainable application of fertilizers aligned with actual soil requirements. Consequently, comprehensive evaluation of soil physico-chemical properties and their association with

nutrient status is imperative for improving crop productivity, sustaining soil health and ensuring long-term agricultural sustainability.

2. Study Area

The Sendra Block of VNMKV, Parbhani district, lies between 76°48'0" - 76°50'0" E longitude and 19°12'30" - 19°14'0" N latitude at an elevation of 410 - 430 m above mean sea level. The region has a tropical climate with an average annual rainfall of 960.7 mm, mostly received from the Southwest Monsoon. In 2024 September recorded the highest rainfall (34.21% of the annual total). The mean maximum temperature ranges from 29 °C in December to 40 °C in May while the mean minimum varies from 13.2 °C in January to 24.3 °C in May. The highest and lowest temperatures recorded in 2024 were 44.0 °C and 4.1 °C respectively. Relative humidity ranges from 92% in September to 18% in March indicating hot, dry summers and cool winters.



3. Material and Methods

3.1 Collection of Soil Samples

Soil sampling was conducted at predefined grid points across the study area using a systematic grid sampling approach to ensure complete spatial coverage supported by ArcGIS software. A total of 80 surface soil samples (0-30 cm depth) were collected from each site with approximately 500-1000 g per sample, following the guidelines of the Soil Survey Staff (1975) [17]. The latitude and longitude of each sampling location were recorded using GPS Waypoint software. In the laboratory samples were air-dried at room temperature, gently crushed with a wooden mortar and

passed through a 2 mm sieve. Each sample was properly labeled and stored in polythene bags for subsequent laboratory analysis. For specific parameters, such as organic carbon estimation the samples were further ground and sieved through an 80-mesh screen.

3.2 Chemical Analysis of Soil Samples

Soil pH and electrical conductivity (EC) were determined using a 1:2.5 soil-to-water suspension. The pH was measured electrometrically with a digital pH meter, whereas EC was evaluated using the standard conductivity method. Calcium carbonate was quantified by the rapid titration

procedure described by Richard (1954) [16]. Organic carbon content was estimated using the modified Walkley and Black's back titration method, as outlined by Jackson (1973) [10]. Available nitrogen was analyzed through the modified Kjeldahl method (Jackson, 1973) [10], and available phosphorus was determined using the Olsen extraction method. Available potassium was extracted with 1 N ammonium acetate solution (pH 7.0). Available sulphur was measured turbidimetrically, following the procedure of Jackson (1973) [10]. Micronutrients including iron (Fe), manganese (Mn), zinc (Zn), and copper (Cu) were extracted using DTPA (0.005 M) and quantified by atomic absorption spectrophotometry, following Lindsay and Norvell (1978) [11]. Water-soluble boron was determined by hot water extraction and subsequent color development with Azomethine-H reagent, as described by Berger and Troug (1939) [2].

4. Results and Discussion

4.1 Chemical Properties of Soil

The soil pH is a fundamental chemical property that exerts a significant influence on nutrient availability, microbial dynamics, and overall soil fertility. It governs the solubility of minerals and determines the chemical forms in which nutrients are accessible to plants. In the Sendra block pH values range from 7.05 to 7.97 indicating a neutral to moderately alkaline reaction. This pH range is conducive to active microbial processes and enhanced macronutrient availability, corroborating the observations of Mali and Raut (2001) [12]. The Electrical Conductivity (EC) of soil serves as an indicator of salinity which affects nutrient mobility and plant growth. The EC values recorded in the Sendra block range between 0.14 and 0.43 dS m⁻¹ signifying low salinity levels that are favorable for agricultural production. The relatively low EC in certain soil samples can be attributed to efficient drainage conditions, which facilitate the leaching of soluble salts (Chandrashekhar *et al.*, 2014) [5]. Organic Carbon (OC) is a key determinant of soil fertility, contributing to improved nutrient retention, water-holding capacity, and microbial activity. The OC content in the Sendra block varies from 0.16 to 0.57 g kg⁻¹. The comparatively low organic carbon levels are likely due to the rapid decomposition of organic matter under hyperthermic climatic conditions (Bhanwaria, 2011) [3]. The Calcium (Ca) content in the soils of the Sendra block ranges

from 5.21 to 13.7 g kg⁻¹. The presence of calcium carbonate (CaCO₃) in these soils exerts a marked influence on soil pH, often increasing alkalinity, which may consequently affect nutrient solubility and plant nutrient uptake (Bolland, 1998) [4].

Table 1: Soil Chemical Status of Sendra Block VNMKV, Parbhani

Particulars	pH	EC (dSm ⁻¹)	OC (g/kg)	CaCO ₃ (g/kg)
Mean	7.69	0.16	3.30	94.10
Range	7.07- 8.10	0.10 - 0.39	1.60 - 6.30	48.60 -145.00

4.2 Macronutrient Status of Soil

Soil nutrients play a crucial role in ensuring healthy plant growth and optimal crop productivity. Among the essential macronutrients Nitrogen (N) is vital for vegetative growth and chlorophyll synthesis, Phosphorus (P) supports root development and energy transfer processes, Potassium (K) contributes to disease resistance, water regulation, and overall plant vigor, while Sulphur (S) is important for protein formation and enzymatic activity. In the soils of the Sendra Block of VNMKV nitrogen levels show considerable variation ranging from 108.17 to 190.34 kg ha⁻¹ with an average value of 123.69 kg ha⁻¹. The entire study area (100%) is categorized as having low nitrogen content which can be attributed mainly to the low organic carbon levels reported in the region (Pradeep, 2006). Phosphorus content in the area varies from 5.35 to 15.32 kg ha⁻¹ with an average of 8.54 kg ha⁻¹. Approximately 98.75% of the soils exhibit low phosphorus availability while only 1.25% fall under the medium category. Similar findings were reported by Waikar *et al.* (2004) [20], who observed available phosphorus ranging from 10.00 to 19.10 kg ha⁻¹ in soils from the south-central part of Maharashtra. The potassium (K) content ranges between 555.86 and 997.92 kg ha⁻¹ indicating relatively high levels of K₂O. This enrichment is largely due to the presence of potassium-rich minerals in the Vertisols and their associated soils as noted by Gajbe *et al.* (1976) [8]. Sulphur (S) concentrations in the soils range from 5.17 to 14.74 mg kg⁻¹. Higher sulphur levels are typically observed in the surface layers compared to the subsurface layers which may be attributed to the greater organic matter content in the upper soil horizons (Thangasamy *et al.*, 2005) [19].

Table 2: Status of Available Macronutrients in Soil of Sendra Block.

Particular	Available Macronutrient			
	N (kg/ha)	P (kg/ha)	K (kg/ha)	S (mg/kg)
Mean	123.69	8.54	817.04	9.62
Range	108.17 - 190.34	5.35 - 15.32	555.86 - 997.92	5.17 - 14.74
Critical limit	280	14	150	10
Sufficient	0%	1%	80%	35%
Deficient	80%	79%	0%	45%

4.3 Micronutrient status of soil

The iron (Fe) content in the soils of the Sendra Block ranges from 1.44 to 4.91 mg kg⁻¹ indicating a high level of available iron. Similar observations were reported by Patel *et al.* (2015) [13] who found elevated iron concentrations in the soils of central India largely attributed to iron-rich parent materials. The manganese (Mn) content varies from 7.43 to 15.16 mg kg⁻¹ also suggesting a high level of availability Patel *et al.* (2015) [13], similarly noted abundant manganese

in central Indian soils resulting from manganese-rich parent rock formations. The zinc (Zn) concentration ranges between 0.28 and 0.94 mg kg⁻¹ indicating a moderate level of this essential micronutrient. According to Dhamak *et al.* (2014) [6] zinc availability can vary from deficient to sufficient when compared with the critical threshold of 0.6 mg kg⁻¹. The copper (Cu) content lies between 1.07 and 2.79 mg kg⁻¹ suggesting moderate to high availability. Sharma *et al.* (2003) [18] reported comparable copper levels

(0.5 - 3.9 mg kg⁻¹) in the soils of the Nagpur district, Rajasthan. The boron (B) content ranges from 0.34 to 0.84 mg kg⁻¹. Soils in Maharashtra particularly those developed

on Vertisols and Inceptisols often exhibit variable boron availability, primarily influenced by soil texture, pH, and organic matter content. (Patil *et al.* 2010)^[14].

Table 3: Soil available micronutrients status of Sendra Block, VNMKV Parbhani.

Particular	Available Micronutrient				
	Cu (mg/kg)	Zn (mg/kg)	Fe (mg/kg)	Mn (mg/kg)	B (mg/kg)
Mean		0.66	3.76	12.44	0.54
Range	1.07 - 2.79	0.28 - 0.94	1.44 - 4.91	7.43 - 15.16	0.34 - 0.84
Critical limit	0.8	0.6	2.5	8	0.5
Sufficient	80%	49%	68%	77%	49%
Deficient	0%	31%	12%	3%	31%

4.4 Correlation between physico-chemical properties and available nutrients

Correlation analysis helps identify the influence of soil's physical and chemical properties on nutrient availability.

This understanding is vital for designing effective soil management practices to enhance fertility and improve crop productivity in the Sendra Block.

Table 4: Correlation between physico-chemical properties and available nutrients in soil samples of Sendra Block, VNMKV Parbhani.

Available Nutrients	pH	EC	OC	CaCO ₃
Nitrogen	-0.068	0.170	0.057	0.114
Phosphorus	*0.244	0.128	0.001	-0.086
Potassium	0.212	-0.066	0.071	-0.054
Sulphur	*-0.269	0.063	0.076	-0.216
Ferrous	-0.166	0.060	0.047	-0.085
Copper	-0.047	0.032	-0.143	-0.053
Manganese	0.028	-0.010	-0.058	-0.062
Zinc	0.056	0.207	-0.187	*0.227
Boron	-0.057	0.097	0.047	0.104

** Correlation significance @ 1% Level * Correlation significance @ 5% Level

The correlation coefficient ($r = 0.244$) indicates a weak positive relationship between soil pH and phosphorus availability. As pH increases phosphorus becomes slightly more available due to reduced fixation under less acidic conditions. Similar results were reported by Ghode (2020)^[9] in tamarind-growing soils of the Marathwada region. The correlation coefficient ($r = -0.269$) indicates a weak negative

relationship between soil pH and sulphur availability, suggesting that higher pH levels slightly reduce sulphur solubility and plant uptake. The correlation value of $*r = 0.227$ indicates a slight positive relationship, suggesting that calcium carbonate has a minor influence on increasing zinc availability in the soil.

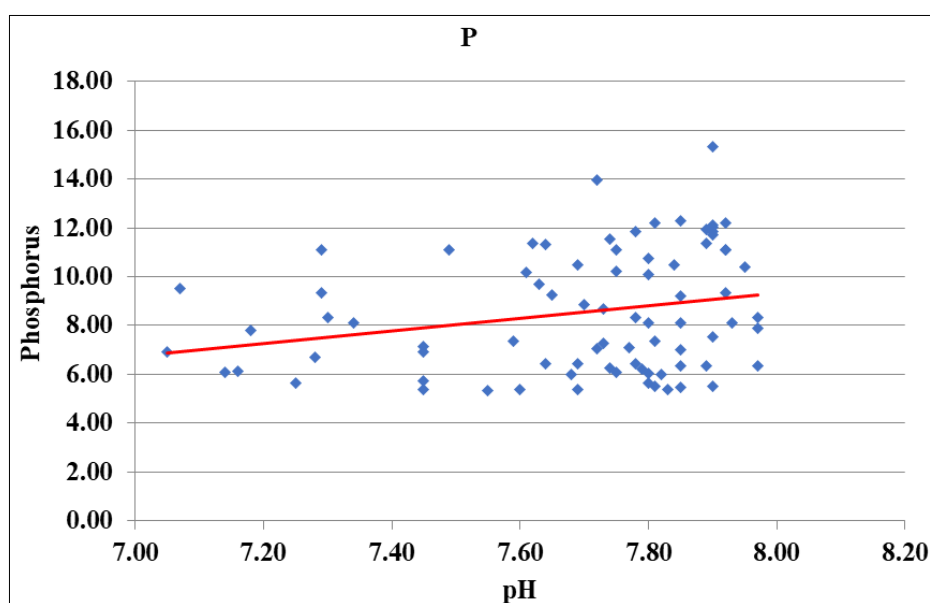


Fig 1: Relationship between (pH) and Phosphorus (kg/ha) in study area

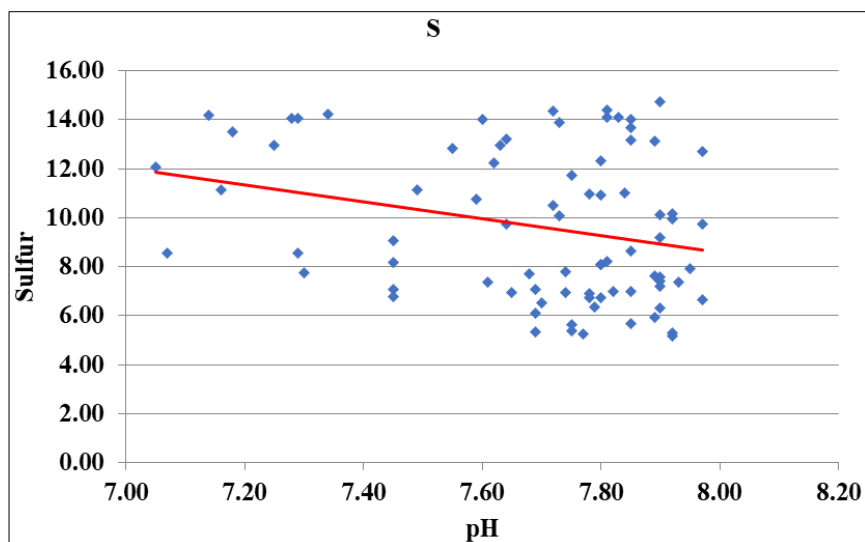


Fig 2: Relationship between (pH) and Sulfur (mg/kg) in study area

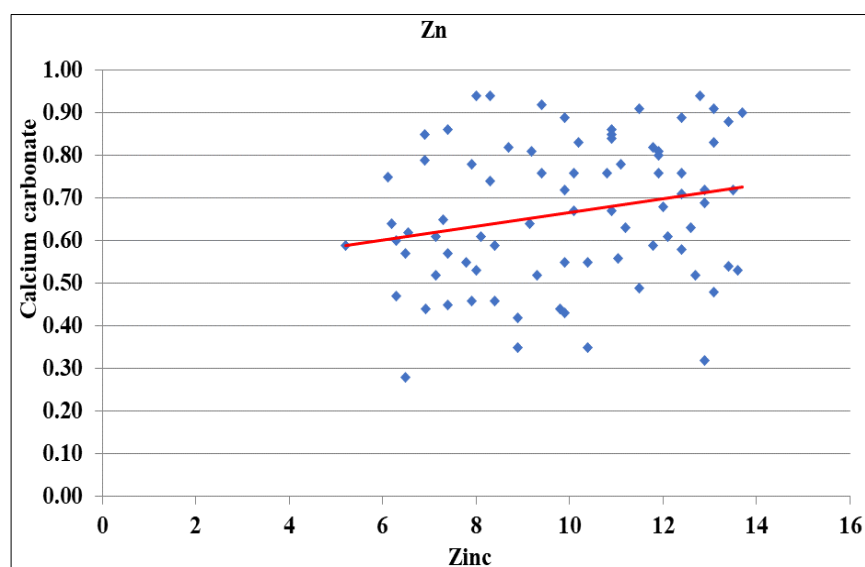


Fig 3: Relationship between calcium carbonate and Zinc (mg/kg) in study area

Conclusion

The predominant soil type in the Sendra Block is black cotton soil (Vertisols), characterized by high clay content, good water-holding capacity, moderate bulk density, and favorable porosity for crop growth. The soil pH ranges from neutral to slightly alkaline with low electrical conductivity indicating non-saline conditions suitable for irrigation. Organic carbon content is low suggesting the need for regular incorporation of organic matter to improve soil fertility. Calcium carbonate is present in moderate to high amounts potentially limiting the availability of some micronutrients. Nitrogen and phosphorus levels are low to medium whereas potassium content is sufficient. Sulphur levels are low to medium requiring supplementation for crops like oilseeds. Boron availability is generally low to moderate. Micronutrient analysis indicates variation in iron, copper, manganese, and zinc with some areas showing deficiencies. A positive correlation between zinc and calcium carbonate may result from localized mineralogical variations or historical fertilization practices. Overall, the soils of Sendra Block are suitable for agriculture but require integrated nutrient management to enhance organic matter and correct micronutrient deficiencies.

References

1. Brady NC, Weil RR. The nature and properties of soils. 13th ed. New Jersey: Prentice Hall; 2002.
2. Berger KC, Troug E. Boron determination in soils and plants. Industrial and Engineering Chemistry Analytical Edition. 1939;11(10):540-545.
3. Bhanwaria R. Studies on fertility status and mapping of soils of Bhilwara district of Rajasthan using GIS [dissertation]. Udaipur: Maharana Pratap University of Agriculture and Technology; 2011.
4. Bolland MDA. Influence of soil pH on nutrient availability. Journal of Agriculture Western Australia. 1998;39(4):230-233.
5. Chandrashekhara CP, Somashekar RK, Shivamurthy D. Assessment of soil fertility status using GIS in Varahi Command Area of Karnataka. International Journal of Advanced Research. 2014;2(9):553-560.
6. Dhamak AL, Deshmukh KK, Shinde DN. Status of available micronutrients in soils of Jalgaon district of Maharashtra. International Journal of Agricultural Sciences. 2014;10(1):157-160.

7. Das DK, Mandal B, Patra AK. Soil fertility and nutrient management. 2nd ed. New Delhi: Indian Council of Agricultural Research (ICAR); 2020.
8. Gajbe RS, Tomar VS, Tiwari KN. Status of potassium in swell-shrink soils (*Vertisols*) of Madhya Pradesh. *Journal of the Indian Society of Soil Science*. 1976;24(3):273-279.
9. Ghode MK. Studies on evaluation of *Tamarindus indica* growing soils of Marathwada region of Maharashtra [dissertation]. Parbhani: Vasantrya Naik Marathwada Krishi Vidyapeeth; 2020.
10. Jackson ML. Soil chemical analysis. 2nd ed. New Delhi: Prentice Hall of India Pvt. Ltd.; 1973.
11. Lindsay WL, Norvell WA. Development of a DTPA soil test for zinc, iron, manganese, and copper. *Soil Science Society of America Journal*. 1978;42(3):421-428.
12. Mali CV, Raut VR. Effect of soil reaction on availability of nutrients. *Journal of Maharashtra Agricultural Universities*. 2001;26(2):235-237.
13. Patel MS, Patel KP, Maji AK. Micronutrient status of soils in relation to parent material and land use in central India. *Agropedology*. 2015;25(2):166-172.
14. Patil RG, More SR, Ghodpage RM. Micronutrient status of soils in different tehsils of Sangli district (Maharashtra). *Journal of Soils and Crops*. 2010;20(1):123-126.
15. Pradeep S. Studies on soil fertility status and crop response in selected soils of Karnataka [dissertation]. Dharwad: University of Agricultural Sciences; 2006.
16. Richards LA. Diagnosis and improvement of saline and alkali soils. USDA Handbook No. 60. Washington, D.C.: U.S. Department of Agriculture; 1954.
17. Soil Survey Staff. Soil Survey Manual. USDA Handbook No. 18. Washington, D.C.: U.S. Department of Agriculture; 1975.
18. Sharma BL, Arora H, Ghosh AB. Micronutrient status in soils of Nagpur district, Rajasthan. *Journal of the Indian Society of Soil Science*. 2003;51(4):532-534.
19. Thangasamy A, Naidu MVS, Ramavatharam N, Raghava Reddy C. Characterization, classification, and evaluation of soils on different landforms in Ramadugu Mandal of Karimnagar District in Andhra Pradesh for sustainable land use planning. *Agropedology*. 2005;15(2):58-67.
20. Waikar SL, Kharche VK, Patil RG. Status of available phosphorus and its relationship with soil characteristics in soils of Latur District (Maharashtra). *Journal of Soils and Crops*. 2004;14(1):144-147.