Environment and Ecology 42 (4B) : 1843—1852, October—December 2024
Article DOI: https://doi.org/10.60151/envec/UCPI2827
ISSN 0970-0420

Assessment of Soil Quality of Different Villages in Chauth Ka Barwara Block in Sawai Madhopur District, Rajasthan

Kamlesh Kumar Akhand, Y.V. Singh, Prem Kumar Bharteey, Rajesh Kumar, Kajal Singh, Ayush Bahuguna, Ramawatar Meena

Received 5 September 2024, Accepted 3 November 2024, Published on 16 December 2024

ABSTRACT

A study was conducted to assess the soil quality of Chauth Ka Barwara block in Sawai Madhopur district, Rajasthan. A total of thirty soil samples were collected at a depth of 0–15 cm. The samples were obtained at regular intervals of around 1 km, utilizing a random sampling approach. The soil samples were air dried in a shade area at room temperature, grind into a fine powder using a ceramic mortar, and filtered a 2 mm sieve and subsequent physico-chemical analysis. The results showed the bulk density (1.12–1.46 g cm^{-3}), particle density (2.22–2.92 g cm^{-3}), porosity (38.72–52.35%), water holding capacity (27.30-44.92%), pH (6.2–8.2), electrical conductivity (0.11–0.89 dS m^{-1}), organic carbon (0.16–0.99%), available nitrogen (62.72–188.16 kg ha^{-1}), available phosphorus (6.72-52.86 kg ha^{-1}), available potassium (246.4–397.5 kg ha^{-1}), available sulfur (1.11–12.26 kg ha^{-1}), available calcium (1.10–25.5 meq 100^{-1}), available magnesium(1.8–23.6 meq 100^{-1}), available iron (1.80–7.40 mg kg^{-1}), available manganese (1.50–8.10 mg kg^{-1}), available copper (0.11–2.30 mg kg^{-1}), and available zinc (0.10–4.30 mg kg^{-1}). The analysis reveals that 43.33% of the samples demonstrate a moderately alkaline response, 6.66% produce a strongly alkaline reaction, and 26.66% present a neutral reaction. 90% of samples fall within the acceptable range while 10% exceed it marginally. The organic carbon content is classified as low at 53.33%, high at 16.66%, and medium at 30%. The study emphasizes the vital significance of soil fertility in fostering sustainable agricultural output.

Keywords Macronutrient, Micronutrient, Physico-chemical properties, Soil quality.

INTRODUCTION

Soil plays a crucial role in determining agroecosystem's sustained productivity because it provides vital nutrients for plant growth (Jones 2012). It was noted that various factors such as the interplay between the key nutrients affect the ability of plants to uptake macronutrients and micronutrients (Fageria *et al.* 2016). Soil deterioration is becoming more common due to

Kamlesh Kumar Akhand[1], Y. V. Singh[2], Prem Kumar Bharteey[3]*, Rajesh Kumar[4], Kajal Singh[5], Ayush Bahuguna[6], Ramawatar Meena[7]

[2]Associate Professor, [3,4,6,7]Assistant Professor
[1,2,5,7]Department of Soil Science & Agricultural Chemistry, Institute of Agricultural Sciences, BHU, Varanasi 221005, UP, India

[3]Department of Agricultural Chemistry and Soil Science, CCRD College, Muzaffarnagar 251001, UP, India

[4]Department of Agronomy, Kissan (PG) Simbhaoli, Hapur 245207, UP, India

[6]Department of Agricultural Chemistry & Soil Science, CCR (PG) College, Muzaffarnagar 251001, UP, India
Email: prembharti406@gmail.com
*Corresponding author

both natural processes and human activities, thereby affecting production. As the human population grows, there is an increasing need for the soil to supply vital minerals for food and fiber production (Verma *et al.* 2023). Regrettably, the soil's intrinsic capacity to provide these nutrients has decreased, mostly because of the increasing plant yield linked to a growing need for food. Currently, a significant challenge lies in the progress and use of soil, crop and nutrient management techniques that improve the productivity of plants. While maintaining the quality of soil water and air. The process of evaluating soil fertility entails measuring the amount of readily available plant nutrients and assessing the soil's capacity to continuously supply minerals to crops over a prolonged period (FAO 2020). Factors influencing nutrient availability include soil type, irrigation methods, pH levels, and organic matter content. Singh *et al.* (2016) suggest that physical, chemical and biological processes lead to deterioration in terms of productivity or fertility in soil quality. Comprehending and dealing with these deterioration processes are crucial requirements for adopting suitable conservation efforts to oversee and protect our natural resource foundation. Sand, salty, alkaline, and calcareous soils, also known as clay, loamy and black lava soils, make up the majority of Rajasthan's soil types. The region has a significantly low groundwater level, mostly because of the average annual rainfall of around 360 mm. Consequently, one can access groundwater at depths ranging from 100 to 61 meters. Three agro-climatic zones divide Rajasthan: Zone VI, encompassing the Trans-Genetic Plains region, Zone VIII, encompassing the Central Plateau and Hills region and Zone XIV, symbolizing the Western Dry region. The USDA and Division program classifies the soil in Rajasthan into different categories. These categories include aridisols, alfisols, entisols, inceptisols, and vertisols. Scientists have conducted a limited investigation into the fertility condition of soils in the Chauth Ka Barwara block within the Sawai Madhopur District region, noting differences in nutrient availability. The soils in the Chauth Ka Barwara block typically have a pH that ranges from neutral to alkaline. They have low levels of organic carbon and available nitrogen, while available phosphorus amounts are moderate and available potassium amounts are high. In addition, scientists discovered a shortage of sulfur in the settlement's soils. To gain a thorough understanding fertility of soil in the area or block, it is necessary to analyze a substantial number of samples from different places. Although the current findings offer vital insights into the fertility level of the block, a full assessment requires a broader scope of analysis adopting this technique is crucial for efficiently strategizing and executing policies for the management of nutrients and fertilizers in the region. To fulfil this requirement, we gathered a substantial quantity of soil samples from the Chauth Ka Barwara area for this study and assessed the soil's fertility level for both macronutrients and micronutrients. Furthermore, the research sought to demonstrate and explain the diversity in soil fertility levels at the block level. We also attempted to identify connections between the soil's nutrient content and important soil characteristics. The present study aims to assess the macronutrient concentrations in Chauth Ka Barwara soils and investigate any potential associations with other soil characteristics. This analysis yielded useful insights into recognizing inadequacies in different components and calculating the optimal application of fertilizers based on their condition. The study conducted an examination of the macronutrient levels and their correlation with the physico-chemical characteristics of the soils in the Chauth Ka Barwara block, located in the Sawai Madhopur District of Rajasthan.

MATERIALS AND METHODS

Current study area

Chauth Ka Barwara block situated in Sawai Madhopur District of Rajasthan, spans from 26.0505°N to 76.1530°E (Fig. 1). It is 135 meters above sea level on average. The Chauth Ka Barwara block has a total geographic area of 3050.13 hectares. The climate of Chauth Ka Barwara is more sub-humid than that of ordinary semi-arid Rajasthan. Approximately 510 mm of rain falls in this territory each year on average and it rains from July to September. Only during the monsoon months does the humidity increase. It remains dry for almost the entire year. Summers are hot and the temperature during the peak summer months of May–June exceeds 43°C. In the winter months that stretch from November to February, the

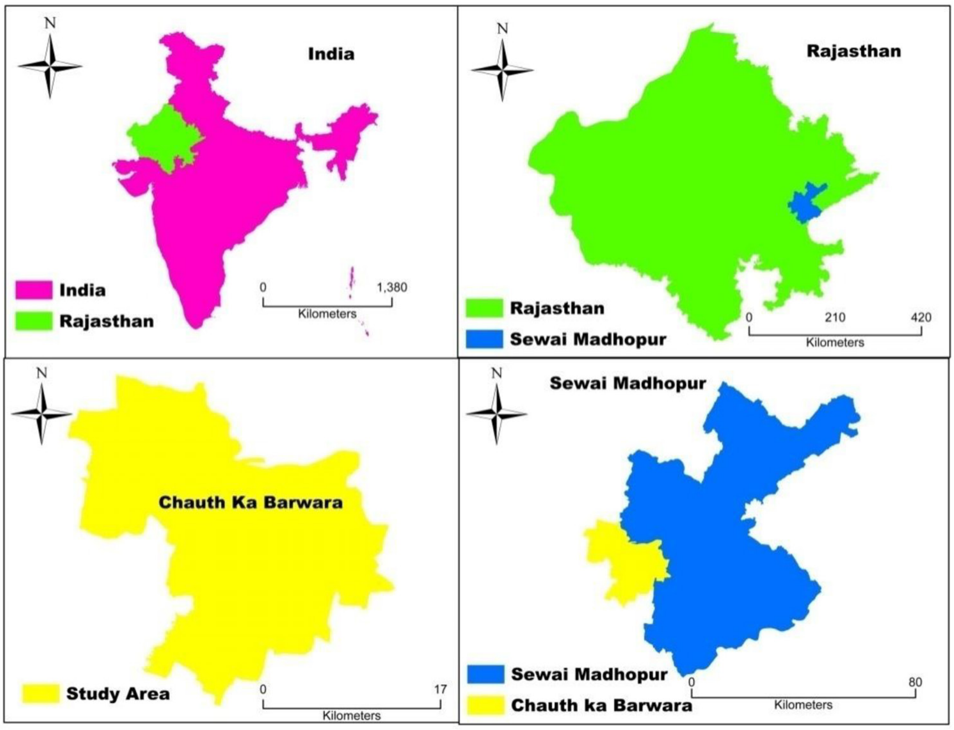

Fig. 1. Study area map.

average temperature is low, around 22°C, but the lowest temperature drops to range from 5–6°C.

Soil sample collection, processing and analysis

Thirty representative soil samples (0–15 cm) were collected in 2023 using a spade, from six distinct communities in the Chauth Ka Barwara block. Five samples of dirt were taken from every village. Jola (V1), Manpur (V2), Rajwana (V3), Ratanpura (V4), Roopnagar (V5), and Shiwar (V6) are some of these settlements. Before sampling, first clear away any grass, dead plants, and other leftover debris. Make "V" shaped cuts at random intervals between 0 and 15 cm deep, and then gather soil samples in a labeled polythene bag. The collected soil samples were transferred to the laboratory for soil physico-chemical analysis. To begin with, these samples were carefully dried in the shade to ensure accuracy in subsequent processing steps. The first step in the process involved removing any unwanted materials such as roots and stones from the samples. Additionally, clods present in the samples were broken down using a wooden mallet. Following this, the samples were sieved using a 2 mm sieve to ensure uniformity. After being sieved, the samples were carefully placed in polybags to be examined subsequently for a variety of physico-chemical characteristics. The bulk density and particle density were determined by a pycnometer as described by Black (1965). Pore volume was calculated by employing the values of the bulk and the particle densities. The water holding capacity was estimated by using the keen box method (Piper 1966). Electrical conductivity was recorded using EC meter while pH was done using the potentiometric procedure whereby a 1:2.5 dilution was prepared, environmental soil water suspension (Jackson *et al.* 1973). Organic carbon was determined by the potassium dichromate acetic acid titration according to the Walkley and Black (1934) method. There was use of the alkaline potassium permanganate method as described by Subbiah and Asija (1956), as well as Kjeltech semi-automatic nitrogen analyzer. An analysis of the available phosphorus was carried out using Olsen method which was developed by Olsen *et al*. (1954). Potash was assayed, using flammable photometer with normal neutral ammonium acetate as an extractant (Hanway and Heidal 1952). To assess the levels of exchangeable calcium and magnesium Versanate titration was used as described by Cheng and Bray (1951). Available sulfur was also analyzed using the turbimetric method using a spectrophotometer based on the Chesnin and Yien method (1950). The micronutrients were analyzed using an Atomic Absorption spectrophotometer applying the DTPA method (Lindsay and Norvell 1978) concerning the micronutrient concentration to the soil solution.

Statistical analysis

Snedecor and Cochran (1967) technique for doing simple statistical analysis was used. These analyses included maximum, minimum, mean, CV, correlation and PCA analysis. GIS and SPSS software were used to conduct spatial and statistical analysis.

RESULTS AND DISCUSSION

Physical properties

The data revealed that soil samples' bulk density values ranged from 1.12 to 1.46 Mg m^{-3}, with a mean value of 1.37 Mg m^{-3} (Table 1). The standard deviation of bulk density is 0.06, and the coefficient of variation is 4.67%. The lowest bulk density was observed in Rajwana village (sample 14) due to the high organic carbon content in Rajwana village (1.43%). The highest bulk density was observed in Roopnagar village (sample 22) because of the low organic carbon content in the village (0.63%) and soil compaction by intensive agriculture practices. So the study reveals that the bulk density depends on the consolidation of the soil and compaction, but it is negatively correlated to the organic content (Fig. 2). Similar results were also recorded by Lelago and Buraka (2019). The particle density values ranged from 2.22 to 2.92 Mg m^{-3} with a mean value of 2.62 Mg m^{-3} (Table 1). The standard deviation of particle density is 0.16, and the coefficient of variation is 5.94%. The lowest particle density was observed in Rajwana village (sample 14) and highest in Jola (sample 3) village. The values of porosity ranged from 38.72 to 52.35%, with a mean value of 47.84% (Table 1). The lowest porosity was observed in Shiwar (sample 27) village whereas the highest value for porosity was observed in Manpura village (sample 9). The standard deviation value of porosity is 3.03, and the coefficient of variation is

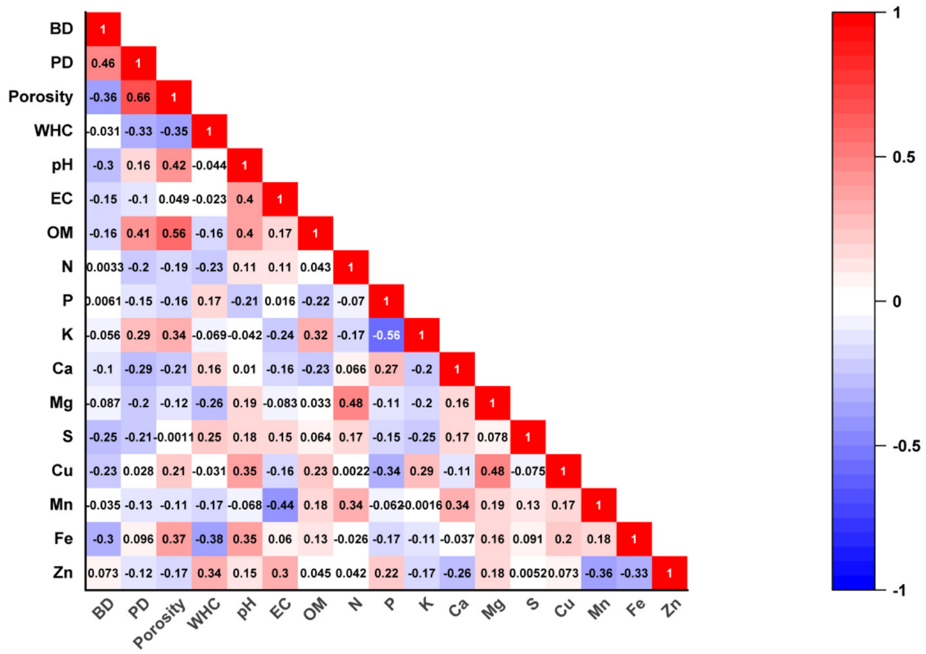

Fig. 2. Correlation between soil physico-chemical properties of the study area.

Table 1. Statistical data of soil physico-chemical parameters of different villages of Chauth Ka Barwara block of Sawai Madhopur district in Rajasthan.

Soil parameters	Range	Mean	SD	CV (%)
BD (g cm^{-3})	1.12-1.46	1.37	0.06	4.67
PD (g cm^{-3})	2.22-2.92	2.62	0.16	5.94
Porosity (%)	38.72-52.35	47.84	3.03	6.33
WHC (%)	27.30-44.92	34.81	4.73	13.59
pH	6.2-8.5	7.36	0.61	8.34
EC (dS m^{-1})	0.11-0.89	0.40	0.24	61.32
OC (%)	0.16-0.99	0.49	0.21	41.71
Av N (kg ha^{-1})	62.72-188.16	128.87	28.32	21.97
Av P (kg ha^{-1})	6.72-52.86	25.43	9.92	39.00
Av K (kg ha^{-1})	246.4-397.6	307.66	38.72	12.59
Ex Ca (Meq/ 100 g)	1.1-25.5	12.01	5.95	49.50
Ex Mg (Meq/ 100 g)	1.8-23.6	11.82	5.50	46.55
Av S (mg kg^{-1})	1.11-12.26	4.31	2.56	59.39
Av Fe (mg kg^{-1})	1.80-7.40	4.65	1.60	34.45
Av Mn (mg kg^{-1})	1.50-8.10	5.03	1.55	30.89
Av Cu (mg kg^{-1})	0.11-2.30	0.44	0.46	105.15
Av Zn (mg kg^{-1})	0.10-4.30	0.97	1.15	119.26

6.33%. The soil's porosity mainly depends on the pore space in the soil and its bulk density. Shiwar village showed the lowest porosity due to a high bulk density. The values of porosity ranged from 38.72 to 52.35%, with a mean value of 47.84% (Table 1). The lowest porosity was observed in Shiwar (sample 27) village whereas the highest value for porosity was observed in Manpura village (sample 9). The standard deviation value of porosity is 3.03, and the coefficient of variation is 6.33%. The soil's porosity mainly depends on the pore space in the soil and its bulk density. Shiwar village showed the lowest porosity due to a high bulk density. The soil samples' water holding capacity ranged from 27.30 to 44.92%, with an average value of 34.81% (Table 1). The standard deviation of water holding capacity is 4.73, and the coefficient of variation is 13.59%. The lowest water holding capacity was observed in village Ratanpura (sample 16) due to low organic carbon content. In contrast, the highest water holding capacity 44.92% was in Shiwar (sample 27) village, as there is a high

Table 2. Percentage-wise distribution of soil chemical and nutrient properties of Chauth Ka Barwara block (Ramamoorthy and Bajaj 1969).

Parameters	Range	Class	Total number of samples	Percentage of samples
pH	6.1-6.5	Slightly acidic	2	6.66
	6.6-7.3	Neutral	8	26.66
	7.4-7.8	Slightly alkaline	5	16.66
	7.9-8.4	Moderately alkaline	13	43.33
	8.5-9.0	Strongly alkaline	2	6.66

Table 2. Continued.

Parameters	Range	Class	Total number of samples	Percentage of samples
EC (dS m^{-1})	<0.7	All crops	27	90
	0.7-2.0	Most crops	3	10
	2.0-10.0	Salt tolerant	-	-
	10-32	Most halophytes	-	-
	>32	No crops	-	-
OC (%)	<0.5	Low	16	53.33
	0.5-0.75	Medium	9	30
	>0.75	High	5	16.66
Av N (kg ha^{-1})	<280	Low	21	70
	280-560	Medium	8	26.66
	>560	High	1	3.33
Av P (kg ha^{-1})	<12.5	Low	4	13.33
	12.5-25	Medium	14	46.66
	>25	High	12	40
Av K (kg ha^{-1})	<135	Low	0	0
	135-335	Medium	23	76.66
	>335	High	7	23.33
Av S (kg ha^{-1})	<10	Low	29	96.66
	10-20	Medium	1	3.33
	>20	High	0	0
Av Ca (cmol (P+) kg^{-1})	<1.5	Deficient	-	-
	>1.5	Sufficient	30	100
Av Mg (cmol (P+) kg^{-1})	<1.0	Deficient	-	-
	>1.0	Sufficient	30	100
Available Fe (mg kg^{-1})	<4.50	Deficient	12	40
	4.50-9	Sufficient	18	60
	>9	High level	0	0
Available Mn (mg kg^{-1})	<3.5	Deficient	3	10
	3.5-7.0	Sufficient	24	80
	>7.0	High level	3	10
Available Zn (mg kg^{-1})	<0.60	Deficient	18	60
	0.60-1.2	Sufficient	5	16.66
	>1.2	High level	7	23.33
Available Cu (mg kg^{-1})	<0.20	Deficient	11	36.66
	0.20-0.40	Sufficient	4	13.33
	>0.40	High level	15	50

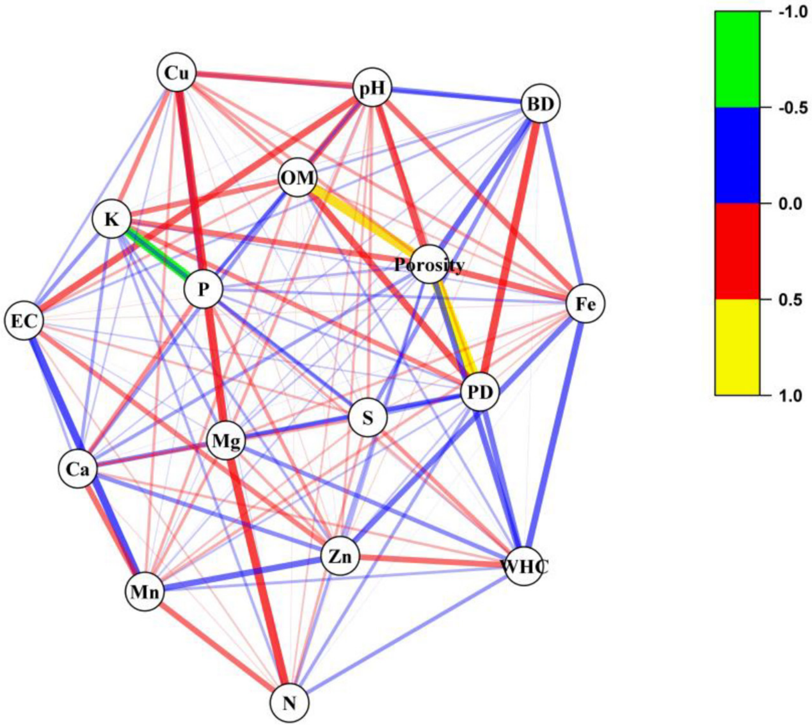

Fig. 3. A network analysis of soil physico-chemical and nutrient properties of Chauth Ka Barwara block.

organic carbon content of the village. The result shows that variation in water holding capacity is due to organic carbon content in the soil. Similar results were also reported by Tale and Ingole (2015).

Chemical properties

The pH levels of studied soils was varied between 6.2 and 8.5. Roopnagar village (sample 21) had the lowest pH, whereas Roopnagar village (sample 22) had the highest pH, with a standard deviation (SD) value of 0.61 and a coefficient of variation (CV) value of 8.34% (Table 1). In the research area, the Chauth Ka Barwara block has a majority of cultivated lands with a pH of 43.33%, indicating a moderately alkaline nature. Additionally, areas classified as severely alkaline have a pH of 6.66% (Table 2). According to Choudhary *et al.* (2024), the remaining 26.66% of soils have a neutral response. The electrical conductivity (EC) of the soil samples varied between 0.11 and 0.89 dS m^{-1}. The hamlet of Ratanpura in the Chauth Ka Barwara block (sample 19) exhibited the lowest EC value, whereas the village of Ratanpura (sample 17) had the highest value. The soil samples' pH and EC have a strong positive connection (r= 0.687**), which was significant for the entire sample at levels of significance (Fig. 2). Additionally, there was a significant positive correlation (r= 0.222*) with nitrogen. A similar favorable non-significant connection between phosphate and soil sample pH (r= 0.81) was found by Bharteey *et al.* (2023).

For soil electrical conductivity (EC), the standard deviation (SD) and coefficient of variation (CV) were 0.24 and 61.32%, respectively (Table 1). According to the results, only 10% of the samples slightly overflowed the permitted limit, with the other 90% of samples falling within the allowed range. The organic carbon content of the soil samples ranged from 0.16% to 0.99%. The coefficient of variation for the organic carbon was 41.71, with a standard deviation of 0.21. Based on the results, 53.33% of the samples in Chauth Ka Barwara had low levels of organic carbon content, 16.66% had high levels of organic carbon content, and

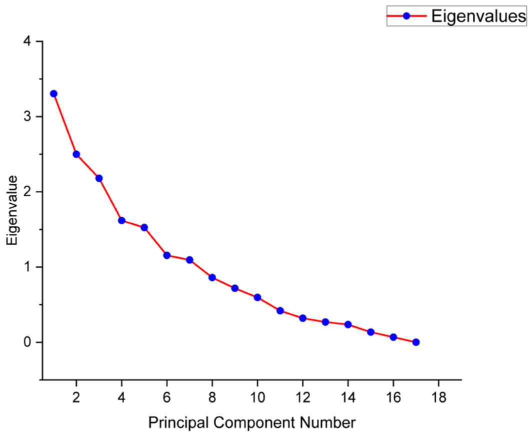

Fig. 4. Scree plot showing Eigenvalue.

the other 30% had medium levels of organic carbon content (Table 2). The organic matter and Nitrogen had a positive correlation (Fig. 2), similar results were also found by Sharma *et al.* (2022).

Available primary nutrients

Table 1 data examination leads to the conclusion that most of the region has limited nitrogen accessibility. The nitrogen concentration in the soil samples ranged from 100.35 to 602.11 kg ha^{-1}, with an average value of 208.86 kg ha^{-1}. The available nitrogen had a standard deviation of 132.52 and a coefficient of variation of 63.45%. The villages of Ratanpura and Roopnagar, specifically sample number 18.25, exhibited the lowest nitrogen levels in the Chauth Ka Barwara block. Alternately Rajwana village, specifically sample no. 11, displayed the highest nitrogen levels. Out of whole the soil samples, 70% exhibited a low nitrogen level, 26.66% displayed medium levels, and 3.33% showed high nitrogen levels (Table 2) (Pandey *et al.* 2020). The soil samples ranged in their accessible phosphorus content, from 6.72 to 52.86 kg ha^{-1}, with an average value of 25.43 kg ha^{-1}. Out of the 30 soil samples collected, 13.33% had a low phosphorus concentration, 46.66% had medium phosphorus content, and 40% had a high phosphorus content (Table 2), the potassium concentration in the soil samples ranged from 246.4 to 397.6 kg ha^{-1}, with an average value of 307.66 kg ha^{-1}. Jola village (sample 3) had the highest phosphorus level, while Shiwar village (sample 30), Chauth Ka Barwara, had the lowest concentration. The standard deviation (SD) and coefficient of variation (CV) values for Jola village were 38.72 and 12.59%, respectively. Olsen's study in 1954 classified 76.66% of the soil samples into the medium potassium range and 23.33% as high (Table 2). Similar findings were also reported by Verma *et al.* (2023).

Available secondary nutrients

The calcium concentration varied between 1.1 and 25.5 Meq/100 g, with an average value of 12.01 Meq/100g (Table 1). Manpura village (sample 8) had the lowest calcium level, while Rajwana village (sample 12) in the Chauth Ka Barwara block had the highest calcium concentration. The standard deviation had a value of 5.95, while the coefficient of variation had a value of 49.50%. All of the soil samples had elevated amounts of calcium content. The magnesium level of the soil samples ranges from 1.8 to 23.6 Meq/100g, with an average value of 11.82 Meq/100 g. The standard deviation had a value of 5.50, while the coefficient of variation had a value of 46.55%. Jola village, specifically sample 4, had the lowest calcium level, but Manpura village, particularly sample 10, located in Chauth Ka Barwara, demonstrated the greatest value. We classified 30 soil samples as being in the high range. The soil samples had a sulfur concentration ranging from 1.11 to 12.26 mg kg^{-1}, with an average value of 4.31 mg kg^{-1}. The standard deviation of sulfur was 2.56, and the coefficient of variation was 59.39%. Among the villages in Chauth Ka Barwara block, Manpura village (sample number 10) exhibited the lowest level of sulfur content, whereas Manpura village (sample 6) had the highest level of the 30 soil samples obtained, 96.66% had low sulfur content, whereas 3.33% had medium sulfur content (Table 2). A similar result was also reported by Bharteey *et al.* (2017).

Available micronutrients

The soil samples iron content ranged from 1.80 to 7.40 mg kg^{-1} with a mean value of 4.65 mg kg^{-1} (Table 1). Roopnagar village (24th sample) had the lowest Fe content, while Rajnagar (sample 14) had the highest. The iron standard deviation & coefficient of variation

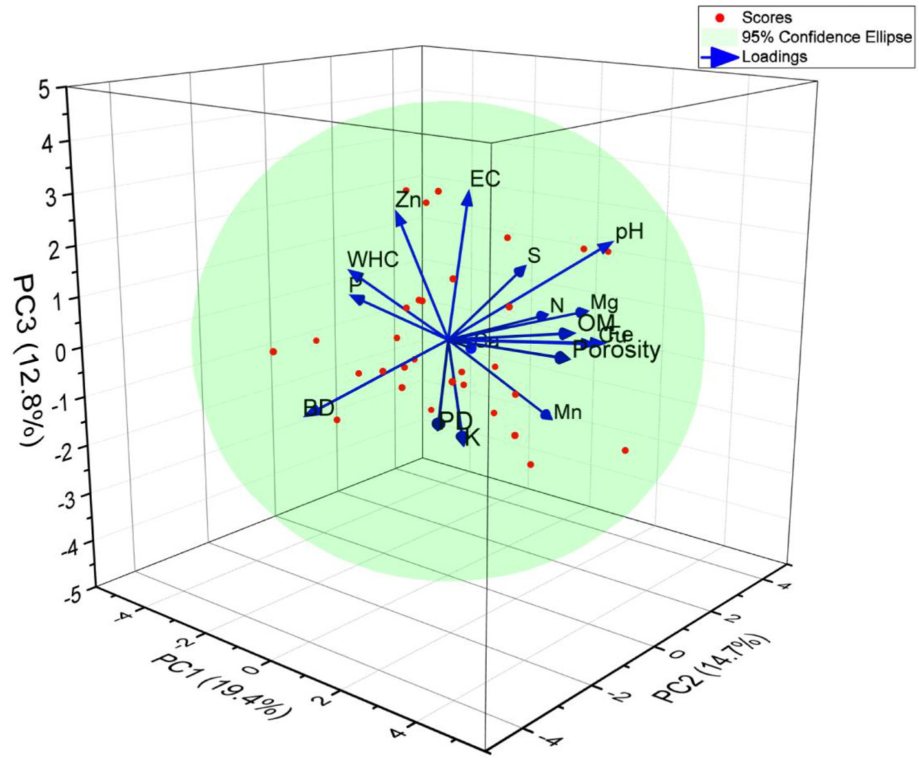

Fig. 5. 3D biplot showing the soil physico-chemical and nutrient properties.

were 1.60 and 34.45%, respectively. 40% of the soil samples had a low iron concentration and 60% were medium (Table 2). The average manganese level in soil sample values was 5.03 mg kg^{-1}, with a range of 1.50-8.10 mg kg^{-1}. Shiwar village (sample 29) had the greatest Mn concentration, whereas Manpura village (sample 6) in Chauth Ka Barwara block had the lowest. The coefficient of variation was 30.89%, while the standard deviation was 1.55%. With a mean value of 0.97 mg kg^{-1}, the Zn concentration of the soil samples varied from 0.10 to 4.30 mg kg^{-1} (Bhanwaria *et al.* 2011). The zinc standard deviation and coefficient of variation values were 1.15 and 119.26%, respectively. Manpura village (sample 6) had the lowest zinc content, while Rajwana village (sample 15) had the highest. Out of 30 soil samples, 23.33% were of high zinc content, and 16.66% were marginal in Zn content (Table 2). The values of the copper content in soil samples ranged from 1.11 to 12.26 mg kg^{-1} with a mean value of 0.44 mg kg^{-1} (Table 1). Cu standard deviation and coefficient of variation were 0.46 and 105.15%, respective Jola village (sample 4) had the lowest copper content, while Manpura village (sample 10) of Chauth Ka Barwara block had the highest copper content. Similar results were also found by Bharteey *et al.* (2017).

Soil nutrient index

To evaluate one area's soil fertility compared to another, it was essential to obtain a sole value for each nutrient. The nutrient index approach suggested by Parker *et al.* (1951) was used to calculate the nutrient-supplying capacity of soil to plants. This index is used to measure soil fertility status based on the sample percentage in each of three classes i.e. low, medium and high. The nutrient index values for the Chauth Ka Barwara were low for organic carbon (1.2), nitrogen (1.4) and sulfur (1.4), medium for phosphorus (2.1) and high for Potassium (2.8), Iron (2.6), Copper (2.3), Zinc (1.3), Manganese (2.5) (Rai and Singh 2018).

Table 3. Principal component analysis of soil physico-chemical and nutrient analysis of Chauth Ka Barwara block.

Parameters	PCA1	PCA2	PCA3
Eigenvalue	3.3	2.5	2.18
Variance (%)	19.43	14.7	12.82
Cumulative (%)	19.43	34.13	46.95
Bulk density	-0.13	-0.30	-0.19
Particle density	0.33	-0.34	-0.07
Porosity	0.46	-0.09	0.09
Water holding capacity	-0.27	-0.06	0.21
Soil reaction (pH)	0.29	0.22	0.34
Electrical conductivity	0.03	0.04	0.52
Organic matter	0.38	0.01	0.12
Available N	-0.03	0.36	-0.04
Available P	-0.30	-0.03	0.10
Available K	0.28	-0.23	-0.20
Available Ca	-0.19	0.27	-0.19
Available Mg	0.05	0.43	-0.03
Available S	-0.03	0.29	0.17
Available Cu	0.26	0.21	-0.03
Available Mn	0.03	0.32	-0.42
Available Fe	0.27	0.23	-0.03
Available Zn	-0.12	-0.04	0.45

Network analysis

The color band (based on 'r' values) in the network among different soil physico-chemical and nutrient properties depicts the strength of association (Fig. 3). The broader lines indicate a strong correlation (both positive and negative) and narrow lines suggest a weak correlation. Available nitrogen was only positively associated with OM content. It was almost perfectly and negatively correlated with PD and WHC. A significant negative correlation of BD with parameters like OM, FC, and pH while porosity, and positive relation with PD. The available P with Ca and Cu had a positive correlation. The available K with available P had a strong correlation.

Principal component analysis

The outcomes PCA using KMO statistical method indicated that the analyzed 17 soil properties were successfully accounted for by the three major components whose Eigenvalues were more than 1.5 which accounts for 46% variation in the soil parameters (Table 3), the first three components, namely PCA1 (19.43%), PCA 2 (14.7%) and PCA 3 (12.82%). The presenting a 3D PCA biplot with loadings for soil physico-chemical parameters (Fig. 4) and scree plot (Fig. 5), the PD, porosity, pH, EC, OM, available K, Mg, Zn and BS had positive loading PCA1, the BD, PD, Porosity, WHC, available P, K, Zn had negative loading on PCA2, and the pH, EC, OM, available N, Ca, Mg, S, Cu, Mn and Fe had positive loading on PCA2 and the less positive and negative loaded of soil parameters on PCA 3 (Deka and Dutta 2016).

CONCLUSION

The soil analysis results from Chauth Ka Barwara in the Sawai Madhopur district demonstrate unequivocally that the soils contain a normal amount of soluble salts and have a pH level that is neutral to slightly alkaline. The levels of organic carbon, nitrogen, and sulfur are classed as low, while phosphorus is classified as medium. Potassium and micronutrient cations (such as copper, iron, zinc and manganese) are classified as medium to high. The findings of this study may prove valuable to farmers in terms of assessing the quality of their produce and enhancing agricultural output by implementing soil conservation practices and improving environmental protection measures.

ACKNOWLEDGMENT

The facilities required to complete this work were generously provided by the Head of the Department of Agricultural Chemistry and Soil Science Institute of Agricultural Sciences, BHU, Varanasi 221005, UP, India.

REFERENCES

Bhanwaria R, Kameriya PR, Yadav B (2011) Available micronutrient status and their relationship with soil properties of mokala soil series of Rajasthan. *Journal of the Indian Society of Soil Science* 59(4): 392—396.

Bharteey PK, Deka B, Dutta M, Goswami J, Saikia R (2023) Geospatial variability of soil physico-chemical properties of Moridhal watershed in Dhemaji district of Assam, India using Remote sensing and GIS. *Annals of Plant and Soil Research* 25 (1) : 99—109.

Bharteey PK, Singh YV, Sharma PK, Sukirtee, Rai KA, Kumar M (2017) Available micro-nutrient status and their relationship with soil properties of Narayanpur Block, District Mirzapur, Uttar Pradesh, India. *International Journal of Current Microbiology and Applied Sciences* 6 (7) : 2838—2843.

Black CA (1965) Soil plant relationship. 2nd edn. Publ New York, USA, pp 515—516.

Cheng KL, Bray RH (1951) Determination of magnesium and calcium in soil and plant material. *Soil Science* 72 : 44.

Chesnin L, Yien CH (1950) Turbidimetric determination of available sulfur. *Proceedings of the Soil Science Society of America* 14 : 149.

Choudhary R, Diwakar AK, Meena AK, Shukla S, Prakash C (2024) Assessment of fertility status of soils under different cropping patterns in rainfed semi-arid eastern plain of Rajasthan, India. *International Journal of Environment and Climate Change* 14 (5) : 192—204.

Deka B, Dutta M (2016) Principal component analysis of soil properties in assessing erodibility indices in the Northern Brahmaputra plains of Assam. *Journal of Soil and Water Conservation* 15 : 277—283.

Fageria NK, Gheyi HR, Carvalho MC, Moreira A (2016) Root growth, nutrient uptake and use efficiency by roots of tropical legume cover crops as influenced by phosphorus fertilization. *Journal of Plant Nutrition* 39 (6) : 781—792.

FAO (2020) Crop production manual: A guide to fruit and vegetable production in the Federated States of Micronesia. FAO Subregional Office for the Pacific, Food and Agriculture Organization of the United Nations, Apia 2020.

Hanway JJ, Heidel H (1952) Soil analysis methods as used in Iowa State College soil testing laboratory. Iowa Agric, pp 57.

Jackson ML, Miller RH, Forkiln RE (1973) Soil Chemical Analysis. New Delhi, India: Prentice-Hall of India Pvt Ltd, 2nd Indian Rep.

Jones JB Jr (2012) Plant Nutrition and Soil Fertility Manual. CRC Press.

Lelago A, Buraka T (2019) Determination of physico-chemical properties and agricultural potentials of soils in Tembaro District, Kembata Tembaro Zone, Southern Ethiopia. *Eurasian Journal of Soil Science* 8 (2) : 118—130.

Lindsay WL, Norvell WA (1978) Development of a DTPA soil test for zinc, iron, manganese, and copper. *Soil Science Society of America Journal* 42 (3) : 421—428.

Olsen SR, Cole VC, Watanabe FS, Dean LA (1954) Estimation of available phosphorus in soils by extraction with sodium bicarbonate. USDA Circular, pp 939.

Pandey L, Prajapati A, Singh S, Singh S (2020) An assessment of soil available nutrients status of Chunar area in Mirzapur District of eastern Uttar Pradesh. *Journal of the Indian Society of Soil Science* 68 (3) : 237—243.

Parker FW, Nelson WL, Winters E (1951) The broadinterpretation and application of soil test information.

Piper CS (1966) Soil and Plant Analysis. Bombay, India : Hans Publishers, pp 368—374.

Rai A, Singh S (2018) Available nutrients status in black soils of Varanasi district of eastern part of Uttar Pradesh. *Journal of Applied and Natural Science* 10 (4) : 1238—1242.

Ramamoorthy B, Bajaj JC (1969) Available nitrogen, phosphorus, and potassium status of Indian soils. Fertilizer News.

Sharma S, Hasan A, Thomas T, Kumar T, Sharma V, Sharma A, David AA (2022) Assessment of soil physical properties from different blocks of Jaipur District, Rajasthan, India. *International Journal of Plant and Soil Science* 34 : 87—95.

Singh YV, Singh SK, Sahi SK, Verma SK, Yadav RN, Singh PK (2016) Evaluation of soil fertility status from Milkipur village, Arajiline block, Varanasi district, Uttar Pradesh, in relation to soil characteristics. *Journal of Pure and Applied Microbiology* 10(2): 1455—1461.

Snedecor GW, Cochran WG (1967) Statistical Methods. Calcutta, India: Oxford and IBH Publ Co, pp 135—198.

Subbiah BW, Asija GL (1956) A rapid procedure for the estimation of available micronutrient in soils. *Current Science* 25 : 259—260.

Tale KS, Ingole S (2015) A review on role of physico-chemical properties in soil quality. *Chemical Science Review and Letters* 4 (13) : 57—66.

Verma VK, Bahuguna A, Bharteey PK, Singh GR, Luthra N, Pal S (2023) Assessment of soil fertility status in Marori Block of Pilibhit District, Uttar Pradesh, India. *International Journal of Environment and Climate Change* 13 (11) : 1012—1025.

Walkley A, Black IA (1934) An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. *Soil Science* 37 (1) : 29—38.