PHYSICO-CHEMICAL ANALYSIS OF SOILS IN KARTALA BLOCK, KORBA DISTRICT OF CHHATTISGARH, INDIA

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ABSTRACT

Objective: The objective of present investigation is to determine the physico-chemical parameters of soils at various stations such as Bolti, Charmar, Champa, Dadarkala, Dhitori, Gumiya, Jogipali, Kalgamar and Koi villages of Kartala block of Korba district.

Method: The physico-chemical parameters were measured using a pH meter for (pH), conductivity meter for electrical conductivity(EC),Fourier-transform infrared and ultraviolet (UV) spectrophotometer for organic carbon (OC). The Kjeldahl method was used to estimate nitrogen (N_2), the flame photometer was used to estimate potassium (K), sodium (Na), and calcium (Ca), and the titrimetric method was used to estimate magnesium (Mg).

Results: Among these, pH (5.40-6.40), EC (0.10-0.41 ds/m), OC (0.20% - 0.79%), N (101.31-335.50 Kg/Ha), P (11.33-73.32 Kg/Ha), K (156.21-571.10 Kg/Ha), S (17.90-44.33 ppm), Zn (0.21-0.78 ppm), B (0.04-0.44 ppm), Fe (21.24-29.70 ppm), Mn (19.38-40.35 ppm) and Cu (0.82-3.89 ppm) ranges were recorded at all the stations.

Conclusion: This study is an initial effort to investigate the characteristics of the soils in various agricultural areas within the Kartala block of the Korba district in Chhattisgarh, India. This could aid in determining the district's nutrient profile and in recommending the crop's nutrient levels for optimal growth.

Keywords: Soil, Physico-Chemical parameters,Nutrient, Optimal growth.

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INTRODUCTION

The foundation of our food security is the soil. Farmers couldn't supply us fuel, food, fiber, or feed without healthy soils. Our farmers must be aware of the elements that comprise the soil in which their crops are planted. A soil lack in nutrients slows down the rate at which plants grow, which is why proper nutrition is essential for both adequate crop growth and its yield.

The ability of plants to take water and nutrients is greatly influenced by the physical and chemical characteristics of the soil. In addition to producing higher-quality food and fiber, high-quality soils also support the development of natural ecosystems and improve the quality of the air and water. The size, pore space, amount of organic content, structure, shape, and mineral composition of the soil all affect its physical characteristics. The interactions of different chemical ingredients between soil particles and sail solution determine the chemical characteristics of the soil [1].

A plant's primary need for nutrients is nitrogen, which is followed by phosphorus and potassium (Samuel and Ebenezer, 2014; Solanki and Chavda, 2012). [19, 24]; Potassium is a crucial nutrient that supports a variety of physiological functions in plants, enhancing their physical traits and ability to fend off illness. According to Mahajan and Billore (2014), magnesium deficiency results in the loss of the vibrant green color of leaves since it is essential for the synthesis of chlorophyll pigment in green plants [13, 20].

The primary component in lowering the amount of salt erosion in soil and the flowage-induced loss of phosphorus is calcium ions. Since plant growth is dependent on the availability of phosphorus content in the soil, phosphorus is the most significant element. Crop productivity and quality are directly impacted by soil fertility and nutrient management, two significant aspects.

A variety of soil samples were taken from pre-selected locations in order to determine the fertility status of the chosen area. The soil samples were then analyzed for chemical characteristics, including fertility parameters like exchangeable basic cations that make up calcium and magnesium, and physico-chemical properties (pH and electrical conductivity).

MATERIALS AND METHODS

According to a previous literature assessment, no analytical technique has been developed for figuring out the physico-chemical characteristics of the agricultural soils in the Korba district. An effort was undertaken to determine the physic-chemical properties and nutrient content of a few agricultural soils in the Korba district.

Study area

Kartala is a town and block in Korba district of Chhattisgarh. Total area of kartala block is 662 km². This study includes the Kartala block in the Korba district. The Kartala block is situated in Chhattisgarh's Korba district. Kartala Block is located 31 km towards east from district head quarters Korba and surrounded by Korba block of Korba district towards west, Sakti block of Sakti district towards south, Dharamjaigarh block of Raigarh district towards east, Kharsia block of Raigarh district towards south. Korba city, Champa city, Sakti city, Dipka city are the nearby cities to Kartala block. The block area lies between 22.14° and 22.18° N latitudes and 82.56° and 83.59° E longitudes. Administrative map of the block is shown in Fig.1.

Soil samples collection

Soil samples were collected from various stations such as Bolti, Charmar, Champa, Dadarkala, Dhitori, Gumiya, Jogipali, Kalgamar and Koi villages of Kartala block of Korba district.

Instruments required

Fourier-transform infrared (FTIR), ultraviolet (UV) spectrophotometer, sonicator (Ultrasonic Sonicator), conductivity meter, flame photometer, pH meter (Thermo Scientific), and microbalance (Sartorius) were used.

Methodology

pH determination

After being weighed, a 20 g sample of 2.0 mm air-dried soil was put into a beaker. Add 50 ml of distilled water, thoroughly mix with a glass rod for about 5 minutes, and let away for half an hour. Next, the soil samples were placed beneath the pH meter to determine the pH [3], and the results are shown in Table 3.

Electrical conductivity (EC)

The same sample solutions which were prepared for measuring the pH were used for measurement of EC by allowing the soil water suspension in the beaker to settle down the soil for additional ½ h. Recorded the EC of sample solutions in ds.m−1 using CM [4,6], and the results are shown in Table 3.

Estimation of sodium, potassium, and calcium in flame photometer

Preparation of standard stock solutions of sodium, potassium, and calcium

Stock solutions of sodium chloride, potassium chloride, and calcium carbonate were made it has a 1000 μg/ml concentration. From these, to test the flame photometer, linear concentrations of 2, 4, 6, 8, and 10 µg/ml were produced and injected. Table 2 displays the percentage flame intensity of the standard solutions.

Preparation of sample solutions for the estimation of sodium, potassium, and calcium

50 ml of ammonium acetate solution was added to 5 g of soil sample, and the mixture was shaken for 15 minutes on a reciprocating shaker. Following filtering, the resultant solution was formed into serial dilutions and added to the flame photometer [10–12]. Table 3 displays the percentage flame intensity of the samples.

Estimation of magnesium

After being weighed and put into a conical flask, 2-4 g of a sieved (2 mm) soil sample were used. After that, 30 milliliters of ammonium acetate were added, and the mixture was shaken for five minutes. 30 cc of 0.5N HCl was added to each sample solution after the ammonium acetate solution had been shaken and decanted. Following a 5-minute vigorous stirring period with the contents upright and loose, the mixture was filtered using Whatman filter paper grade No. 1. Following the collection of 20 milliliters of filtrate, 50 milliliters of distilled water, 10 to 15 milliliters of ammonium chloride–ammonium hydroxide buffer solution, and ten drops of potassium ferric cyanide, triethanolamine, hydroxylamine hydrochloride, and eriochrome black T indicator were added all at once. Subsequently, the resulting solution was titrated using regular EDTA until a blue hue became permanent [16, 17]. Table 3 presents the findings.

Estimation of nitrogen procedure

10 milliliters of concentrated sulfuric acid and 0.1 grams of potassium sulfate were added to the 5 grams of soil sample. The mixture was then heated to 420°C for 30 minutes, and selenium catalyst was added. After cooling the mixture to between 50 and 60°C, 50 milliliters of distilled water were added. After that, 50 milliliters of 35% sodium hydroxide were added, and the mixture was heated to 100 milliliters. This was mixed with 25 milliliters of 4% boric acid, and methyl orange was used as an indicator to titrate the mixture with 0.1 M hydrochloric acid [21, 22]. Table 3 presents the findings.

Identification of organic carbon (OC) by FTIR

Each soil sample was applied in modest amounts to the IR sample cell [25, 26], and the peaks were noted.

Estimation of OC by UV-visible spectroscopy

Preparation of standard stock solution

1gram of sucrose was mixed with 1000 milliliters of distilled water. Following that, concentration solutions of 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100µg/ml were made by filling each 100 ml volumetric flask with 10 ml of potassium dichromate and 20 ml of sulfuric acid. Following that, a UV visible spectrophotometer was used to measure the absorbance's of the resultant solutions [27–29]. The findings are displayed in Table3.

Preparation of sample solutions

Each soil sample weighed 1 gram, which was then put into a 100 milliliter flask. Subsequently, 10 milliliters of potassium dichromate and 20 milliliters of sulfuric acid were added, well mixed, and allowed to cool on an asbestos sheet. After adding distilled water to reach 100 ml, the volume was maintained overnight. The results are displayed in Table 2 after the absorbance was measured using a spectrophotometer at a wavelength of 660 nm [7, 14].

Fig.1: Map of Kartala Block

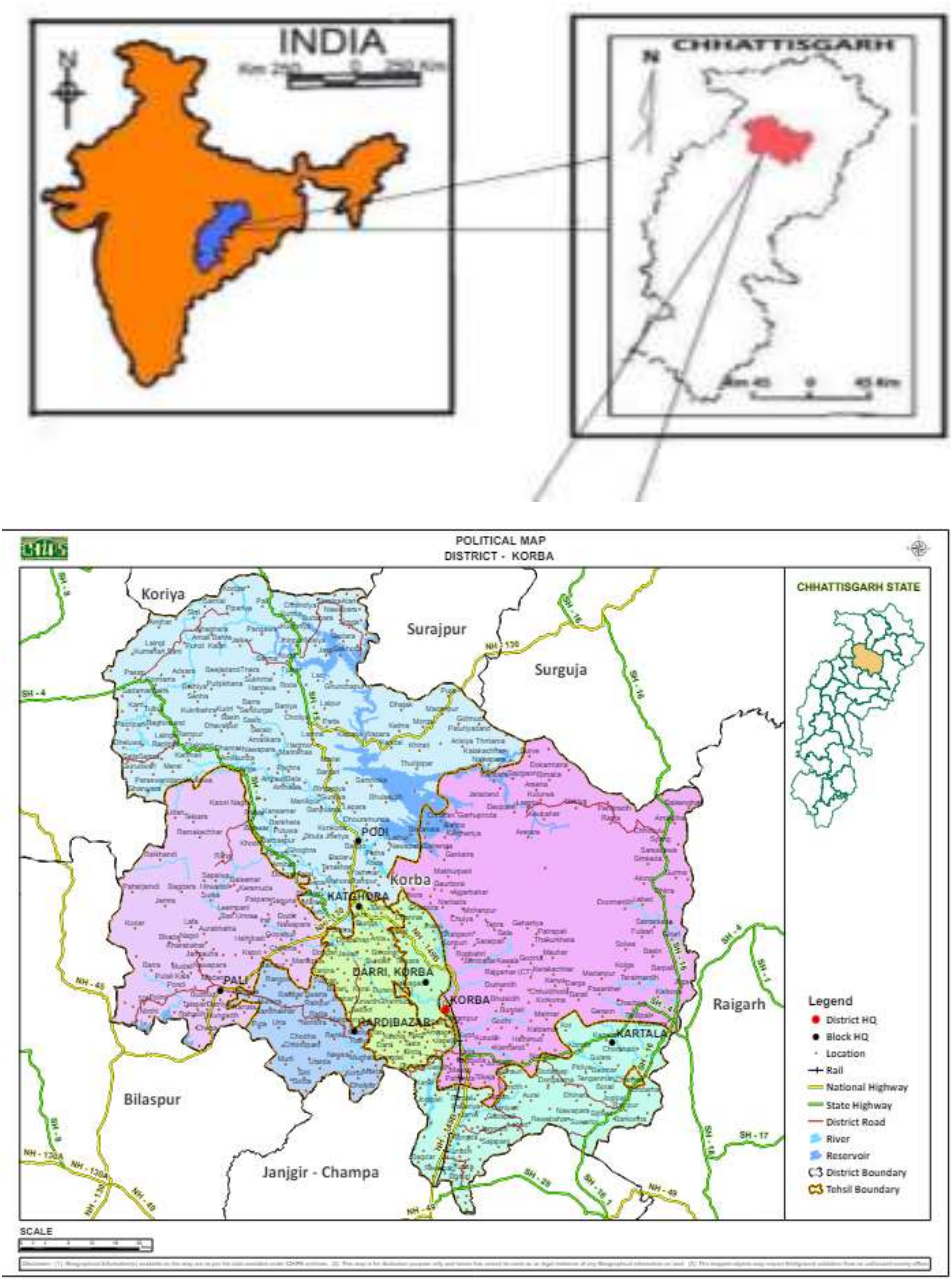

Fig.2: Korba District Location Map

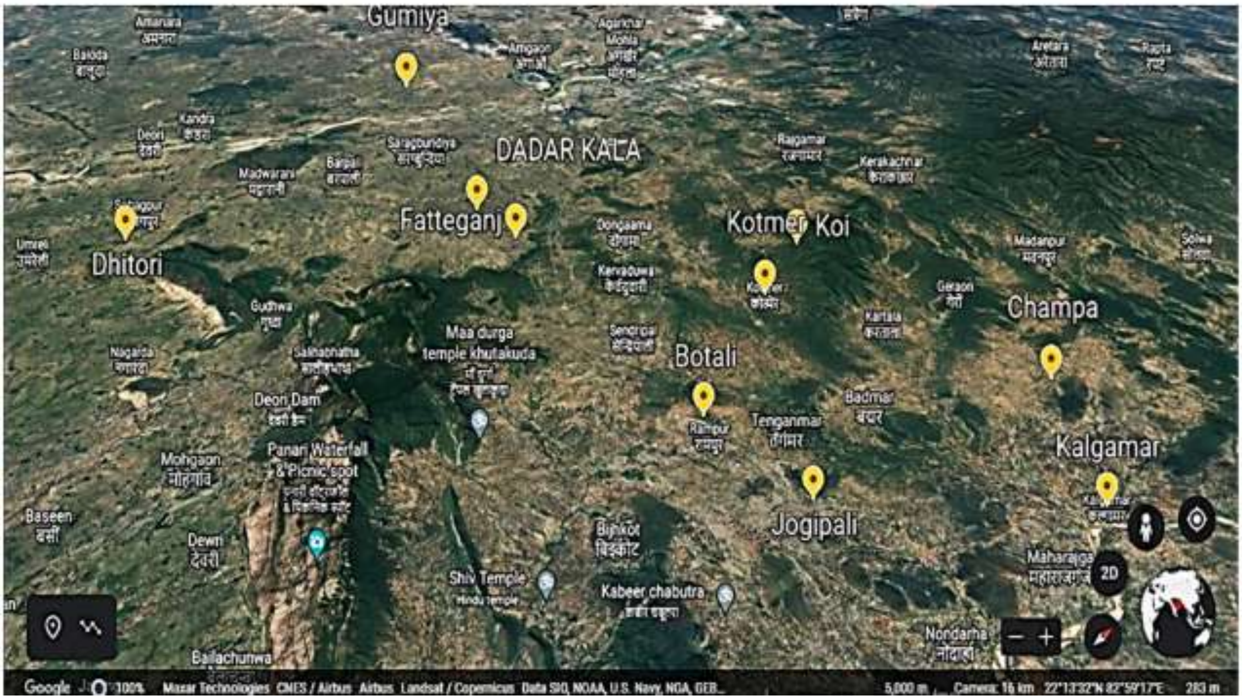

Fig.5: Map showing a satellite view of different sampling sites (Source: Google)

Table 1: Procedure used for Physico-Chemical analysis of Soil

Particulars	Methods	Scientist (years)
Texture	Bouyoucos Hydrometer	Bouyoucos, (1927) [2]
Soil Colour	Munsell Colour Chart	Munsell, (1971)
Particle Density (Mg m^{-3})	Graduated measuring cylinder	Muthuaval *et al.*, (1992) [8]
Bulk Density (Mg m^{-3})	Graduated measuring cylinder	Muthuaval *et al.*, (1992) [8]
Pore Space (%)	Graduated measuring cylinder	Muthuaval *et al.*, (1992) [8]
Water Retaining Capacity (%)	Graduated measuring cylinder	Muthuaval *et al.*, (1992) [8]
Soil pH	Digital pH meter	Jackson, (1958)
Electrical Conductivity	Digital EC meter	Wilcox, (1950)
Organic Carbon (%)	Rapid Titration Method	Walkley and Black, (1947)
Available Nitrogen (kg ha^{-1})	Kjeldahl Method	Subbiah and Asija, (1956) [15]
Available Phosphorous (kg ha^{-1})	Calorimetric Method	Olsen *et al.*, (1954) [9]
Available Potassium (kg ha^{-1})	Flame photometer method	Toth and Prince, (1949)
Calcium and Magnesium (meq $100g^{-1}$)	EDTA method	Jackson, (1961)
Sulphur (mg kg^{-1})	Turbid Metric method	Chesnin and Yein, (1951)
Zinc, Iron and Copper (mg ha^{-1})	DTPA method	Lindsay and Norvell, (1978) [5]

Table: 2 Physical Properties of Soil in Kartala Block of Korba District

Village Name	Sand %	Silt %	Clay%	Porosity	Bulk Density gm / cm^3
Bolti	80.00	2.85	17.15	0.3109	1.79
Charmar	80.44	2.86	16.70	0.3223	1.81
Champa	77.67	2.27	20.06	0.1798	1.85
Dadarkala	81.07	2.90	16.06	0.3394	1.79
Dhitori	81.62	2.91	15.26	0.3560	1.77
Gumiya	81.81	2.92	15.18	0.3565	1.87
Jogipali	85.99	3.13	11.74	0.4501	1.89
Kalgamar	86.90	3.39	11.58	0.4569	1.85
Koi	87.82	3.51	11.54	0.4601	1.88

Table: 3 Chemical Properties of Soil in Kartala Block of Korba District

Sample Element	Name of Village								
	Bolti	Charmar	Champa	Dadarkala	Dhitori	Gumiya	Jogipali	Kalgamar	Koi
pH (1:2.5)	5.90	5.76	5.70	5.90	6.10	5.40	6.21	6.40	5.90
EC (dS/m)	0.16	0.10	0.41	0.22	0.25	0.21	0.14	0.34	0.21
OC (%)	0.31	0.79	0.21	0.38	0.51	0.31	0.36	0.20	0.29
N (Kg/Ha)	150.10	335.50	150.5	175.21	150.34	125.20	126.20	138.70	101.31
P (Kg/Ha)	12.04	13.44	11.33	11.35	39.50	73.32	20.24	18.16	16.27
K (Kg/Ha)	347.11	156.21	280.63	571.10	437.45	392.02	374.20	381.54	347.61
S (ppm)	17.90	38.40	26.26	19.32	36.67	44.33	27.44	35.52	36.63
Zn (ppm)	0.31	0.54	0.32	0.39	0.35	0.78	0.53	0.21	0.43
B (ppm)	0.28	0.41	0.32	0.19	0.14	0.04	0.44	0.16	0.13
Fe (ppm)	21.24	25.53	24.70	22.61	26.81	29.70	21.81	27.41	21.71
Mn (ppm)	21.65	23.91	19.38	26.32	40.35	22.15	20.39	25.09	23.64
Cu (ppm)	0.82	3.89	0.93	0.86	1.05	1.32	1.39	1.44	1.65

RESULTS AND DISCUSSIONS

Several analytical techniques were used to determine the physico-chemical properties and nutrient content of selected soil samples. The findings were as follows.

Soil texture is a crucial aspect of soil science because it influences soil fertility, tilt ability, aeration levels, infiltration rates, and water retention. Soil texture has a major role in determining its electrical characteristics.

The sand, silt and clay percentage ranges from 75.05-85.00%, 2.06-3.00% and 12.00-22.89% respectively. The high content of clay in most of the soil sample suggests that the soil is suitable for paddy growing. Thakre carried out the same investigation [18].

The porosity ranged from 0.1798% to 0.4601% with a mean value of 0.3591%, in line with findings published by Ahmadi and David. Porosity was lowest in the Champa settlement (0.1798%). The Koi settlement exhibited the highest porosity, at 0.4601%.

The bulk density ranged from 1.77 to 1.89 mg m^{-3} with a mean value of 1.83 mg m^{-3}. Dhitori and Jogipali having the lowest and greatest bulk densities, respectively. As soil depth increases, the bulk density falls. Comparable results were reported by Chaudhari et al., (2013) [23].

The pH value ranges from 5.40 to 6.40 with a mean value of 5.91 and the highest value was recorded in Kalgamar. The results concluded that the soil samples are acidic in nature. The low pH values could be caused by low quantities of organic matter and nutrient leaching. Similar results were observed by Upadhyay and Chawla [30].

The electrical conductivity varied from 0.10 dS m^{-1} to 0.41 dS m^{-1} with a mean value of 0.22 dS m^{-1} and Champa having the greatest EC. For soil, an EC value of 0.5 dS m^{-1} is ideal. Similar outcomes were reported by Belwal and Mehta [31].

The soil organic carbon percentage varied from 0.20 % to 0.79 % with a mean value of 0.37% and the highest soil organic carbon percentage was found in Charmar. The organic carbon content decreased with depth. Upreti *et al.*, (2016) reported similar outcomes [32].

Nitrogen content ranges from 101.31 kg ha^{-1} to 335.50 kg ha^{-1} with a mean value of 161.45 kg ha^{-1} and Charmar has the maximum amount of accessible nitrogen. The surface layer was determined to have the highest accessible nitrogen content. Upadhyay et al., (2014) reported similar results [33].

Phosphorus content ranges from 11.33 kg ha^{-1} to 73.32 kg ha^{-1} with a mean value of 23.96 kg ha^{-1} and the highest available phosphorus was found in Gumiya. It has been demonstrated that the maximum accessible phosphorous concentration, which varies randomly with depth, is found in the surface layer. Sannappa and Manjunath observed similar findings [34].

Potassium content ranges from 156.21 kg ha^{-1} to 571.10 kg ha^{-1} with a mean value of 365.31 kg ha^{-1} and the highest available potassium was found Dadarkala. Similar results were reported by Patel [35].

Sulpher content ranges from 17.90 ppm to 44.33 ppm with a mean value of 31.38 ppm and the highest available sulpher was found in Gumiya.

Zinc content ranges from 0.21 ppm to 0.78 ppm with a mean value of 0.42 ppm and the highest available zinc was found in Gumiya. The availability of zinc declines as soil pH rises. Similar results were reported by Shukla [36].

Boron content ranges from 0.04 ppm to 0.44 ppm with a mean value of 0.23 ppm and the highest available boron was found in Jogipali.

Iron content ranges from 21.24 ppm to 29.70 ppm with a mean value of 24.71 ppm and the highest available iron was found in Gumiya.

Manganese content ranges from 19.38 ppm to 40.35 ppm with a mean value of 24.76 ppm and the highest available manganese was found in Dhitori.

Copper content ranges from 0.82 ppm to 3.89 ppm with a mean value of 1.48 ppm and the highest available copper was found in Charmar.

CONCLUSION

It is crucial to analyze the physico-chemical properties of soil, such as its pH, bulk density, texture, porosity, electrical conductivity, organic carbon content, and composition of macro- and micronutrients. As soil depth increases, plant absorption and leaching cause soil nutrients to decrease. There wasn't much organic stuff in the soil. The pH of the soil is significant because different pH ranges have an effect on the quantity of macro and micronutrients in the soil.

The pH of soil is strongly acidic in nature and the Electrical Conductivity was suitable for all crops. Organic carbon was found low. These soils have low Nitrogen in 95 percentage villages. Phosphorus is found low to medium. Potassium is found medium to high. All the soil samples were found to be high with respect to Fe, Cu and Mn whereas Zn and B were found deficient.

This analysis shows that the Kartala block in the Korba district has productive and fertile soil, which makes it ideal for farming. Appropriate integrated soil can improve soil health and reduce cultivation costs. These studies might support farmers in maintaining appropriate nutrient management to produce high-quality goods at a high yield. Enhancing cropping patterns, breaking down organic waste, mulching, and tillage techniques can all lead to further development. This could help to understand the nutrient profile of the district and to prescribe the nutrients levels of the crops for their effective growth.

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