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Soil Analysis Of Kasdol Block, Balodabazar With Special Reference To Physicochemical And Nutritional Perspectives

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Abstract:

A physicochemical study of soil is based on various parameters like soil pH, electrical conductivity (EC), organic carbon (OC), available nitrogen (N), phosphorus (P), potassium (K), and micronutrients (Fe, Mn, Cu and Zn). Four representative samples were obtained and analyzed for its alkalinity content, pH, electrical conductivity, organic carbon, sodium, potassium. A five soil samples were collected at a depth of 0–20 cm and analyzed for soils were neutral to slightly alkaline. The value of soil pH found to be 7.60 to 8.81, conductivity was ranging from 0.50 to 0.73 dSm−1, organic carbon was found to be 0.52 to 0.72%, range of sodium was 0.52 to 0.97meq% and potassium 125.31 to 630.15 kg/ha. Among the nutrients, available Nitrogen was found to be 140.01 to 252.68 kg/ha, Phosphorous was ranging from 15.11 to 54.13 kg/ha. This information will help the farmers to know amount of fertilizers to be added in soil to make production.

Keywords:-soil analysis,physicochemical,micronutrients,fertility,sustainable, contamination, Fluctuations, laboratory, chemical manifestations

Introduction:

The physical characteristics of soil, such as its colour, texture, moisture content, and pH, as well as its chemical properties, such as its cation exchange capacity, organic matter levels, and available nutrients, all contribute to the soil's general condition. To varying degrees, the nutrient content of a soil determines its conceivable applications and, to a greater extent, its yield. The physical and chemical features of a soil are the primary factors that define whether or not it is suitable for the use that is intended for it, as well as the management needs that are necessary to maintain its highest level of productivity. These characteristics influence not only the types of crops that can thrive in the soil but also the practices needed to enhance its fertility and health over time. Understanding these characteristics is essential for effective land management and sustainable agricultural practices,(jaiswal,2004).

When evaluating the degree to which toxic metal contamination of soil occurs, the physicochemical features of the soil play a significant part in the identification process. The colour of the soil under study can determine its state. The colour of the soil close to the surface ranges from practically white to hues of brown and grey and finally to black. The light tint suggests that there is a low amount of organic matter, whereas the dark colour shows that there is a considerable amount. The colour of the soil is an essential visible signal that may be used to evaluate the amount of organic matter that is present in it, which can have an effect on the soil's capacity to retain toxic substances. Therefore, having a grasp of these colour fluctuations is beneficial for assessing the general health of the soil as well as the quantities of pollutants it contains (jaiswal,2004).

Most people agree that pH plays a significant role in determining the quantity of agreeable and plant-available metals. Metal permeability has a tendency to rise when the pH is lower, and it seems to go down when the pH is higher. Both the amount of clay present in the soil and the amount of organic matter present in the soil were shown to be associated with an improvement in the cation exchange capacity of the soil. The cation exchange was also discovered to be dependent on the negative charges that are present on the surfaces of soil colloids, as well as the respective charges that are present on the metal species that are present in solution and on the surface of the soil. The intricate relationship between the soluble nature of metals and the cation exchange highlights the substantial influence of pH, soil composition, and the chemical properties of metal species. The solublity of metals increases as pH levels decline, which highlights the significance of acidic circumstances in enhancing the availability of certain metals. At the same time, the ability to exchange cations is greatly improved by the presence of a greater clay content and organic matter within the soil. This is because these factors encourage a more fluid relationship between the particles of the soil and the metal ions. The negative charges that are present on soil colloids alter this interaction even more. These charges dictate the extent to which different metal species can interact with each other. These factors together show how important it is to keep a delicate balance in order to manage soil health and fertility well. This will eventually have an impact on crop yields and the stability of ecosystems.

The presence of increased amounts of nitrite and nitrate nitrogen in the soil is an evident indication of human-rich nitrogenous compounds. Although beneficial to plant growth, these elements may affect soil health. This suggests that while nitrogen-rich substances can increase soil productivity and plant growth, they may also harm soil health and ecological systems over time. When it comes to nitrogen inputs, careful control is very necessary in order to prevent unfavourable results.

Researchers have designed several extraction methods in a lab to evaluate the available nutrients in the soil. The chemical properties of the soil, in particular its pH, are considered when deciding which method to use for a certain nutrient throughout the cultivation process. The chemistry of soil is very complicated; the majority of nutrients are present in a variety of chemical manifestations, and not all of these forms are equally accessible to plants. When it comes to the majority of nutrients, the extraction methods that are typically utilised make an effort to rank the relative abundance of the nutrients, rather than the total soil concentration of that particular nutrient. Thus, interpret the results of soil testing as an indication of nutrient availability, not as a numerical value. When analysing the results of soil tests, it is of the utmost importance to be aware of the laboratory procedures that were used. This is due to the fact that two distinct lab procedures may provide substantially distinct numerical values for the same nutrient. It is also essential to be aware of the fact that there is a lack of appropriate data to use as a foundation for establishing interpretative norms for some laboratory procedures that are used by certain commercial labs.

A nutritional administration approach that is based on soil tests is now recognised as a crucial problem in the context of attempts to boost agricultural output. In the last few years, there has been a shift in the growth of agriculture, shifting away from normal and traditional farming methods and towards advanced techniques that include the use of chemical fertilisers and pesticides along with irrigation systems (Nounamo *et al*., 2000). The consistent use of chemical fertilisers gradually altered the quality of the soil, which ultimately resulted in a decrease in productivity over the long term. As a consequence, chemical substances have leached into both the surface water and the groundwater. The adoption of monoculture cropping patterns continues to contribute to the deterioration of water while also contributing to the degradation of soil health. This is because of the growing desire for agricultural products (Dandwate 2020).

In the process of agricultural farming, the two resources from nature most significant are soil and water. The evaluation of the current state of the soil was the primary purpose of the investigation. An examination was carried out on the physicochemical characteristics of selected soil samples obtained from four distinct locations in the Balodabazar-Bhatapara (Kasdol). These characteristics included soil pH, electrical conductivity (EC), organic carbon (OC), available nitrogen (N), and phosphorus (P), as well as potassium (K). This investigation describes the analytical methods that have gained the most widespread acceptance and documentation which would be useful for further research.

2 Materials and methodology:

2.1 Study area:

Randomized soil samples were taken from several kinds of agricultural land locations located in the Kasdol block of the Baloda-Bazar-Bhatapar District in the state of Chhattisgarh in India. Kasdol, Katagi, Giroudpuri, and Lahod were the locations from where the soil samples were obtained, which can be illustrated in the satellite map presented in Fig.1-2.

Kasdol is located along the banks of the Mahanadi River in the Balodabazar-Bhatapara district of Chhattisgarh, India. The geological location details are 21.621°N 82.423°E. The particular geographical location of Kasdol highlights its position in the central region of India, offering a distinctive ecological and cultural environment shaped by the adjacent river. The location parameters are crucial for mapping and navigation, underscoring their importance in geographic areas and local histories.

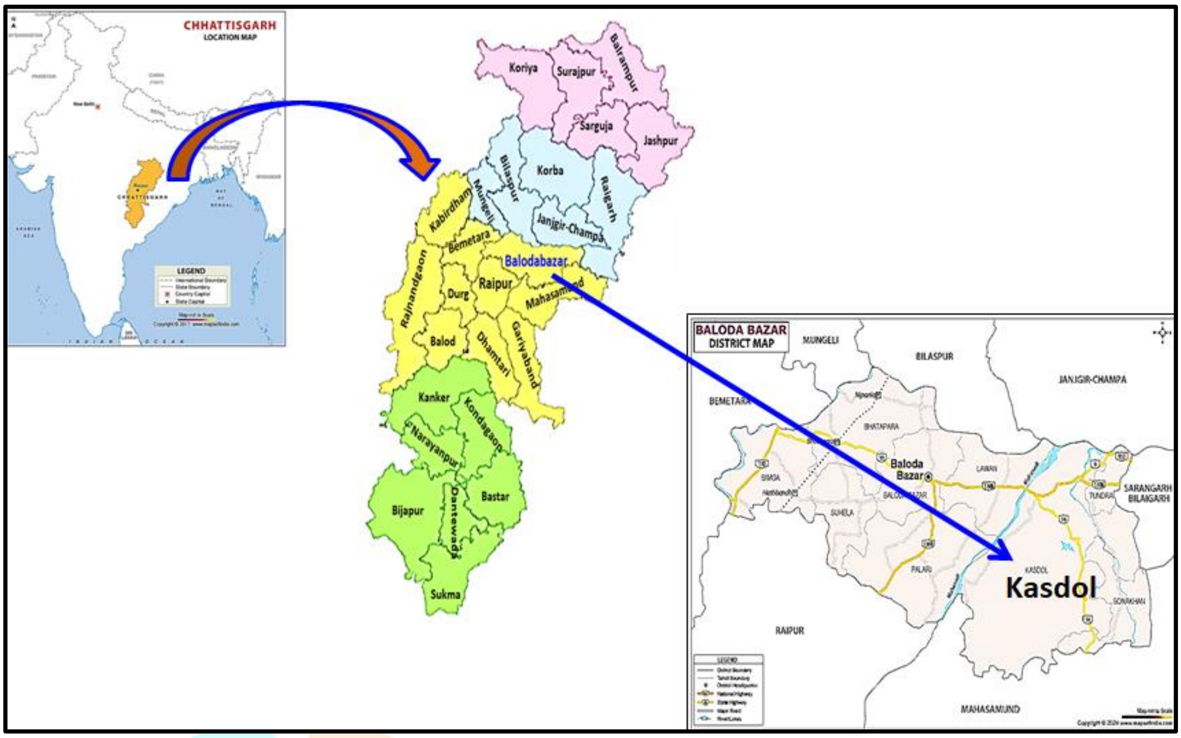

Fig. 1: Study area map and collected sample region

2.1 Sample collection:

Four locations were selected from every acre of land at each of the research sites to gather the samples. In June of 2022, a soil sample was obtained by excavating an excavation in the form of a V along with the assistance of a spade at a depth of around 30 centimetres. Next, the team incorporated a piece of new fabric into the dirt. After being ground up with the use of a mortar and pestle, the soil particles were further processed through a sieve. Thereafter, they placed the soil samples in plastic containers, labelled them, and then transported them to the lab for further processing and investigation.

2.2 Samples Pre-Treatment:

Sample pre-treatment were completed as per previously described technique Nounamo *et al*., (2000). Following homogenisation and air-drying in a heated oven at 30°C for a period of time, soil samples from each location were subsequently put through a sieve with a mesh, thereafter placed the sifted soil samples in plastic containers, in preparation for the examination.

2.3 Quality Assurance:

All glass waves, plastic containers, crucibles, mortar and refuse were washed. Glasses were washed with liquid soap, raised with distilled water and then soaked in 10% HNO3 solution for 24hours (Todoroui *et al*., 2001). They were then washed with distilled water and dried in Mammary drying oven at 80oC for 5 hours.

2.4 Measurement of Physico-chemical Parameters

a) **pH**: 20g of each air-dried soil was weighed into 50 ml beaker and 20 ml of distilled water was added. It was stirred with a glass rod and allowed to stand for 30 minutes. Calibrated HANNA PH meter (Model H 1991000) was inserted into the shiny and pH recorded (Black, 1965).

b) **Electrical conductivity:** 25 g of air dried soil sample was placed into a 250 ml beaker. Distilled water was added slowly drop by drop uniformly over the entire soil surface until the soil appears to have been wetted. A stainless steel spatula was used to form a homogeneous soil saturated paste. The beaker was then covered with a petri-dish. 50ml distilled water was added and shaken for 1hour. 40ml of the diluted extract was placed into 100ml beaker and the conductivity meter was inserted and the electrical conductivity of the soil recorded in uScm-1.

c) **Colour:** Refuse waste soil sample were compared to colour standards and suitably graded.

d) **Organic Carbon:** The organic carbon content of the soils were determined by wet oxidation of Walkley and Black in which organic carbon is oxidized by K2Cr O7 in the presence of sulphuric acid (H2SO4) according to the following reaction (Todoroui *et al*., 2001)

$$2K_2Cr_2O_7 + 8H_2SO_4 \longrightarrow 2Cr_2(SO_4)_3 + 8H_2O + 3O_2$$

$$3C + 3O_2 \longrightarrow 3CO_2$$

The soil samples were sieved using 0.5mm sieve often which, they were weighed in duplicate and transferred to a 250 ml Erlenmeyer Flash. Exactly 10 ml of 1m potassium heptaoxodichromate (VI) (K2Cr2O7) was pipetted into each flash and swirled gently to dispose the soil followed by adding 20 ml concentrated sulphuric acid. The flask was swirled gently until soil and reagents were thoroughly mixed. The mixture was thus allowed to stand for 30 minutes on a glass plate. 100ml of distilled water was added followed by addition of 3-4 drops of ferrois indicator, after which it was titrated with 0.5m, ferrous sulphate solution. A blank titration was similarly carried out. The percentage organic caution is given by the equation (Todoroui *et al*., 2001)

$$OC\ \% = \frac{M(eq)\ (K_2Cr_2O_7 - FeSO_4)\ x\ 1.331\ x\ F}{\text{Mass of soil}}\ x\ 100$$

Where, F is the correction factor, Meq is the molarity equivalent of solution transferred multiplied by volume in ml of solution used, OC% organic carbon in the soil, and its value is OC % x1.729.

e) **Cation exchange capacity (CEC):** 10 g of soil sample was weighed into 100 ml plastic beaker. 40 ml of 1.0 moldm3 ammonium acetate solution (pH 7) was added and the suspension stirred with glass rod and left overnight. It was the suction-filtered with 55 mm Buchner funnel. The residue from filtration was leached with four 25ml portions of 1 moldm3 NH4Cl solution (pH 7). The solution was discarded and the electrolyte washed out of the sample with 150 ml ethanol. The sample was allowed to drain completely and leached gradually with acidified NaCl to 250 ml. 50 ml of 2% boric acid was measured into 250 ml comical flash and 3 drops of mixed indicator were added.

The acidified NaCl leachate was poured into 500 ml Kjeldahl flask and 10 ml of 1.0 moldm3 NaOH and anti-bumping granules were added. The leachate was distilled over the boric. 1.5 ml of ammonium borate distillate was titrated with standard 0.1 moldm3 HCl and the CEC determined as follows (Todoroui *et al*., 2001)

$$\text{CEC \%} = \frac{(\text{Titre - Blank}) \quad \text{x M}}{\text{Sample weight}} \text{ x } 100$$

Where, CEC is the cation exchange capacity in concentration per mole per kilogram (C mol kg^{-1})

f) **Moisture content:** 1g of sieved soil sample was weight into dry crucible. The crucible was then placed in an air circulated oven at 105oC and dried to constant weight (for 6 hours). The sample was cooled in a desicator and re-weighed. The percentage air dried moisture from the loss weight was then determined as fellows (Nounamo *et al*., 2000)

$$\text{MC \%} = \frac{W_A}{W_B} \text{ x } 100$$

Where, MC is the moisture content, WA is the losses in weight, and WB is the initial weight.

2.5 Mineral determination

Element and mineral analysis by atomic absorption spectrophotometer (AAS):

The collected soil was analysed for its elemental and mineral content in the same way as Kashyap et al. had done so previously (2022). The collected soil was analysed using an atomic absorption spectrophotometer to identify the presence of major and trace elements. This was accomplished by adding 20 mL of concentrated HNO3, 2 mL of HClO4 and HCl (10:1) to a powdered sample of 1 g of each soil, waiting 5 minutes and then digesting the mixture at 80 °C using a hot plate. After the tissue was completely digested, the solution was allowed to evaporate to dryness, the temperature was increased to 105°C to reduce the volume to 1.0 ml, and 10 mL of distilled water was added to boil the resulting residue. Elements were measured using an atomic absorption spectrophotometer after the liquid was cooled, filtered using Whatman No. 541, and then brought up to the mark with deionized water (AAS) (Systronic, SYS-WFX-320).

3. Results and discussions:

Table1: Physicochemical analysis of selected soil samples

S. N.	Parameters	Sample 1	Sample 2	Sample 3	Sample 4
1	pH	7.18	7.95	5.3	7.3
2	EC	0.225	0.511	0.163	0.083
3	OC	0.41	0.33	0.29	0.14
4	MC	59	62	48	53
5	CEC	257	282	176	238

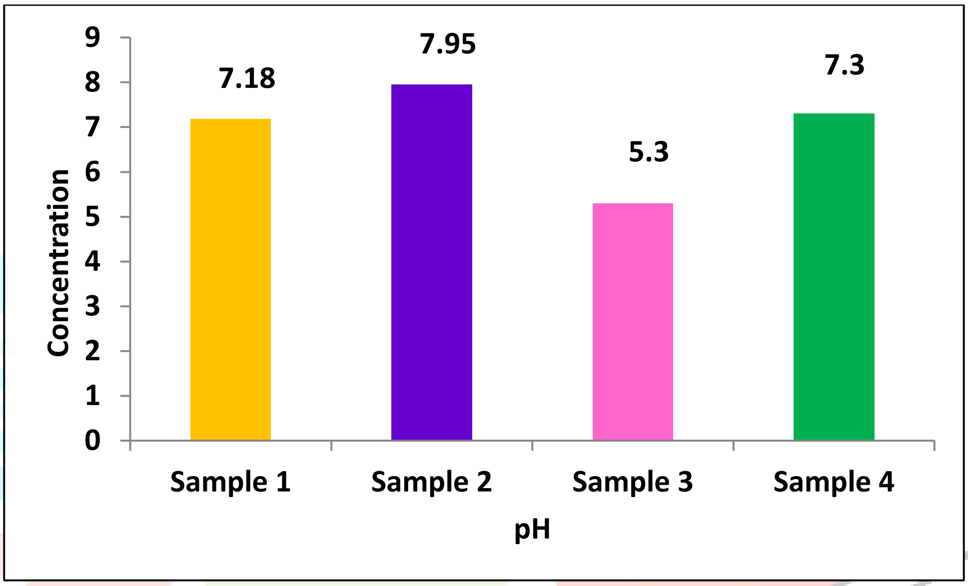

Fig.1: pH concentration analysis of selected soil samples

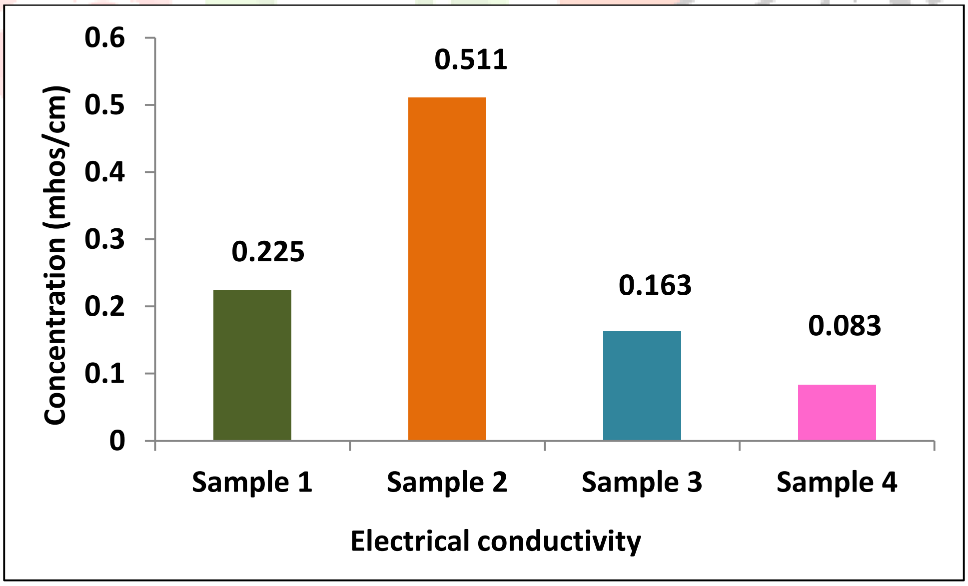

Fig.2: Electrical conductivity analysis of selected soil samples

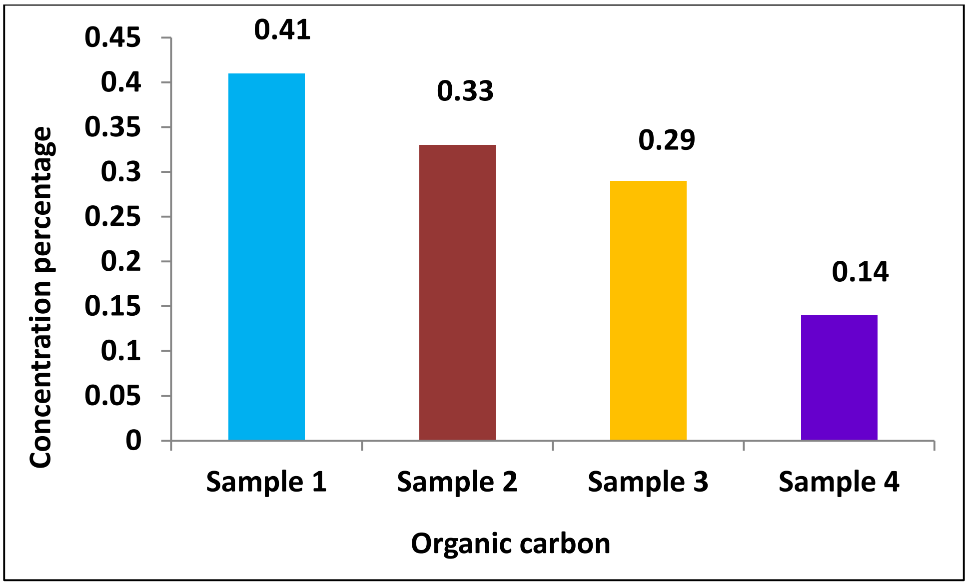

Fig.3: organic carbon analysis of selected soil samples

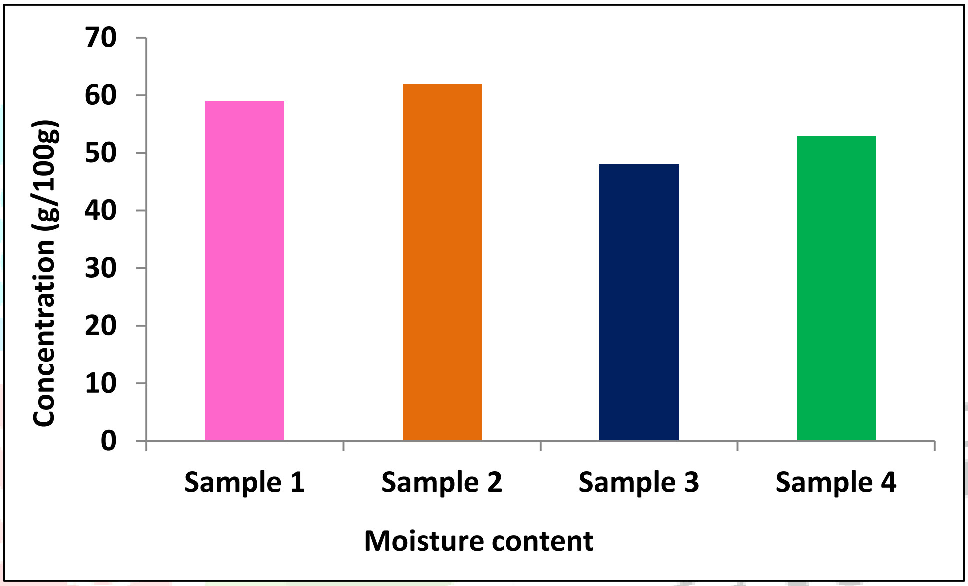

Fig. 4: Moisture content analysis of selected soil samples

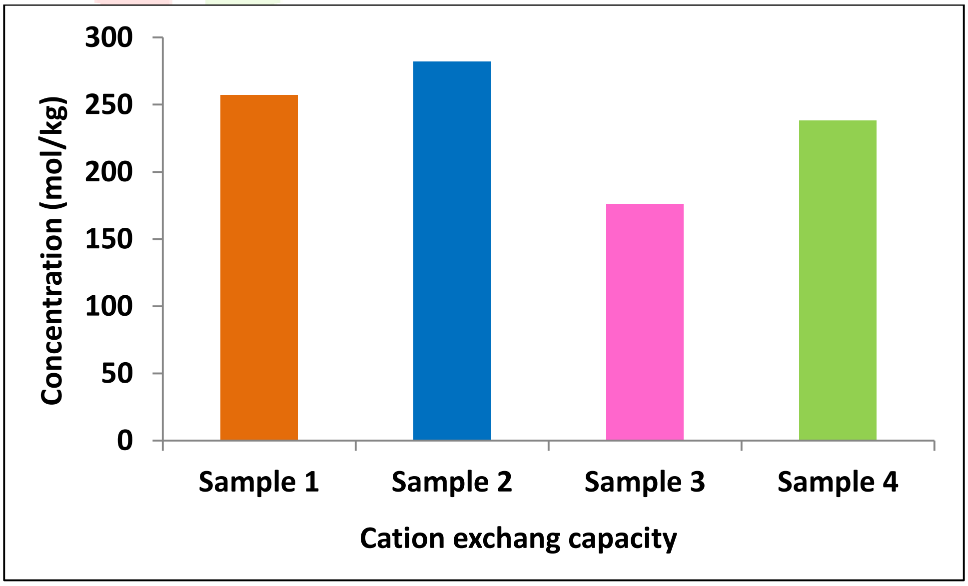

Fig. 5: Cation exchange capacity analysis of selected soil samples

Nitrogen Soil N exist both in mineral (inorganic) forms, available for plant uptake, and in complex organic forms that are not readily available. The most common analytical approach to determine mineral N concentration is potassium chloride extraction. There are two mineral N forms, NO3-N and ammonium-nitrogen (NH4-N); the NO3-N form usually predominates, and often is the only form reported. NO3-N exists only in a soluble form and is easily extracted from soil, and therefore the soil test result unambiguously describes soil NO3-N concentration. Organic N can be characterized in several ways. A "Kjeldahl" digestion dissolves soil organic matter (containing N) in a strong acid solution; results are reported as "Kjeldahl N" or "TKN". Soil can also be heated in a furnace to combust organic matter, with N measured in the furnace exhaust; this is usually referred to as "total N". These measures of organic N may be useful to rank the relative potential of soils to supply N over time, but do not give an indication of current N availability. It should be noted that total N by combustion will include mineral N forms, but in most soils mineral N is a very small fraction of total N (usually < 5%); TKN does not include nitrogen in NO3-N form.

Phosphorus

The "Olsen", or bicarbonate, extraction test is the laboratory method most appropriate for P determination in California soils with pH greater than 6.2. In this method dry soil is extracted with a weak solution of sodium bicarbonate; the extracting solution is adjusted to pH 8.5 to prevent the extraction of P that would not normally be plant-available in alkaline soil. For soils with pH < 6.2, the "Bray" extraction test is most appropriate. The Bray extraction solution is mildly acidic, and therefore similar to soil solution pH in these soils. Both the Olsen and Bray techniques extract only a small portion of total soil P, and therefore should be considered to be indexes of relative soil P availability rather than quantitative measures of soil P content.

Potassium

The most common analytical technique for soil K availability is ammonium acetate extraction. In this method dry soil is extracted with an ammonium acetate solution; the NH4-N ions in solution displace K on soil cation exchange sites; for that reason this procedure is often referred to as the "exchangeable" K test. However, this technique can also extract K from "fixation sites" within the structural layers of some types of silt and clay particles. In soils derived from vermiculitic parent material, and having high silt and clay content, as much as 25% of "exchangeable" K can actually represent "fixed" K. Since in some soils the total amount of fixed K can be much larger than the amount of K on exchange sites, and much of the fixed K may become plant-available over time, the extractable K soil test should be considered to be an index of relative soil K availability rather than a quantitative measure of soil K content Calcium, magnesium and sodium The concentration of these cations can be measured in the same ammonium acetate extract used to determine K availability; many laboratories do just that, reporting "exchangeable" calcium (Ca), magnesium (Mg) and sodium (Na). While this is a valid measure of Na, it does not accurately describe Ca or Mg availability in alkaline soils containing Ca and Mg carbonates; such soils are common in California. The test that more accurately describes soil Ca and Mg availability is saturated paste extraction; in this procedure dry soil is mixed with enough distilled water to create a slurry, which is then filtered under vacuum. Results are often reported as "soluble" or "saturated paste" Ca and Mg. Saturated paste extraction is also the preferred method for evaluating soil salinity.

Table 2: Nutrient analysis of selected soil samples

S. N.	Parameters	S_1	S_2	S_3	S_4
1	N	263.42	238.33	288.51	150.52
2	K	1332.8	706.72	197.12	201.6
3	P	15.23	4.48	7.16	11.64
4	S	12.5	38.75	10	21.25
5	Mn	22.29	16.91	8.02	2.1
6	Fe	7.75	2.26	0.9	1.08
7	Cu	2.99	1.43	0.4	1.27
8	Zn	0.54	0.26	0.18	0.55
9	B	0.3	0.3	0.3	0.2

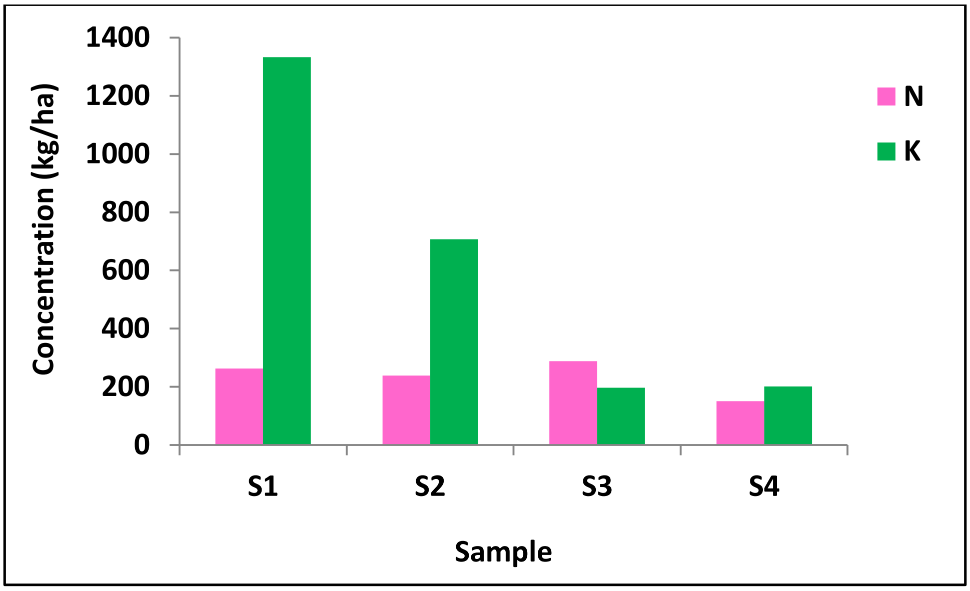

Fig. Available nitrogen and potassium concentrations of soil samples

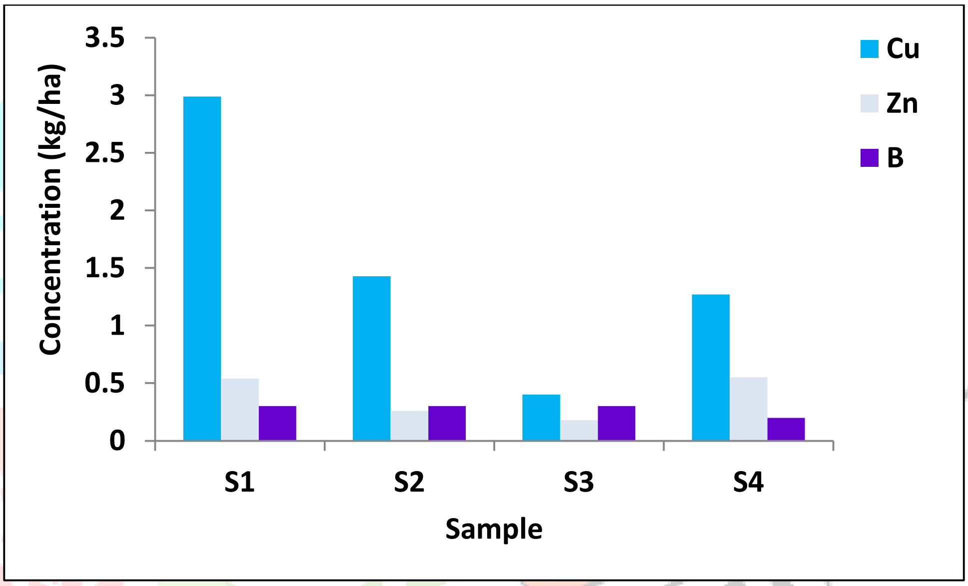

Fig. Available copper, zinc, and boran concentrations of soil samples

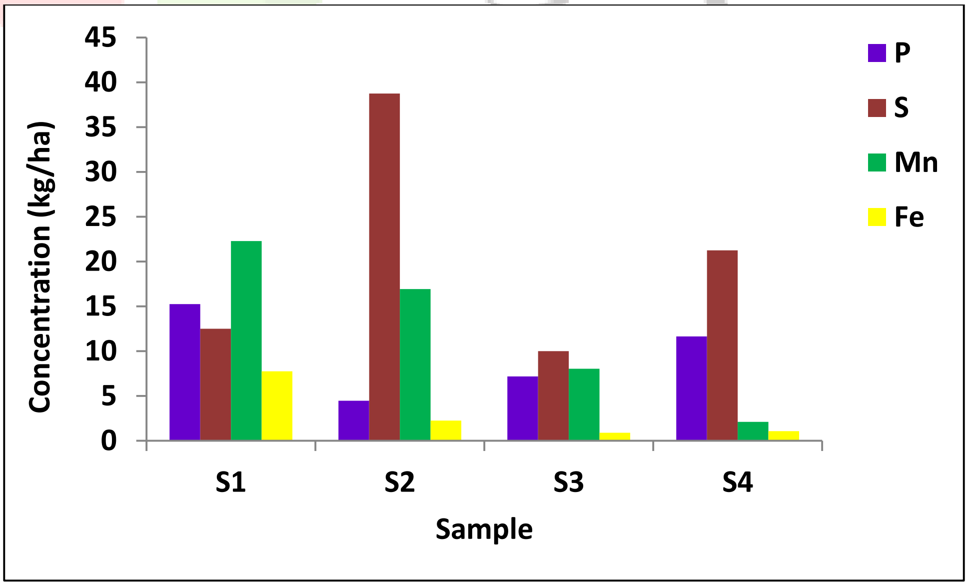

Fig. Available phosphorus, sulfar, manganese, and iron concentrations of soil samples

Micronutrients

Zinc (Zn), iron (Fe), manganese (Mn) and copper (Cu) exist in a variety of chemical compounds in the soil, and determining the fraction that is plant-available is difficult. The most commonly used technique is extraction with DTPA, a chelating compound. Where boron (B) concentration may be low enough to be a limiting factor in crop growth, soil extraction with hot water is a common analytical technique; where the concern is that B may be present in sufficient concentration to be toxic to a crop, saturated paste extraction is the appropriate technique.

Conclusion:

Conclusively from study area soil sample show medium proportion of organic carbon. The higher nutrient fertility status in irrigation fields might be associated with intensive cultivation and plantation of cash crops like sugarcane, cotton, fruit crops etc. in which use of fertilizers as practiced by the cultivators. Classification criteria the study area soils showed normal pH. The majority of soil samples low status of available phosphorous was found in all soil samples the generated nutrient status information can serve as an effective tool for farmers and policy makers in adoption of site specific nutrient management practices.

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