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Physical, Physico-Chemical and Nutrient Analysis of Soils from Certain Farm Holdings of Shamshabad to Evaluate Soil Fertility Status

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Abstract: ***Soil provides plants with essential minerals and nutrients; it provides air for gaseous exchange between roots and atmosphere. It protects the plants from erosion and other destructive on physical, chemical and biological activity. The natural environment is clean but due to man activities, it gets polluted resulting in environmental pollution. In present study three samples of soil taken from different areas to study the different physiochemical parameters of the soil. The analysis of nutrient also done in order to measure the nutrients present in the soil.***
Modern agriculture has become dependent on chemicals, the chemical fertilizers and pesticides which over a period have adverse toxic effects on production.
The increase use of pesticides has posed many environmental and health problems.
The Physico-chemical and chemical constituents study of soil based on various parameters like pH, Electrical conductivity, total organic carbon, available nitrogen (N), available phosphorous (P_2O_5) and available potassium(K_2O).
This information will help the farmers to decide the problems related to soil alkalinity, salt concentration and soil nutrients, may decide amount of fertilizers required, to make the production well. Three samples were taken from three different farms of different areas. All the above parameters were studied and from analysis it was found that nitrogen content is low, phosphorus and potassium levels were medium and organic matter is deficient. The important observation during the study is that the parameters were fluctuating farm to farm. This study can thus provide an indication to the soil health of the particular area.
Keywords: pH, Electrical conductivity, soil nutrients, Fertilizers, Pesticides

I. INTRODUCTION

Soil is a natural body of mineral & organic material differentiated into horizons which differ among themselves as well as from Underlying material in their morphology physical makeup, chemical Composition and biological characteristics. Due to Industrialization and other anthropogenic activities, the soil of city gets polluted. Soil thus form a substrate for plant growth which performs many functions essential to life and in general most plants grow by a nutrients from the soil whose ability to do this depends on nature of soil.

A. Procedure

Three samples of soil taken from three different farms of shamshabad. The samples were preserved in polythene bags for further analysis. The chemicals and reagents were used for analysis and standard instrumental and non-instrumental method was used for analysis for the estimation of these parameters. Chloride in the soil was found by titration method. The fertility of the soil depends on the concentration of N, P, K, Organic & inorganic nutrients and water. Nitrogen is required for growth of plants and constituents of chlorophyll, Phosphorous acts as an energy storage, Potassium found in mineral form and helps in all division, carbohydrate formation etc.

II. MATERIALS AND METHODS

A. Estimation of pH of Soil

To 5ml of distilled water, add a pinch of soil sample. Take a broad range pH paper indicator(a small piece) and dip it in the soil-water suspension. The colour of the paper changes. Match the colour with the colour scale given on a booklet. This gives an approximate pH value. For more correct value, narrow range pH paper indicator of the value indicated by the broad range paper is now taken. The colour change is compared with the scale given on the booklet and approximate pH value is determined.

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B. Estimation of Electrical Conductivity

Prepare a 1:5 soil:water suspension by weighing 10g of air dried soil into a bottle. Add 50 ml deionised water. Mechanically shake at 15rpm for about 1 hour to dissolve soluble salts. Calibrate the conductivity meter using the KCl reference solution to obtain the cell constant. Rinse the cell thoroughly. Measure the electrical conductivity of the 0.01 M KCl at the same temperature as the soil suspensions. Rinse the conductivity cell with the soil suspension. Refill the conductivity cell without disturbing the settled soil. Record the value indicated on the conductivity meter. Rinse the cell with deionised water between samples.

C. Estimation of Organic Carbon

The soil samples were weighed and encapsulated in the foils and were introduced to the furnace at 950^0C of the elemental analyser and flushed with oxygen for complete combustion. The carbon containing compounds were oxidized to CO_2 and separated from all other oxides and lead to the infra red gas analyzer for estimation. The instrument system was calibrated with soil standards, each time the estimation is carried,

D . Estimation of Available Nitrogen(N) Content

Weigh 50g of processed soil sample in a kjeldahl flask. To this add 1g of potassium sulphate (K_2So_4) and 30 ml of conc. Sulphuric acid. Shake the contents and allow to stand for 30 minutes with frequent shaking. Digest the content until greenish color appears.K_2So_4 raises the boiling point of the acid. So that the loss of acid volatile solution is prevented. $CuSo_4$. $5H_2O$ is digestion accelerator which catalyses the speed of digestion process. Run a blank with the same quantities of reagents and subtract the blank value from the value of the soil digest. Digestion is effected on the Kjeldahl digestion rack with low flame for the first 10 – 30 min until the frothing stops and then gradually more strongly until the sample is completely charred. The heat is gradually raised until the acid reaches approximately one third the way up the digestion-flask. The flame is not allowed to touch the flask above the part occurred by the liquid. Excessive boiling may cause volatilization of the acid before the organic matter is oxidized. Cool the content and dilute to about 100 mL with distilled water. Swirl the flask for about 2 minutes and transfer the fluid part to a 1000 mL distillation flask. Wash the residue left in the Kjeldahl flask with 4 or 5 lots of 50 – 60 mL distilled water, decanting the washings into the distillation flask. Add a few, glass bead to prevent bumping. Fit the flask with two neck joints to one neck dropping funnel is connected for adding 40 % NaOH while to the other neck Kjeldahl trap, which is used to trap the NaOH coming with the distillate. The trap is connected to the condenser with a delivery tube which dips into 50 mL of 0.1 N HCl contained in a conical flask, with one or two drops of methyl red indicator. Add about 125 mL (or 100 ml if bumping is a problem) of 40 % NaOH solution till the content are alkaline in reaction (about 5 times the volume of Con. H2SO4 used during the digestion). Heat the RB flask. Allow the ammonia formed to be absorbed in standard HCl. Wash down the end of the tube. 150 mL distilled water is added to the conical flask. When no more ammonia is received (test with a red litmus paper turning blue) stop the distillation. Titrate the excess of the acid with 0.1 N NaOH solution till the pink colour changes to yellow. From the titre value calculate the multi equivalence of the acid participating in the process of ammonia absorbing during digestion.

1) Calculation

a) Blank

Volume of HCl taken for blank = a mL
Volume of NaOH used = b mL
Volume of HCl consumed by liberated NH3 present in blank = a – b = z mL

b) Sample

Volume of HCl taken for sample = v mL
Volume of NaOH used = u mL
Volume of HCl consumed by liberated NH3 present in sample = v – u = w mL
Volume of HCl consumed for NH3 liberated by sample only = w – z = y mL
1000 mL 1N HCl = 1000 mL 1 N NH3 = 17 g NH3 = 14 g N
1 mL 1N HCl = 1 mL 1 N NH3 = 0.014 g N
1 mL 0.1 N HCl = 1 mL 0.1 N NH3 = 0.0014 g N
Weight of Nitrogen in 5 g of Sample = y x 0.0014 g N = q g N
% of nitrogen in sample = q x 100

5

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E. Estimation of Available Phosphorus (P_2O_5) Content

Many tests for determining the so-called " available" phosphorus in soils have beem in use for many years. The sodium bicarbonate method of Olsen et al. (1954) has given better correlation with field responses to phosphate fertilizers on both acid and alkaline soils than many of the other methods.

5 g air-dried soil (passed through 1-2 mm sieve) is suspended in 100 ml of Na HCO3 extraction solution. The suspension is shaken for a period of 30 minutes. The solution is filtrated through a whatman 40 or other suitable filter paper. The concentration of phosphorus in the filtrate is determined by Micro-Vanadate-Molybdate methods.

1-35 ml of soil extract is transferred to a 50 ml volumetric flask. 10 ml of the vanadate solution are added and make the volume to 50 ml with distilled water. After 10 minutes read at 405 nm by using spectrophotometer.

$$\textbf{P mg/100g} = \frac{\text{Reading x Factor}}{10} \times \frac{100}{\text{dry weight at } 105^0\text{C}}$$

F. Estimation of Available Potassium (K_2O) Content

Potassium and sodium ions can be determined quantitatively when they are atomized from solution, led to burner and exited to spectral emission in a flame. Since the intensity of the light emitted by each element depends primarily on the concentration of its atoms in the flame at any given instant, a measurement of the light intensity produced by a given element makes possible the quantitative determination of that element.

Pipet an aliquot of the solution to be analyzed into a 50 ml volumetric flask, complete with 1 N ammonium-acetate solution (pH 7). Determine the potassium concentration by use of the flame photometer and the appropriate calibration curve. Introduce distilled water for approximately 3 minutes to clean the intake and the atomizer/burner assembly. Close the valve of supplying gas. Push down button of gas selection and wait until the flame is extinguished. Switch off main switch. Place cover over the housing after allowing sufficient time for cooling off.

1) Calculation

a) Concentration of K or Na in sample-extract can be calculated by slope calculation. For every concentration of the standard solution (10-100 ppm) the concentration is divided by the reading of the apparatus. Mean of the resulting values is the slope.

b) Content of K and in soil sample Content of K as mg/100g soil (at 105^0C)

G. Estimation of Exchangeable Potassium content

It is estimated by by ammonium acetate method. Ammonium acetate is known to extract the soil exchangeable potassium among other cations. This is rapid procedure for extraction of potassium separately from other exchangeable metallic cations. Potassium adsorbed on the soil particles is exchanged with ammonium of the acetate solution, maximally at the latter's strength.

Add 100 ml of ammonium acetate solution to 5 g air dried soil (passed through 1-2 mm sieve) in a plastic bottle. Place the bottles in the shaker. Shake for 1 hour. Filtrate through filter paper whatman 41 or S & S 512; M & N 280. Receive in a plastic container. Discard the first third of the filtrate.

H. Estimation of Exchangeable Sodium Content

1) Sample Preparation: Weigh 10g of air-dried soil into a 500ml conical flask and add 200ml 1N neutral ammonium acetate solution. Allow to stand for 18 hours, stirring occasionally. Withdraw and centrifuge part of the suspension. Transfer 5ml of the supernatant liquid to a 50ml volumetric flask and dilute to the mark with 1N neutral ammonium acetate.

2) Standard Preparation: Prepare a 5ppm sodium standard as follows: add 5ml of the 1000ppm standard to a 1 litre volumetric flask. Add 1N ammonium acetate to the mark. Prepare 4, 3, 2 and 1ppm sodium standards in a similar way adding 4, 3, 2 or 1ml of the 1000ppm standard to a 1 litre volumetric flask together with 1, 2, 3 or 4ml deionised water (to make a volume of 5ml). Add 1N ammonium acetate to the mark. Prepare a blank solution by adding 5ml deionised water to a 1 litre volumetric flask and make up the volume to the mark with 1N neutral ammonium acetate.

3) Calibration: Set up the flame photometer for sodium measurements, as detailed in the instruction manual. Aspirate the blank solution and set the zero. Aspirate the 5ppm sodium standard solution and set the sensitivity to read 100. Aspirate the other standards in ascending order and construct a calibration graph.

4) Sample Measurement: Aspirate the sample and record its meter reading. Read off the concentration of the sample from the calibration curve.

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I. Estimation of Exchangeable Calcium Content

The concentration of calcium in the soil solution extract is determined by means of a Beckman Model DU Flame Spectrophotometer. The per cent transmittance of each of the calcium standard reference solutions and the soil solution extract is measured according to the operating procedure described in Section II of the Instruction Manual for the Beckman Model DU Flame Spectrophotometer . The amount of calcium in the soil solution extract is determined by referring to a cali- bration curve obtained by plotting the per cent transmittance readings against the calcium concentration of the five reference solutions.

J. Estimation of Exchangeable Magnesium Content

Magnesium is extracted from the soil by mixing 10 milliliters of 1 normal, pH7, ammonium acetate with a 1 gram scoop of air-dried soil and shaking for 5 minutes. The filtered extract is analyzed with an inductively coupled plasma atomic emmission spectrometer (ICP-AES) for magnesium. The results are reported in parts per million (ppm) calcium (Ca) and magnesium (Mg) in the soil.

K. Estimation of Calcium Carbonate Equivalent (%)

Amount of calcium carbonate in soil indicates one of the most important soil properties. In this method it is determined volumetrically by measuring the CO2 volume evolved from the reaction of hydrochloric acid with soil carbonate.

a) Fill the graduated tubes with potassium bichromate and adjust the upper level in both tubes equally.

b) Put 0.10 gm oven-dried CaCO3 in the vail and inserted in an upright position in the reaction flask containing 10 ml of HCL 1:3 after mixing 22.4 cm3 CO2 are evolved under the conditions of the standard temperature and pressure.

A weight of 1 g air dried soil sample is transferred into a plastic vial and inserted in an upright position in the reaction flask containing 10 ml of HCL 1 : 3. Mix it thoroughly. Record the difference of potassium bichromate volume, due to evolved CO2 gas pressure in the graduated upper tubes. Record room temperature. Correct the volume of CO2 for the standard temperature and pressure. Then milligrames of soil carbonates as CaCO3 can be calculated.

$$CaCO3\ \% = \frac{\text{vol. of } Co_2(cm^3) \times 273 \times 100 \times 100 \times 10}{1000 \times (273 + \text{Temperature}) \times 224 \times 1}$$

L. Estimation of Carbonate Carbon Co_3- C (%)

A coulometric titration is used for the determination of carbonate carbon in geological materials. Carbon dioxide is evolved from the sample by the addition of 2 *M* perchloric acid, with heating, and is determined by automated coulometric titration.

In some cases the reaction of gaseous carbon dioxide with a solution of barium hydroxide is used as a basis of an accurate, rapid and inexpensive volumetric method for the determination of carbonate and organic carbon.

M. Estimation of Cation Exchange Capacity (C.E.C)

Weigh 4 g (for medium to fine textured) or 6 g (for coarse textured) air-dry soil into a 40-mL centrifuge tube, and add 33 mL 1 N sodium acetate trihy- drate solution, stopper tube, and shake for 5 minutes. Remove stopper from tube and centrifuge at 3000 rpm until supernatant liquid is clear. Decant the supernatant as completely as possible and discard. Repeat with 33-mL portions 1 N sodium acetate trihydrate solution, a total of four times, discarding the supernatant liquid each time. Then add 33-mL 95% ethanol, stopper tube, and shake for 5 minutes, unstopper tube, and centrifuge until the supernatant is clear and decant. Wash the sample with 33 mL portions 95% ethanol, a total of three times, discarding the supernatant liquid each time. The electrical conductivity (EC) of the supernatant liquid from the third washing should be less than 400 µS/cm.

Replace the adsorbed sodium (Na+) from the sample by extraction with three 33-mL portions 1 N ammonium acetate solution. Each time shake for 5 minutes, and centrifuge until supernatant liquid is clear. Decant the three supernatant liquids as completely as possible into a 100-mL volumetric flask, bring to volume with 1 N ammonium acetate solution, and mix well. Run a series of suitable Na standards, and draw a calibration curve. Measure the samples (soil extract) and take the emission readings by a Flame Photometer. Calculate sodium (Na) concentration according to the calibration curve.

For Cation Exchange Capacity in soil:

$$\text{CEC (meq/100 g)} = \text{meq/L Na (from calibration curve)} \times \frac{A}{Wt} \times \frac{100}{1000}$$

Where: A = Total volume of the extract (mL)

Wt = Weight of the air-dry soi1 (g)

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N. Estimation of Chlorides

Prepare 1:5 soil suspensions by adding 100 ml of distilled water to 20g of soil. Stir mechanically for about one hour. 2) Filter the suspension through Whatman no 50 filter paper using Buchner funnel and vacuum pump. 3) Determine the chloride content in 50 ml soil solution in conical flask and add 2ml of K2CrO4 solution. 4) Titrate the contents against 0.02N, AgNO3, until a persistent red tinge appears.

% of chloride = (ml x N) of AgNo3 x 35.5 ml of solution x 2

O. Estimation of Sulfur

The sample is heated with sodium bicarbonate and silver oxide at 550° for 3h, and the sulphur content of the whole residue is reduced to hydrogen sulphide and determined as methylene blue. It is a rapid and accurate method for the determination of the total sulphur content of soil.

In the present inquisition 0.2 g sample was mixed to the 20 ml of each extractant, i.e., acetone, toluene and xylene at the ratio of 1:100. The solution was shaken thoroughly on suitable shaking machine for 45 minutes to 1 hour and allowed to stand for overnight. Then the solution was filtered through Whatman no.44.

Now 2 ml of aliquot was taken in 50 ml white porcelain basin, 2 ml of Potassium cyanide (KCN, 0.1M: 0.6519 g/100 ml) was added to the sample solution to give thiocyanide which was then titrated with 0.025M $AgNO_3$ (4.2467 g/L) in presence of 2 ml of 0.33 M formalaldehyde (1 ml of Conc.HCOH/100 ml) to bind residual cyanide ions..

For this reason same amount of KCN was added in the solution as to the amount of aliquot in the procedure to achieve the maximum recovery from the sample. Care must be taken during titration, pour down each drop from burette containing 0.025M $AgNO_3$ to the mixture after 4 to 5 seconds. At the end of titration the color should give bright coffee color. The titration reading (R) was note down. Average value of three readings was used in the following calculation after standardize or correction the 0.025M $AgNO_3$ strength with 0.025M NaCl solution (f).

$$\text{Elemental} - \text{sulfur in } \% = \frac{32.06 \text{ X } 20 \text{ ml X } 6 \text{ ml X } 100 \text{ Xf XR}}{1000 \ 0.20\text{g} \ \ 2\text{ml}}$$

P. Determination of Micronutrients by Atomic Absorption Spectrophotometer (AAS)

An atom is capable of absorbing the same wave length of light normally emitted upon exitation. In addition, the transitional intensity of a given wavelength is affected by concentration and thickness of the absorbing medium. According to both principles, the electrically exited element-from a hollow cathode lamp causes a known spectral emission of the element. A part of the lamp beam emission is absorbed in the flame by the neutral atom of the same element in the flame atomized sample solution. Absorbance correlates with element concentration in the sample.

Preparation of standard reference solutions:-

Fe: 0.2, 0.5, 1.0, 2.0, 4.0, 8.0, 16.0 ppm.
Mn: 0.2, 0.5, 1.0, 2.0, 4.0, 8.0 ppm.
Zn: 0.2, 0.5, 1.0, 2.0, 4.0, 8.0 ppm.
Cu: 0.2, 0.5, 1.0, 2.0, 4.0, 8.0 ppm.
Mg: 0.2, 0.5, 1.0, 2.0, 4.0, 8.0 ppm.

1) *Determination:* Set the AAS in work according to operation instructions in the manual of AAS apparatus. Care must be taken that compressed air must be introduced before the fuel gas. (2) After setting on flame, atomize the sample (which must be clear). The value is recorded on digits and printed on chart. (3) Make a blank with extracting solution. Set apparatus to zero with the blank value for every element.
2) *Calculation:* Using slope calculation: for every concentra tion of the standard solution (0.2 – 8 ppm) the concentration is divided by the reading of the apparatus. Mean of the resulting values is the slope.

$$\text{Concentration in ppm} = \text{reading x dilution x factor x } \frac{100}{\text{d.w at } 105^0\text{C}}$$

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III. RESULTS AND DISCUSSION

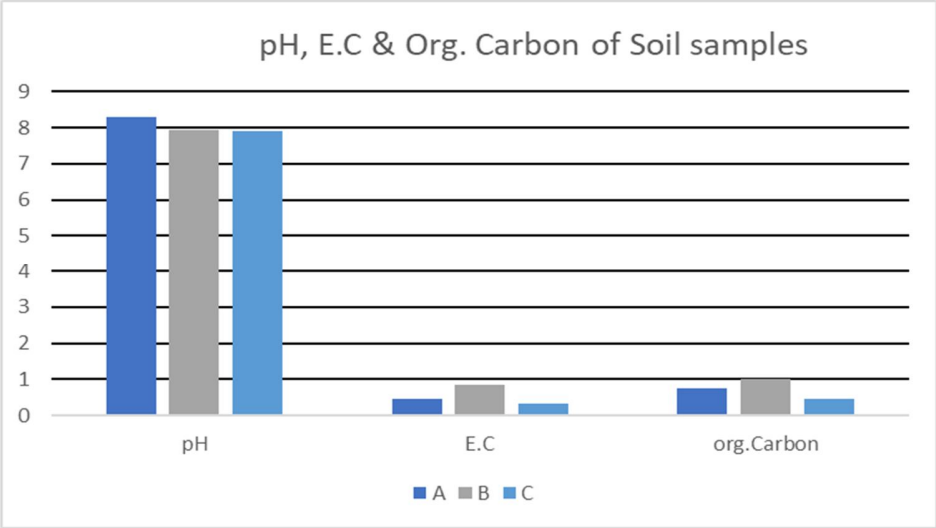
The pH results of these soils shows that these soils are slightly alkaline in nature and the pH values ranged between 7.90 to 8.30. The salt concentration indicated by E.C. revealed that these soils are moderate to high in salt concentration and E.C was ranged between 0.335 to 0.865dS/m. Organic Carbon content of these soils were ranged from Low to High and the values were 0.450 to 1.024%.

Results of major Available Nutrients were Low to Medium. Nitrogen content was low in all the soils tested. Phosphorus content was ranged between 29.75 to 47.25kg/ha. Available Potassium was also similar to Phosphorus content and it was observed to be medium in these soils and it was ranged from 267.50 to 329.50 kg/ha. The fertility status of these soils was found to be as Medium.

The soils are slightly calcareous in nature and the calcium carbonate equivalent was ranged from 0.50 to 3.650%. The exchangeable cations (Sodium, Potassium, Calcium and Magnesium) were normal in these soils. There was no sodium hazard in these soils. The Cation Exchange capacity of these soils was Low to Moderate ranged from 15.110 to 28.654 Meq/100g. Chloride content of these soils was low ranged between 28.650 to 37.120 mg/100g. Available Sulphur content was very low in these soils tested and it was ranged from 6.425 to 8.250 mg/kg and these soils need correction of sulphur by external application of elemental sulphur at the rate of 10.0 to 15.0 kg/ha to enhance sulphur content in these soils.

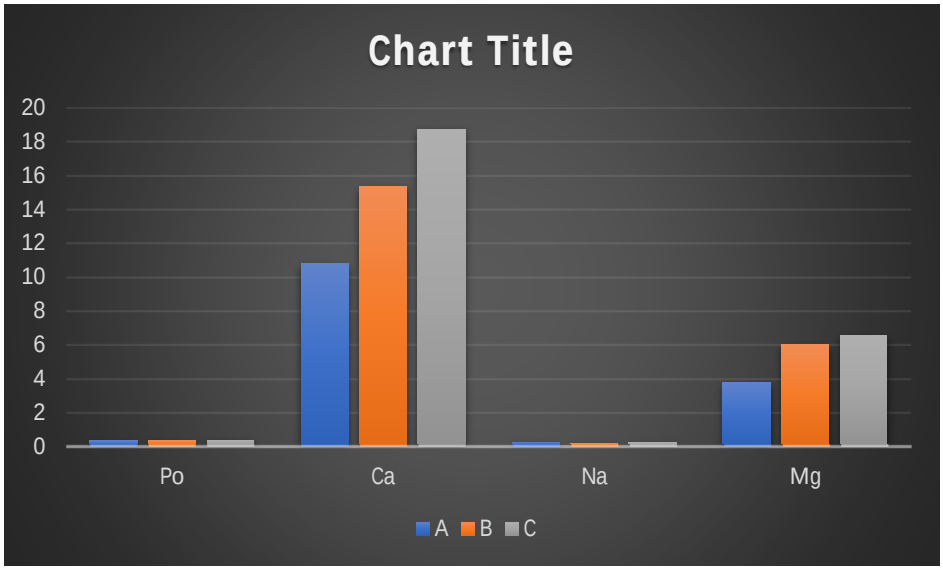
Among Micronutrients tested, it was observed that zinc was deficient and it was ranged from 0.574 to 0.612mg/kg. Rest of all other micronutrients were sufficient in these soils.

Sample	pH	E.C	Organic Carbon	Available Nutrients		
				N	P_2O_5	K_2O
A	8.30	0.450	0.765	178.50	29.75	267.50
B	7.95	0.865	1.024	265.25	47.25	284.50
C	7.90	0.335	0.450	214.75	42.90	329.50



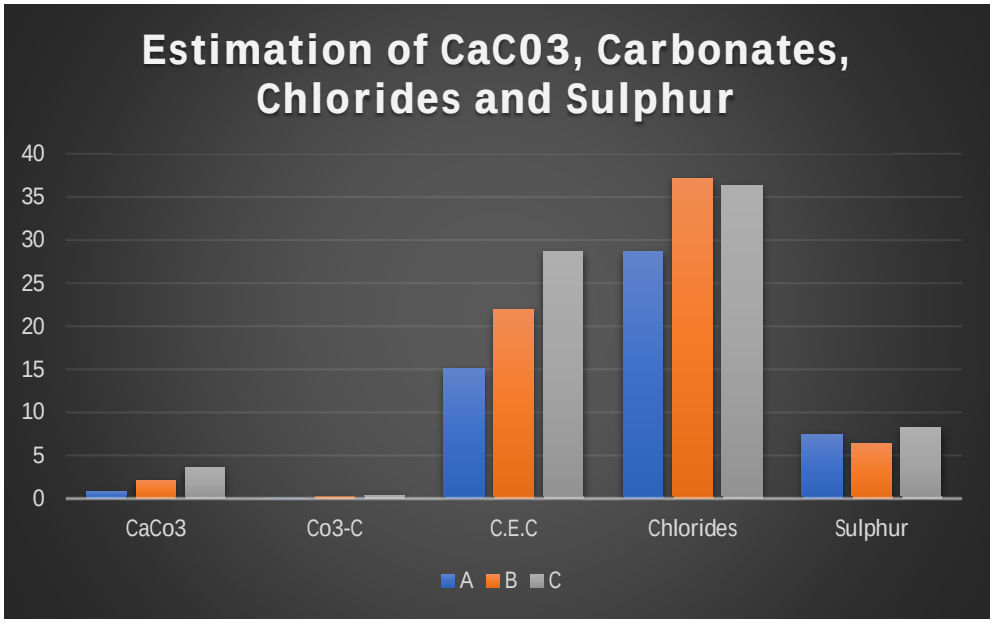
Sample	Exh.Pot	Exc. Ca	Exh.Na	Exc.Mg
A	0.305	10.785	0.245	3.775
B	0.328	15.350	0.185	6.023
C	0.376	18.750	0.225	6.563

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Estimation of $CaCo_3$, carbonate, chlorides and sulphur

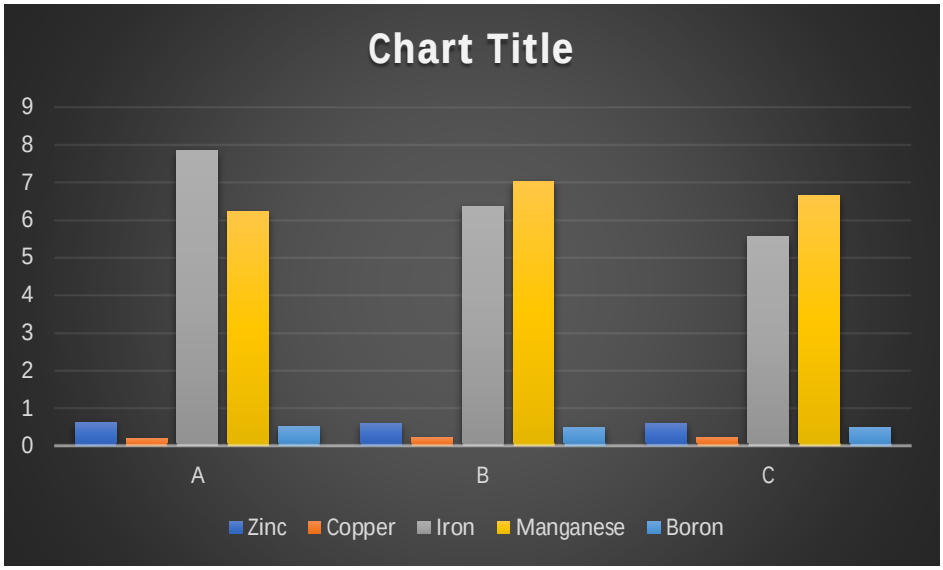
Sample	$CaCO_3$ Equivalent (%)	Carbonate Carbon Co_3- C (%)	C.E.C (Meq/100g)	Chlorides (mg/100g)	Sulphur (mg/Kg)
A	0.850	0.102	15.110	28.650	7.525
B	2.150	0.258	21.886	37.120	6.425
C	3.650	0.438	28.654	36.350	8.250



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A. Availability of Micronutrients

Sample	Zinc	Copper	Iron	Manganese	Boron
A	0.612	0.185	7.850	6.215	0.515
B	0.574	0.215	6.350	7.028	0.495
C	0.585	0.213	5.542	6.650	0.492



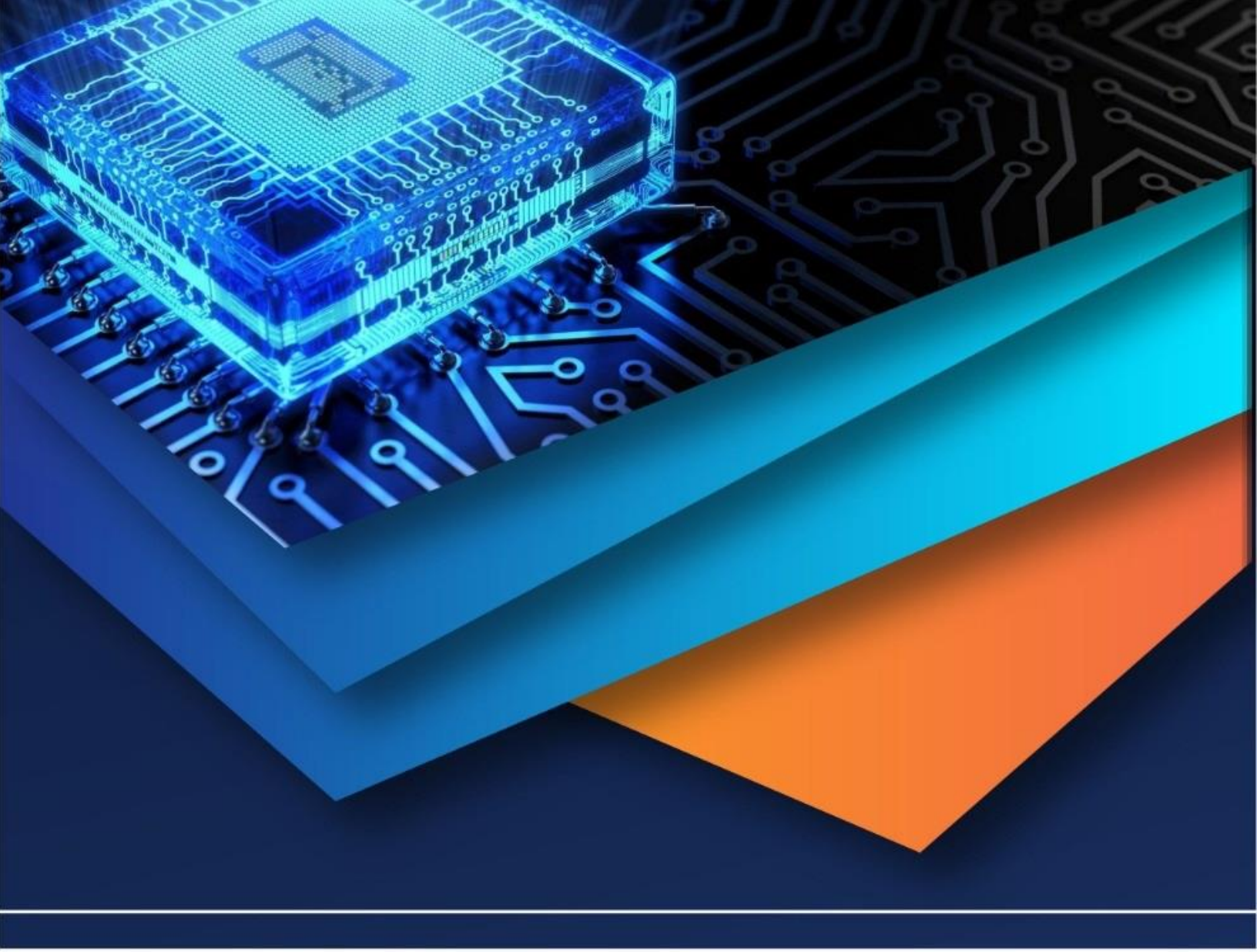
IV. CONCLUSIONS

The fertility status of these soils is Low to Medium. The important observation during the study is that the parameters were fluctuating farm to farm. This study can thus provide an indication to the soil health of the particular area.External application of organic manures and suitable chemical fertilizers have to be added to these soil to enhance productivity of these soils. Application of gypsum at the rate of 1.0 t/ha is recommended for reducing the hazards of calcareousness of these soils. These soils need correction of sulphur by external application of elemental sulphur at the rate of 10.0 to 15.0 kg/ha to enhance sulphur content in these soils. Since these soils are prone to zinc deficiency, zinc sulphate at the rate of 25.0 kg/ha is recommended.

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