

**STUDY OF PHYSICOCHEMICAL PROPERTIES AND NUTRIENT CONTENT OF AGRICULTURAL SOILS OF CHITTOOR DISTRICT USING DIFFERENT ANALYTICAL METHODS**

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**ABSTRACT**

**Objective:** The objective of this study is to determine the physicochemical properties and nutrient content of agricultural soils at various stations such as black soil from Kalroad Palli village (Chandragiri mandal), red soil from Ramapuram village (Ramachandrapuram Mandal), and clay from Yerpedu village (Yerpedu Mandal) of Chittoor district.

**Method:** The physicochemical parameters such as pH was measured using pH meter (Thermo Scientific); electrical conductivity (EC) was measured by conductivity meter (CM180 Elico Technologies); organic carbon (OC) was determined by Fourier-transform infrared (Agilent technologies 630) and with ultraviolet (UV) spectrophotometer (Agilent technologies Cary UV 60); nitrogen (N<sub>2</sub>) was estimated by Kjeldahl method; potassium (K), sodium (Na), and calcium (Ca) were estimated using flame photometer (Elico Technologies CL/361); and magnesium (Mg) was estimated by titrimetric method.

**Results:** Among these, pH (black soil - 7.41, red soil - 6.93, and clay - 7.29), EC (black soil - 1.76, red soil - 0.25, and clay - 0.14 microhoms), OC (black soil - 1.22%, red soil - 0.61%, and clay - 0.66%), N<sub>2</sub> (black soil - 0.22%, red soil - 0.25%, and clay - 0.26%), K (black soil - 5.7 ppm, red soil - 9.1 ppm, and clay - 8.4 ppm), Na (black soil - 9.5 ppm, red soil - 4.5 ppm, and clay - 5.9 ppm), Ca (black soil - 6.2 ppm, red soil - 5.7 ppm, and clay - 7.8 ppm), Mg (black soil - 0.19%, red soil - 0.25%, and clay - 0.17%) ranges were recorded at all the stations.

**Conclusion:** The present study is a preliminary attempt to study the nature of soils in different agricultural areas in Chittoor district of Andhra Pradesh, India. This could help to understand the nutrient profile of the district and to prescribe the nutrients levels of the crops for their effective growth.

**Keywords:** Soil, pH, Electrical conductivity, Nutrient content, Organic carbon.

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**INTRODUCTION**

Soil is the complex mixture of water, organic matter, minerals, air, and countless organisms that together support life on the Earth. Soil usually forms the surface of the land. It is the "Skin of the Earth." Soil is capable of supporting the plant life and the nature. Soil has a natural body which is called as "Pedosphere" which has few important functions such as plant growth which means of water storage, supply, and purification [1,2].

Usually, soil is defined as the unconsolidated organic or mineral matter on the immediate surface of the earth which serves as a natural medium for the plant growth [3]. If the salinity concentrations of soil increase, there was a reduction in seed germination occurs [4].

Soil is the mixture of inorganic materials (sand, silt, and clay particles), non-living organic matter, and living organisms with the particles arranged into soil structures with space between them which contain air and soil solution. Soil hydro-physical properties are particularly important for crop growth and maintaining soil quality [5].

**METHODS**

From the past literature survey, it was come to know that nobody has developed any analytical method for the determination of physicochemical properties and nutrient content of agricultural soils which are present in Chittoor district. Therefore, an attempt was made to determine the physicochemical properties and nutrient content of few agricultural soils of Chittoor district.

**Soil samples collection**

Soil samples were collected from various stations such as black soil from Kalroad Palli village (Chandragiri mandal), red soil from Ramapuram village (Ramachandrapuram Mandal), and clay from Yerpedu village (Yerpedu Mandal) of Chittoor district.

**Instruments required**

Fourier-transform infrared (FTIR) (Agilent technologies 630), ultraviolet (UV) spectrophotometer (Agilent Technologies Cary UV 60), sonicator (Ultrasonic Sonicator), conductivity meter (CM180 Elico Technologies), flame photometer (Elico Technologies CL/361), pH meter (Thermo Scientific), and microbalance (Sartorius) were used.

**Chemicals and reagents**

Ammonium acetate, potassium dichromate, sulfuric acid, boric acid, hydrochloric acid, hydroxylamine hydrochloride, potassium ferric cyanide, triethanolamine, and eriochrome black T were obtained from Merk Specialties.

**Methodology**

Color of soils: By the method of visual evaluation, the color of the soils was identified and shown in Table 1.

**pH determination**

20 g of 2.0 mm air-dried soil sample was weighed and transferred into a beaker. 50 ml of distilled water was added, stirred with a glass rod thoroughly for about 5 min, and kept aside for ½ h. Then, the pH was measured by keeping the soil samples under the pH meter [6], and the results are shown in Table 2.

### 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<sup>-1</sup> using CM [7,8], and the results are shown in Table 3.

### Estimation of sodium, potassium, and calcium in flame photometer using calibration curve method

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

Stock solutions of sodium chloride, potassium chloride, and calcium carbonate were prepared which is having a concentration of 1000 µg/ml. From these, linear concentrations of 2, 4, 6, 8, and 10 µg/ml were prepared and injected into flame photometer. The percentage flame intensity of standard solutions is shown in Table 4.

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

To 5 g of soil sample, 50 ml of ammonium acetate solution was added and kept for shaking on a reciprocating shaker for 15 min. Then, the resulting solution was filtered and serial dilutions were made, then introduced into flame photometer [9-11]. The percentage flame intensity of samples is shown in Table 5.

### Estimation of magnesium

2-4 g of soil sample (2 mm sieved) was weighed and transferred into a conical flask. Then, 30 ml of ammonium acetate was added and shaken for 5 min. After shaking, ammonium acetate solution was decanted, and 30 ml of 0.5N HCl was added to each sample solution. Then, the contents were agitated for 5 min in an upright loosened position, and the solution was filtered through Whatman filter paper grade No. 1. From this, 20 ml of filtrate was collected, then 50 ml of distilled water was added, and 10-15 ml of ammonium chloride-ammonium hydroxide buffer solution, 10 drops each of hydroxylamine hydrochloride, potassium ferric cyanide, triethanolamine, and eriochrome black T indicator were added. Then, the resultant solution was titrated with standard EDTA till permanent blue color will appear [12,13]. The results are shown in Table 6.

### Estimation of nitrogen procedure

To the 5 g of soil sample, 0.1 g of potassium sulfate and 10 ml of concentrated sulfuric acid were added and then heated up to 30 min at 420°C followed by selenium catalyst. The solution was cooled to 50-60°C, and 50 ml of distilled water was added to the above solution. Then, 50 ml of 35% sodium hydroxide was added and heated till the volume reaches to 100 ml. To this, 25 ml of 4% boric acid was added and then titrated with 0.1 M hydrochloric acid using methyl orange as indicator [14,15]. The results are shown in Table 7.

### Identification of organic carbon (OC) by FTIR:

A small amount of each soil sample was placed on the IR sample cell [16,17], and the peaks were recorded which are shown in Figs. 1-3 and spectral ranges are given in Table 8.

### Estimation of OC by UV-visible spectroscopy

#### Preparation of standard stock solution

To the 1 g of sucrose sample, 1000 ml distilled water was added. From that, 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100 µg/ml concentration solutions were prepared by adding 10 ml potassium dichromate and 20 ml sulfuric acid in each 100 ml volumetric flask. Then, the absorbances of resulting solutions were checked using UV visible spectrophotometer [18-20], and the results are shown in Table 9.

#### Preparation of sample solutions

1 g of each soil sample was weighed and transferred into a 100 ml flask. Then, 10 ml potassium dichromate and 20 ml sulfuric acid were added and shaken well and then allowed it to cool on asbestos sheet.

Volume was made up to 100 ml with distilled water and kept for overnight. Then, the absorbance was measured at 660 nm wavelength on spectrophotometer [5,21], and the results are shown in Table 10.

## RESULTS

### DISCUSSION

The physicochemical properties and nutrient content of selected samples were estimated using different analytical techniques, and the results were found to be as follows.

The pH of the different soils was black soil - 7.41 (slightly alkaline), clay - 7.29 (slightly alkaline), and red soil - 6.83 (neutral). EC: black soil - 1.76, clay - 0.14, and red soil - 0.25. The estimation of metal ions such as Na, K, and Ca was done using flame photometry, and the results were found to be as follows: in black soil, Na - 9.5 µg/ml, K - 5.7 µg/ml, and Ca - 6.2 µg/ml; in Clay, Na - 5.9 µg/ml, K - 8.4 µg/ml, and Ca - 7.8 µg/ml; in red soil, Na - 4.5 µg/ml, K - 9.1 µg/ml, and Ca - 5.7 µg/ml. The amount of magnesium was estimated using titrimetric analysis, and the results were found to be as follows: For black soil 0.19%, clay 0.17%, and red soil 0.25%. The nitrogen content was estimated using Kjeldahl method and the result was found to be as follows: for black soil 0.22%, clay 0.26%, and red soil 0.25%. The OC was estimated using IR and UV spectrophotometer, and the content of carbon was found to be 1.22% in black soil, 0.66% in clay, and 0.61% in red soil.

### CONCLUSION

The present study is a preliminary attempt to study the nature of soil in different agricultural areas in Chittoor district of Andhra Pradesh, India. This could help to understand the nutrient profile of the district and to prescribe the nutrients levels of the crops for their effective growth.

Table 1: Color of soils

S.No	Type of soil	Color
1.	Black	Light gray
2.	Clay	Light brown
3.	Red	Red

Table 2: pH of soils

S.No	Type of soil	pH	Result
1.	Black	7.41	Slightly alkaline
2.	Clay	7.29	Slightly alkaline
3.	Red	6.93	Neutral

Table 3: EC of soils

S.No	Soil type	EC in dS.m <sup>-1</sup>	Result
1.	Black	1.76	Poor seed emergence
2.	Clay	0.14	Good soil
3.	Red	0.25	Good soil

EC: Electrical conductivity

Table 4: Percentage flame intensity of standard solutions

S.No	Standard solution (µg/ml)	Sodium (% FI)	Potassium (% FI)	Calcium (%FI)
1.	2	4.18	26.3	25.2
2.	4	6.34	39.1	32.5
3.	6	10.84	48.4	47.2
4.	8	14.76	57.2	53.5
5.	10	19.23	68.4	64.1

Table 5: Percentage flame intensity of soil samples

Metal	Black (mg/ml)			Clay (mg/ml)			Red (mg/ml)		
	100	1	0.01	100	1	0.01	100	1	0.01
Sodium	1871	184.2	18.9	1123	113.2	10.4	690.5	69.5	6.81
Potassium	4784	465.0	45.4	6012	602.9	59.1	6459	642.3	63.2
Calcium	4996	489.9	48.1	5239	517.9	52.54	4787	475.2	46.2

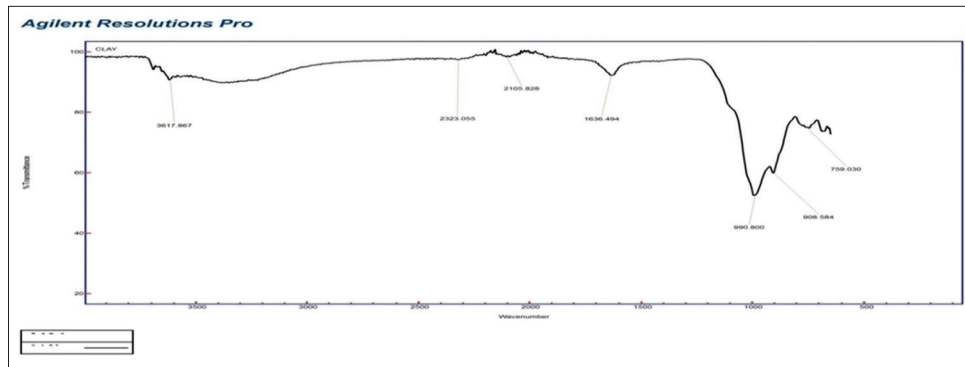


Fig. 1: Infrared spectrum of clay soil

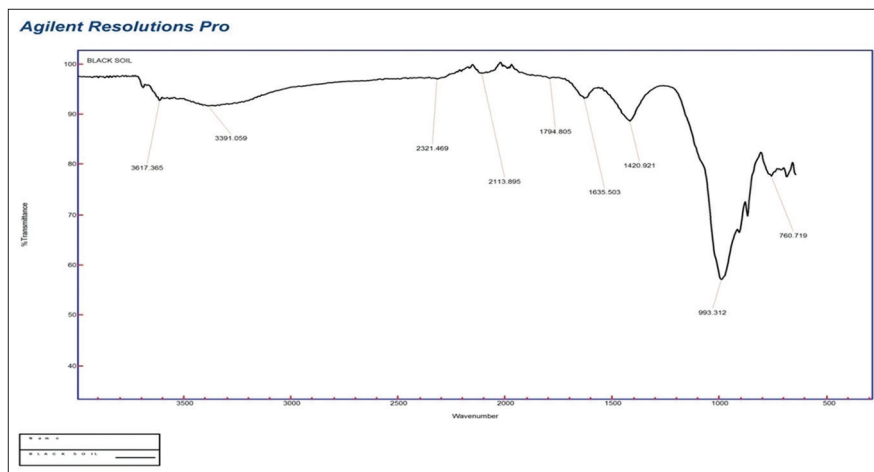


Fig. 2: Infrared spectrum of black soil

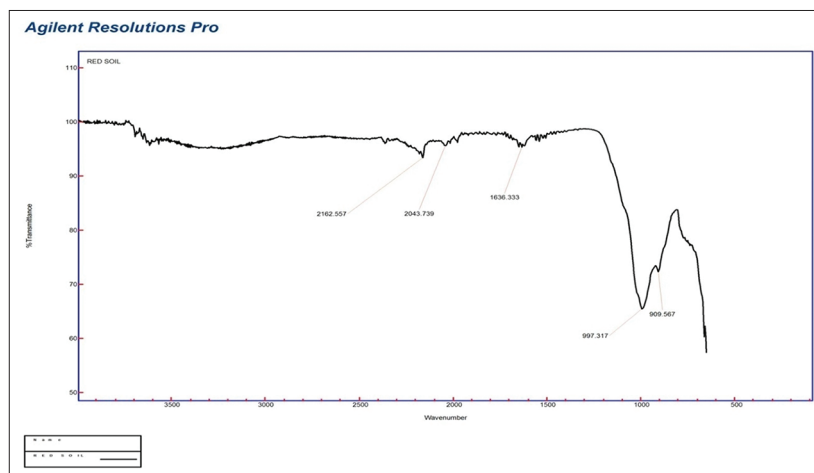


Fig. 3: Infrared spectrum of red soil

Table 6: Percentage Mg content of soils

Type of soil	Titration volume	% Mg
Black	32	0.19
Clay	28	0.17
Red	37	0.24

Table 7: Percentage N<sub>2</sub> content of soils

Type of soil	Titration volume	% N <sub>2</sub>
Black	18	0.22
Clay	21	0.26
Red	20	0.25

Table 8: IR spectral ranges of various soils

Assignment	FTIR region (cm <sup>-1</sup> )		
	Black	Clay	Red
N-H stretch (Amine)	3617.365	3617.867	-
O-H stretch	3391.085	-	-
Alkynyl C = C stretching	2113.895	2105.828	2043.739
C = C bending	1635.503	1636.494	1636.333
C = C stretching	1420.921	-	-
= C-H bending	993.312	990.800	997.317
	760.719	908.584	809.567
		759.030	

FTIR: Fourier-transform infrared

Table 9: UV absorbance of standard solution

S.NO	Standard solution(μg/ml)	Carbon %	Absorbance
1.	10	0.04	0.0541
2.	20	0.16	0.0968
3.	30	0.23	0.1521
4.	40	0.31	0.3106
5.	50	0.49	0.4637
6.	60	0.61	0.6281
7.	70	0.69	0.6829
8.	80	0.94	0.9307
9.	90	1.16	1.1470
10.	100	1.33	1.2995

UV: Ultraviolet

Table 10: UV absorbance of soil samples

S.No	Type of soil	Absorbance	% Carbon
1.	Black	1.2595	1.22
2.	Clay	0.6567	0.66
3.	Red	0.6242	0.61

UV: Ultraviolet

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#### CONFLICTS OF INTEREST

There are no conflicts of interest.

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