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Assessment of soil physico-chemical properties in major cropping systems in Medikondur mandal of Guntur district

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ABSTRACT

Soil physico-chemical properties are fundamental determinants of soil quality, directly influencing plant growth, nutrient dynamics, and overall agricultural productivity. A study was conducted to examine the physico-chemical properties in major cropping systems in Medikondur mandal of Guntur district. Samples are collected by taking GPS locations in the study area. The major cropping systems in study area are rice-rice, rice-fallow, cotton-fallow and maize- blackgram. The soils were neutral to alkaline in reaction and non-saline in nature. The soils of maize-blackgram cropping system reported higher organic carbon and calcium carbonate is higher in cotton-fallow cropping systems. Among these maize-blackgram system has shown efficient results than other cropping systems.

Keywords: *Cropping system, Organic carbon and Calcium carbonate*

Soil is one of the most vital natural resources, essential for all life on Earth. It supports life by providing food, shelter, and other necessities, directly or indirectly. Any alteration in soil properties can limit plant growth and crop yields. Adopting soil health assessment and management practices is crucial for sustaining soil quality (Andrews *et al.,* 2004). Soil physico-chemical properties serve as key indicators of soil quality and are essential in determining the capacity of soil to support plant growth, regulate water, sustain microbial life, and store nutrients.

A crucial part of every agricultural system are cropping systems, which are defined as the way that various crops are cultivated or the order in which they are produced on a piece of land over a predetermined amount of time (Jokela *et al*., 2009). Cropping systems, defined by the type and sequence of crops grown over time, play a key role in influencing soil parameters based on practices like tillage, fertilization, and rotation.

Parameters such as pH, electrical conductivity (EC), organic carbon (OC), and calcium carbonate ($CaCO_f$) play a significant role in influencing nutrient availability, microbial activity, and overall soil productivity. By analyzing these indicators, the study seeks to identify spatial variations in soil quality and understand how different land use and cropping patterns influence soil physico-chemical characteristics. This research is particularly relevant for developing region-specific soil management strategies to enhance nutrient use efficiency, improve soil structure, and promote sustainable agricultural practices. The findings will help in formulating appropriate soil fertility enhancement measures tailored to the agro-ecological conditions of the study area, ultimately contributing to long-term soil sustainability and productivity. Soil quality, though not directly measurable, but assessed through physical, physico-chemical, chemical, and biological indicators (Karlen *et al.,* 2003),. Thus the physico-chemical study of territory is very significant because both physical and chemical properties which bear upon the soil productivity.

MATERIAL AND METHODS

Study area

The study area occupies a geographic extent of about 200-250 km^2 and the decennial average rainfall is about 830.9 mm Globally this mandal lies between $16^0$17’57.18" N and $80^0$25’55.06" of the E and the investigation was carried in the year 2024-25. experiences tropical climate with the average

Table 1. Analytical methods followed for physico - chemical properties of soil

PARAMETER	METHOD	REFERENCE
pH	1: 2.5 (w/v) soil-water suspension, measured in pH Meter	Jackson ., 1973
Electrical conductivity	Supernatant solution of 1:2.5 (w/v) soil-water suspension measured in conductivity meter	Jackson., 1973
Organic carbon	Wet-oxidation method	Walkley and Black., 1934
Calcium Carbonate	Concentrated HCl method	Jackson., 1973

annual temperatures records at 28.4^0 C (83.1^0 F).comprises of Clay, Sandy clay and sandy clay loam soils.

Soil analysis

One hundred soil samples were collected from four major cropping systems *viz.,* rice-rice, rice-fallow, cotton-fallow, maize-blackgram. Each sample contains one kg of surface soil(0-15 cm) were collected by using GPS equipment . The collected soil samples were shade dried, sieved with 2mm sieve and the sieved samples used for analysing physical, physico-chemical, chemical and biological properties. Processed soil samples were analysed for different physico-chemical parameters (Table .1).

RESULTS AND DISCUSSION

Soil Reaction (pH)

The most significant property of soil is its pH level, its effects on all other parameters of soil. The pH of soils under major cropping systems varied in rice- rice, rice- fallow, cotton-fallow and maize-blackgram, cropping systems and mean values of 7.64, 7.67, 7.73 and 7.57,are recorded respectively (Table.2) . Similar findings were aligned by Rajeevana *et al.* (2022) as almost all the samples are in neutral to alkali in range .

This indicates that soil pH is strongly influenced by the cropping pattern and inherent soil characteristics. Soil pH is a measure of the acidity or alkalinity of the soil, and it profoundly influences biological, chemical, and physical processes in the soil by increasing nutrient availability, Microbial activity and reducing toxicity of elements (Aluminum, Manganese and Iron) especially in acidic soils Spatial variability was depicted in fig.1

Electrical conductivity

The electrical conductivity of a soil solution increases with the increased concentration of ions. Electrical conductivity is a very quick, simple and inexpensive method to check health of soils. Soils were non-saline with EC ranging from 0.2 to 0.66 dS m^{-1}.

Slightly higher salts may result from semi-arid climate, fine soil texture, low rainfall limiting leaching, irrigation with saline water, fertilizer use, and shallow groundwater causing salt rise. Similar results were aligned with Harika *et al.* (2022) EC is within a favorable range helps in efficient root uptake, Guides fertilizer management by monitoring and preventing over-fertilization, which could otherwise lead to salt stress. Spatial variability was depicted in fig.2

Organic carbon

The organic carbon content of the soils (Table 2) varied from 0.34 to 0.94 per cent with a mean of 0.63 % in maize-blackgram and lowest mean in 0.57

Table 2. Range and Mean of physico-chemical parameters in soils of major cropping systems of Medikondur mandal.

SOIL PROPERTIES	Rice-Rice		Rice-Fallow		Cotton-Fallow		Maize-Blackgram	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
pH	7.34 - 7.97	7.64	7.39 - 7.98	7.67	7.37 - 7.98	7.73	7.25 - 8.04	7.57
EC (dS m^{-1})	0.30-0.58	0.42	0.21 - 0.56	0.38	0.20- 0.66	0.4	0.29- 0.56	0.37
OC (%)	0.34-0.94	0.57	0.35 - 0.82	0.59	0.35-0.89	0.6	0.39-0.88	0.63
$CaCO_3$ (%)	1.50 – 13.0	5.91	1.0 - 10.5	4.96	1.5 - 15.5	7.48	1.5 - 12.5	6.13

in rice-rice cropping system. The organic carbon was 33% of low, 46% of medium and 21% of samples are high in organic carbon content.the maize-blackgram cropping system. Organic carbon is a key component of soil organic matter and serves as an indicator of soil fertility and biological activity by improves soil structure, enhances nutrient supply, promotes microbial activity and increases water retention. Spatial variability was depicted in fig.3.

The variation in soil organic carbon content might be due to differences in the rate of application of organic manures such as farm yard manure and crop residues by farmers Subbaiah (2020). Additionally, factors such as soil microbial activity, soil texture, and cropping intensity influence organic carbon levels. Intensive cultivation and frequent tillage can accelerate organic matter breakdown, reducing carbon stocks.

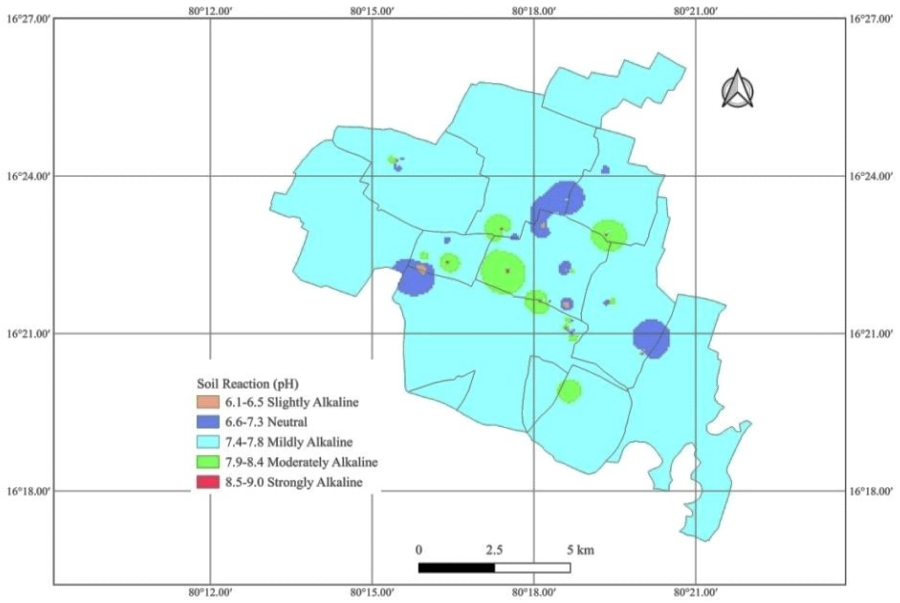

Fig. 1 Spatial variability of Soil Reaction (pH) in Medikondur mandal

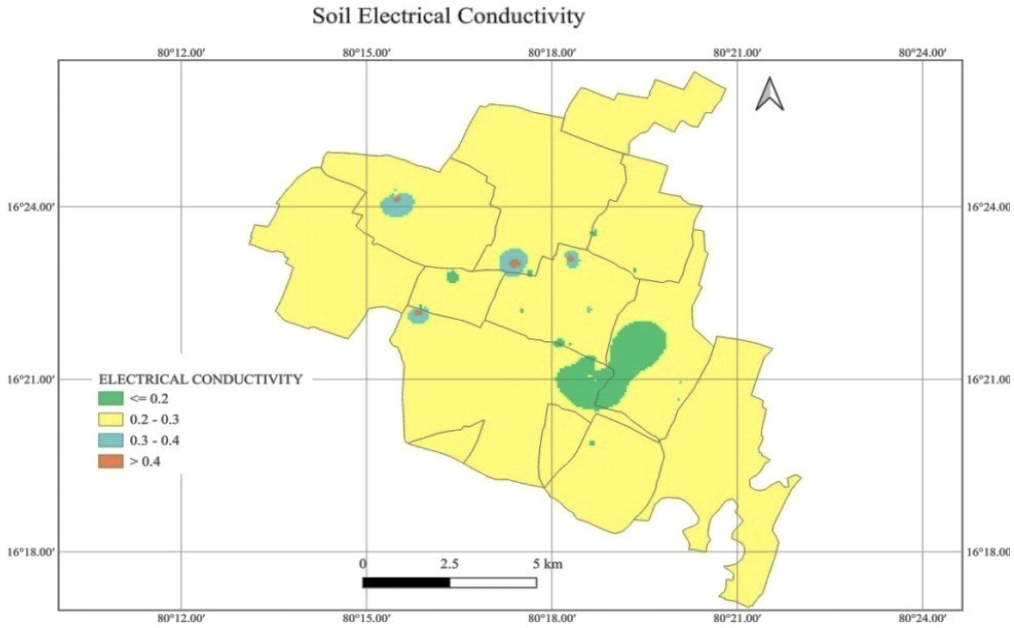

Fig. 2 Spatial variability of Electrical Conductivity in Medikondur mandal

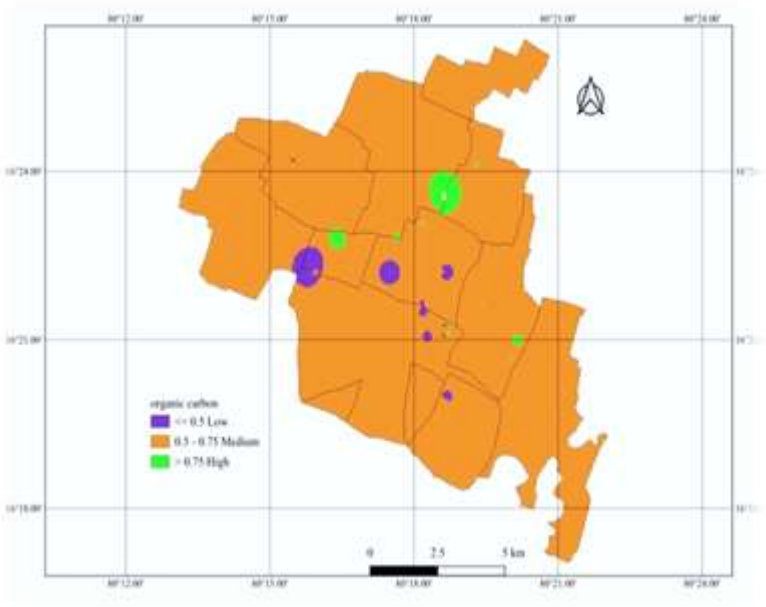

Fig. 3 Spatial variability of Organic Carbon in Medikondur mandal

Calcium carbonate

The calcium carbonate content of the soils (Table 2) varied from 1.0 to 15.5 per cent with a mean of 7.48 % in Cotton-fallow and lowest mean in 4.96 in rice-fallow cropping system. The lower calcium carbonate content in some soils may be due to leaching of bicarbonates from the upper layers during the rainy season. CaCO*ƒ* is commonly present in arid and semi-arid soils and influences the buffering capacity and pH stability. Which helps in maintaining a stable soil pH by neutralizing acids, thus preventing sudden changes in soil chemistry, improves soil structure, reduces nutrient leaching and enhances microbial balance by maintaining near-neutral pH, CaCO*ƒ* supports the survival of a diverse and active microbial community (Himabindu *et al.,* 2019).

Other factors influencing calcium carbonate variation include soil texture, with finer soils tending to retain more calcium carbonate crop type and root activity, which can affect carbonate dissolution soil pH and microbial activity influencing carbonate precipitation, decomposition and irrigation practices that may either dilute or concentrate calcium carbonate in the soil profile.

CONCLUSION

Generally the study revealed that among the four predominant cropping systems, legume based cropping systems *i.e.* maize–blackgram cropping system recorded the efficient physic-chemical properties highlighting its superiority in maintaining soil health. This improvement is largely attributed to the inclusion of legumes, which contribute to biological nitrogen fixation, enhanced organic matter input, and increased microbial activity - all of which positively influence key soil quality parameters and it is considered as the most sustainable cropping systems in Medikondur mandal of Guntur district.

DISCLAIMER(ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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