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Physico-chemical properties of salt-affected agricultural soils of Telangana

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ABSTRACT

The investigation assessed soil reaction, electrical conductivity and organic carbon in the salt-affected agricultural survey dataset of Telangana. Soil samples represented 0–15 and 15–30 cm depths. Soil pH and electrical conductivity were determined in saturation extracts, while organic carbon was estimated by the Walkley–Black wet oxidation method. The available dataset comprised 31 observations at each depth and was summarized using mean, standard deviation and coefficient of variation. Mean pH increased from 7.81 in the surface layer to 7.92 in the subsurface layer, while mean electrical conductivity increased from 3.76 to 4.14 dS m⁻¹. Organic carbon decreased from 3.95 to 3.14 g kg⁻¹. Electrical conductivity showed greater relative variability than organic carbon at both depths. The results indicate an observed subsurface increase in salt concentration and a decline in organic carbon within the sampled soil layer. These findings provide baseline information for assessing soil constraints and planning management according to local soil conditions.

Keywords: Salt-affected soils, soil reaction, electrical conductivity, organic carbon, soil depth, Telangana

Introduction

Salt accumulation in agricultural soils can restrict crop growth through osmotic stress and ion-related effects. Its development depends on interactions among soil characteristics, water movement, irrigation and drainage. Assessment of soil properties is therefore essential for understanding the constraints operating in salt-affected agricultural environments (Rengasamy, 2006; Rengasamy, 2010; Munns *et al.*, 2008) [1, 2, 3]. Soil reaction, electrical conductivity and organic carbon provide useful information about the chemical environment of agricultural soils. Soil pH influences nutrient availability, electrical conductivity reflects soluble salt concentration, and organic carbon contributes to nutrient cycling and soil functioning. Studies in Telangana have documented variability in these properties across soil types and sampling depths (Narsaiah *et al.*, 2018; Shalini *et al.*, 2022; Vidyavathi *et al.*, 2024) [4, 5, 6]. The present investigation assessed these three properties in the salt-affected agricultural survey dataset of Telangana at 0–15 and 15–30 cm depths.

Materials and Methods

Study area and sampling

The study was conducted in Telangana, India, to assess soil reaction, electrical conductivity and organic carbon in salt-affected agricultural soils. Sampling locations were identified using NRSC soil degradation maps (2015–16) as a baseline.

Soil samples were collected during summer 2025 from 30 salt-affected agricultural locations in Telangana and a reference site at the nearest research station. Samples were collected at 0–15 and 15–30 cm depths at each location, resulting in 62 samples from 31 locations.

The collected soil samples were air-dried, and stones, visible roots and other debris were removed. The samples were gently crushed and passed through 2 mm and 0.5 mm sieves for laboratory analysis.

Soil reaction and electrical conductivity

For salt-affected soils, soil reaction was determined in the saturation extract. Distilled water was gradually added to the soil to prepare a saturated paste with a smooth, glistening surface. After equilibration, the extract was obtained by vacuum filtration, and its pH was measured at room temperature using a calibrated digital pH meter. Electrical conductivity was determined in the saturation extract following (Richards) [7] using a conductivity meter and expressed in dS m⁻¹.

Organic carbon

Organic carbon was determined by the Walkley–Black wet oxidation method [8]. One gram of soil passed through a 0.5 mm sieve was placed in a conical flask and treated with 10 mL of 1 N potassium dichromate and 20 mL of concentrated sulphuric acid. After 30 minutes, distilled water, orthophosphoric acid and

diphenylamine indicator were added. The remaining dichromate was back-titrated with 0.5 N ferrous ammonium sulphate, and organic carbon was expressed in g kg^{-1} .

Data analysis

Mean, standard deviation and coefficient of variation were used to describe the properties at each depth. The coefficient of variation was calculated by dividing the standard deviation by the mean and multiplying by 100. Depth-wise patterns were described using the reported means. Depth differences were evaluated descriptively; no inferential test of depth differences was performed.

Results and Discussion

Soil reaction

Mean soil pH increased from 7.81 at 0–15 cm to 7.92 at 15–30 cm, indicating alkaline mean soil reaction at both depths (Table 1). The corresponding standard deviations were 0.70 and 0.74, showing variation among observations. The depth-wise means of the three properties are illustrated in Figure 1.

The slightly higher subsurface pH may be associated with differences in basic cation distribution, salt composition and soil buffering. Soil reaction in salt-affected environments depends on the composition of soluble and exchangeable ions, and salinity does not necessarily imply strongly alkaline conditions (Rengasamy, 2010) [2]. Variation in soil reaction has also been reported among saline soils of Telangana (Vidyavathi *et al.*, 2024) [6].

The observed pH values characterize soil reaction but do not independently establish sodicity. Sodium-related measurements are required to distinguish saline conditions from sodic or saline-sodic conditions (Richards, 1954) [7].

Electrical conductivity

Mean saturation-extract electrical conductivity increased from 3.76 dS m^{-1} in the surface layer to 4.14 dS m^{-1} in the subsurface layer. Standard deviation increased from 1.17 to 1.41 dS m^{-1} , while the coefficient of variation increased from 31.10 to 33.99%. Thus, electrical conductivity showed appreciable variability among observations at both depths.

The higher subsurface mean indicates greater soluble salt concentration in the saturation extract at 15–30 cm. This pattern may reflect downward salt redistribution and differences in salt removal through drainage. The movement and accumulation of salts within soil profiles depend on water flow, evaporation, irrigation and drainage conditions (Rengasamy, 2006) [1].

The subsurface mean exceeded the conventional saturation-extract EC threshold of 4 dS m^{-1} used in the classical identification of saline soils, whereas the surface mean was below this threshold (Richards, 1954) [7]. However, these are dataset means; individual sites should be classified using their own measurements.

Variability in electrical conductivity may be associated with differences in irrigation water quality, drainage and management history. Similar variation has been documented among saline soils sampled in Telangana (Vidyavathi *et al.*, 2024) [6]. Elevated salt concentrations can limit crop water uptake and cause ion-related stress, although crop response also depends on species, growth stage and environmental conditions (Munns *et al.*, 2008) [3].

Organic carbon

Mean organic carbon decreased from 3.95 g kg^{-1} at 0–15 cm to 3.14 g kg^{-1} at 15–30 cm. This represents a 20.5% decrease relative to the surface mean. The standard deviations were 0.91 and 0.77 g kg^{-1} , and the coefficients of variation were 23.07 and 24.53%, respectively.

The higher surface organic carbon content may be attributed to greater inputs of crop residues and root-derived organic materials in the upper soil layer. The vertical distribution of soil organic carbon is influenced by vegetation and the allocation of organic inputs within the soil profile (Jobbágy *et al.*, 2000) [9]. A decrease in organic carbon with depth has also been reported under different cropping systems in northern Telangana (Shalini *et al.*, 2022) [5].

Variation among sampling locations may reflect differences in residue management, organic inputs and soil characteristics. Regional soil characterization studies have similarly documented variability in organic carbon among agricultural soils of Telangana (Narsaiah *et al.*, 2018) [4]. The present results show the distribution of organic carbon but do not establish the individual contributions of management or salinity to this pattern.

Table 1. Soil reaction, electrical conductivity and organic carbon at two depths

Property	Depth (cm)	Mean	Standard deviation	CV (%)
Saturation-extract pH	0–15	7.81	0.70	9.02
Saturation-extract pH	15–30	7.92	0.74	9.31
Saturation-extract EC (dS m^{-1})	0–15	3.76	1.17	31.10
Saturation-extract EC (dS m^{-1})	15–30	4.14	1.41	33.99
Organic carbon (g kg^{-1})	0–15	3.95	0.91	23.07
Organic carbon (g kg^{-1})	15–30	3.14	0.77	24.53

Standard deviation and coefficient of variation describe variability among the 31 observations at each depth. Coefficients of variation are

reproduced from the source calculations.

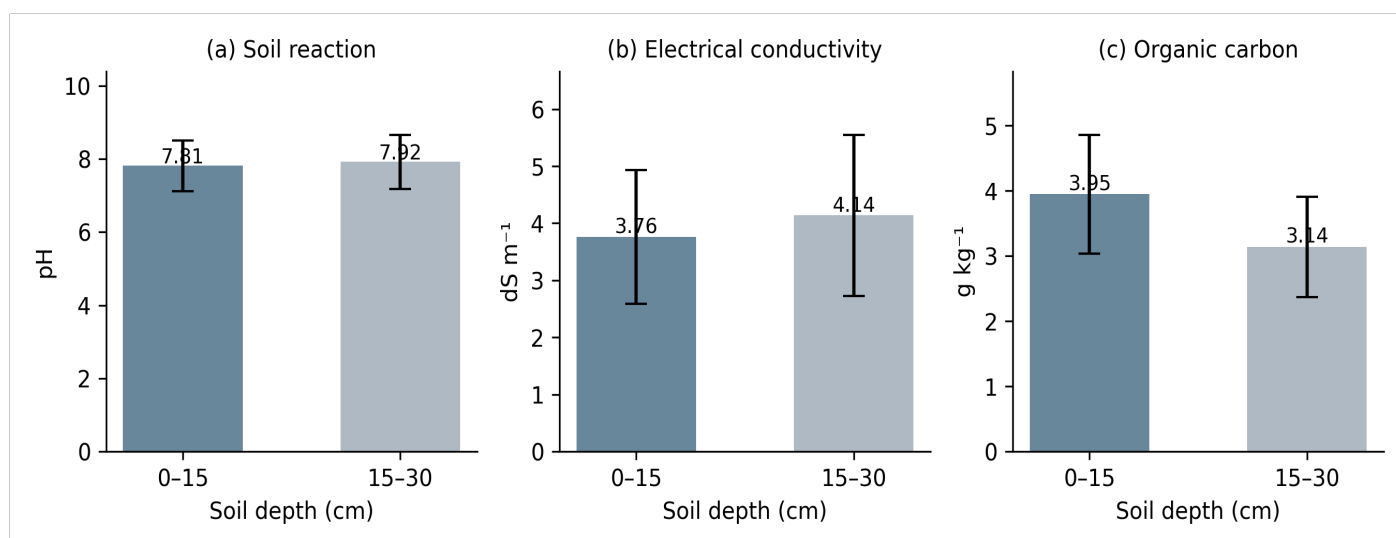


Figure 1. Mean soil reaction (a), saturation-extract electrical conductivity (b) and organic carbon (c) at two depths. Error bars represent $\pm$ one standard deviation among observations ($n = 31$ per depth); they do not indicate a test of depth differences.

Conclusion

Mean soil pH increased from 7.81 at 0–15 cm to 7.92 at 15–30 cm. Electrical conductivity increased from 3.76 to 4.14 dS m⁻¹, while organic carbon decreased from 3.95 to 3.14 g kg⁻¹. These depth-wise patterns provide baseline information for planning soil management in the sampled salt-affected agricultural soils of Telangana

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