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Effect of Saline and Sodic Water Irrigation on Physico-Chemical Properties of Inceptisols

P. Dayana Lakshmi[1*], K. Manikandan[2], D. Leninraja[2], M. Joseph[3] and A. Kavitha Pushpam[3]
[1]PG Scholar, Department of Soil Science and Agricultural Chemistry,
Agricultural College and Research Institute, Killikulam, Thoothukudi (Tamil Nadu), India.
[2]Assistant Professor, Department of Soil Science and Agricultural Chemistry,
Agricultural College and Research Institute, Killikulam, Thoothukudi (Tamil Nadu), India.
[4]Associate Professor, Department of Soil Science and Agricultural Chemistry,
Agricultural College and Research Institute, Killikulam, Thoothukudi (Tamil Nadu), India.

(Corresponding author: P. Dayana Lakshmi)*
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ABSTRACT: The impact of saline and sodic water irrigation on the physico-chemical properties of inceptisol was studied at Agricultural College and Research Institute, Killikulam, Tamil Nadu, India during 2022. Pots filled with red soil collected from college farm that belongs to Inceptisols. *Talinum fruitcosum* was used as test crop for pot experimentation. Saline and sodic water were used in the experiment. Six levels of salinity and nine levels of sodicity were artificially created in irrigation water and used for irrigating soil. Saline and sodic water significantly influenced the soil properties. Increasing salinity and alkalinity increased the salinity and sodicity hazards of soil.

Keywords: Saline water, Sodic water, pH, EC

INTRODUCTION

Salinity and sodicity is considered as one of the major environmental hazard at global level and it affected as more than 25% of the total land and 33% of the irrigated land (Mohanavelu *et al.*, 2021). In India, 6.73 million ha of land has been degraded due to salinity and sodicity. Approximately 25% of the land world-wide is affected by high salt concentration which renders the land productivity significantly (Bennett 2009; Rengasamy, 2016; Shahid *et al.*, 2018).

Poor quality irrigation water especially salinity and alkalinity are injurious to soil and crop health. Introduction of irrigation is considered as the prime factor for increasing salinity in western parts of India (Singh, 2009). Saline water refers to the concentration of salts in the irrigation water that is sufficiently high to adversely affect crop yield or crop quality. Salty irrigation water usually contains higher salts that accumulate in soil with the progressive application of irrigation water over time and resulting in adverse changes in soil properties (Huang *et al.*, 2011), inhibition of plant growth (Hussain *et al.*, 2015), reduction of yield and decreasing produce quality (Li *et al.*, 2019). Salty water lowers osmotic potential of the soil solution (Manchanda and Garg 2008) and renders the plant ability to absorb water from soil (Rengasamy and Olsson 1993). The higher concentrations of specific ions (Cl, Na, CO_3, HCO_3, etc.) injure the crop (Lauchli and Epstein 1990) resulting in reduction of plant growth and yield.

Sodicity, on the other hand, is related to the higher proportion of Na in the irrigation water in comparison to calcium and magnesium. Sodic water contributes to the deterioration of soil physical properties (Choudhary and Mavi 2019), which can indirectly affect plants via crusting (Sumner *et al.*, 1998), reduced infiltration (Kaur *et al.*, 2008), increased soil strength (Peng *et al.*, 2005), and reduced aeration (De Pascale and Barbieri 1995). Irrigation with sodic waters having higher carbonates and bicarbonates, leads to increase in soil pH and sodium (Na) saturation of soils, aeration and permeability problems due to clay dispersion, crusting, and clay migration leading to clogging of pores (Grattan and Oster 2003; Levy *et al.*, 2003; Oster, 2004) thereby adversely affecting crop productivity (Josan *et al*., 1998; Choudhary *et al*., 2004, 2006; Sharma and Minhas 2005; Minhas *et al*., 2007).

MATERIALS AND METHODS

The study was conducted at Agricultural College and Research Institute, Killikulam, Tamil Nadu, India during 2022 with the goal of assessing the effect of saline and sodic water on the physico-chemical properties of Inceptisol. The experiment was conducted in pot filled with red soil by adopting completely randomized block design. Two types of water viz., saline and sodic water with varying level of intensity were used for irrigation. Six levels of salinity *viz.*, EC value of < 1, 2, 4, 6, 8 and 10 dS m^{-1} were artificially created by adding salts and utilised for irrigation, separately. EC of the irrigation water is artificially

stimulated by considering the relationship between EC and total dissolved salt *i.e.*, TDS (mg/L) = EC × 640. Salt mixture of $CaCl_2$-$MgCl_2$-NaCl in the proportion of 4:2:1 was utilized for preparing saline water of desirable EC.

Sodic water with eight levels of soluble sodium percentage (SSP; < 10, 20, 30, 40, 50, 60, 70 and 80) was artificially established using sodium carbonate in consideration with the initial sodium content in the irrigation water. Bore well water is considered as control for both salinity and sodicity as it has an EC and SSP values of < 1 dS/m and < 10, respectively. The treatment details were T_1 - EC <1 dS m^{-1} & SSP<10; T_2 - EC 2 dS m^{-1}; T_3- EC 4 dS m^{-1}; T_4- EC 6 dS m^{-1}; T_5- EC 8 dS m^{-1}; T_6 - EC 10 dS m^{-1}; T_7 - SSP 20; T_8 - SSP 30; T_9 - SSP 40; T_{10} - SSP 50; T_{11} - SSP 60; T_{12} - SSP 70; T_{13} - SSP 80.

Red soil (Inceptisol) was collected from the B block of Agricultural College and Research Institute, Killikulam. The bulk soil was collected and the pots were filled equally with 12 kg soil and the initial characteristics of collected soil were mentioned in Table 1.

Table 1: Initial characteristics of Inceptisols.

Parameter	Red soil
pH	7.09
EC (dSm^{-1})	0.15
CEC (c mol (p^+) kg^{-1})	14.60
Organic carbon (g kg^{-1})	5.76
Available N (kg ha^{-1})	181.53
Available P (kg ha^{-1})	8.96
Available K (kg ha^{-1})	100.94
Available S (mg kg^{-1})	8.34
Exchangeable Na (c mol (p^+) kg^{-1})	1.3
Exchangeable K (c mol (p^+) kg^{-1})	2.4
Exchangeable Ca (c mol (p^+) kg^{-1})	7.05
Exchangeable Mg (c mol (p^+) kg^{-1})	3.75
DTPA extractable Zn (mg kg^{-1})	0.22
DTPA extractable Fe (mg kg^{-1})	4.45
DTPA extractable Cu (mg kg^{-1})	0.52
DTPA extractable Mn (mg kg^{-1})	3.00
Soil texture	Sandy loam

Statistical analysis. The data collected from the pot experiment were subjected to statistical analysis based on one way analysis of variance (ANOVA) and least square significance test for $p < 0.05$ was studied. The statistical analysis was carried out using AGRES software version 7.0.

RESULT AND DISCUSSION

Physico-chemical characteristics of soil. The physico-chemical properties of Inceptisol differed significantly under the influence of saline and sodic water irrigation.

(a) pH. Soil properties were significantly altered by the added irrigation water (Fig. 1). Saline water irrigation decreased the soil reaction slightly. Irrigation with saline water having EC of 10 dS/m resulted in the decreased soil reaction (pH 7.03) to the tune of 0.17 unit compared to control (pH 7.20). The proportion of soluble ions determines the direction of pH change with the addition of saline irrigation. The predominance of soluble calcium in association with chloride and sulphate decreases the soil pH (Tavakkoli *et al.*, 2015; Al-Busaidi and Cookson 2003). Similar negative relationship between salinity and pH was reported by Choudhary *et al.* (2004).

Sodic water considerably increased the soil reaction compared to saline water irrigation. Increasing sodicity hazard in terms of increasing SSP sequentially increased the soil pH and the highest pH of 8.07 was observed in soils irrigated with water having SSP of 80 (T_{13}) and the lowest pH value of 7.20was noticed in soils irrigated with water having SSP of < 10 (T_1; Table 2). The carbonate and bicarbonate ions dissociation from the sodic water (de Andrade *et al.*, 2018) might be prime reason for the increasing soil pH. Increasing sodicity hazard in irrigation water positively increases the soil pH significantly (Yaduvanshi and Sharma 2008).

(b) Electrical Conductivity. EC of neutral soil significantly increased with increased irrigation with saline and sodic water (Fig. 2). The soils irrigated with water having EC < 1dS/m (T_1) observed for the lowest EC value of 0.16dS/m, while the maximum EC of 0.27 dS/m was detected in soils irrigated with water having EC of 10 dS/m (T_6). The soils irrigated with SSP 80 (T_{13}) had the greatest EC value of 0.44, while the lowest EC value of 0.20 was detected in soils irrigated with SSP 20 (T_7). Saline water significantly increased the electrical conductivity of the soil (Ahmed *et al.*, 2010) owing to the addition of soluble salts both cations (Ghallab and Usman 2007) and anions (Ragab *et al.*, 2008) by the salty irrigation water (Doneen, 1954).

Table 2: Physico-chemical properties of Inceptisol.

Treatments	pH	EC (dS/m)
T_1- EC <1 dS m^{-1}& SSP<10	7.20	0.16
T_2- EC 2 dS m^{-1}	7.18	0.21
T_3- EC 4 dS m^{-1}	7.14	0.25
T_4- EC 6 dS m^{-1}	7.11	0.28
T_5- EC 8 dS m^{-1}	7.06	0.31
T_6- EC 10 dS m^{-1}	7.01	0.35
T_7- SSP 20	7.36	0.18
T_8- SSP 30	7.44	0.21
T_9- SSP 40	7.56	0.23
T_{10}- SSP 50	7.68	0.26
T_{11}- SSP 60	7.80	0.28
T_{12}- SSP 70	7.91	0.30
T_{13}- SSP 80	8.07	0.31
SEd	**0.03**	**0.04**
CD (0.05)	**0.06**	**0.09**

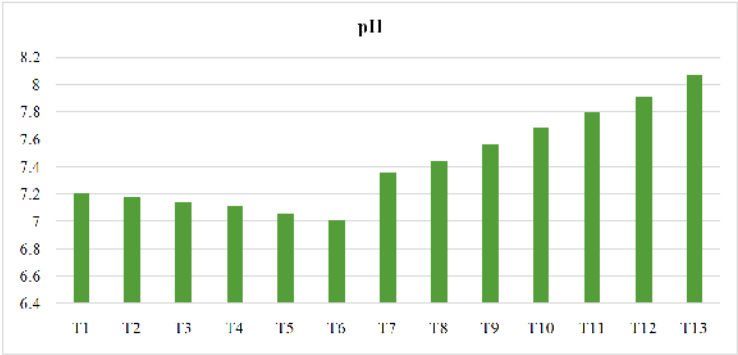

Fig 1. Effect of saline and sodic water irrigation on soil pH.

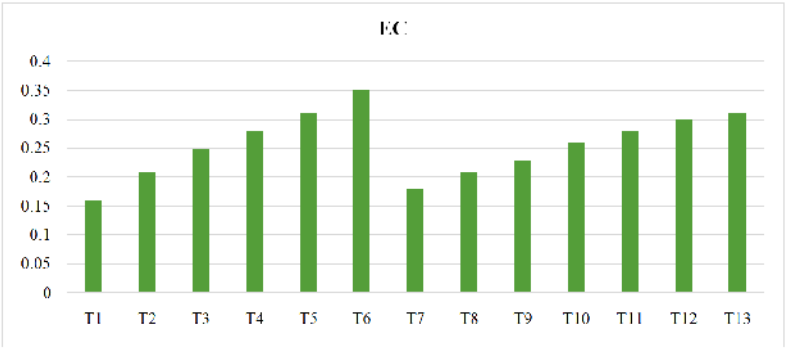

Fig. 2. Effect of saline and sodic water irrigation on soil EC.

CONCLUSION

The current investigation found that irrigation with saline and sodic water considerably changed the physico-chemical characteristics of the Inceptisol. Under irrigation with saline water, soil pH marginally dropped as irrigation water salinity increased, but soil pH increased as irrigation water sodicity increased. Both saline and sodic water irrigation enhanced inceptisol's electrical conductivity. The amount of EC growth accelerates when irrigation water's salinity and sodicity hazards increases. According to the study's findings, using saline water that has a larger percentage of soluble calcium together with chloride and sulphate is helpful for lowering soil alkalinity.

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Conflict of Interest. None.

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