# EFFECT of pH, EC, $CaCO_3$, CEC, ESP on DIFFERENT FRACTIONS OF Fe UNDER SALINE SOIL OF NAVSARI DISTRICT


## ABSTRACT

This study investigates the distribution and interrelationship of iron (Fe) fractions in salt affected soils of Navsari District, Gujarat, during the summer 2023-24. A total of 60 soil samples were collected from two depths (0-20 cm and 20-40 cm) across saline prone villages, including coastal high salinity zones. Samples were analysed for pH, Electrical Conductivity (ECe), calcium carbonate ($CaCO_3$), Cation Exchange Capacity (CEC), Exchangeable Sodium Percentage (ESP) and various Fe fractions viz., Fe- Mn-O-Fe, Org-Fe, $CO_3$- Fe, Exch-Fe and WS-Fe. Soil pH ranged from neutral to strongly alkaline, with higher ECe observed in coastal region areas. The dominant Fe fractions followed the order under coastal region areas were: Fe- Mn-O-Fe > Org-Fe > $CO_3$- Fe > Exch-Fe > WS-Fe. All the Fe fractions were lower in saline areas except $CO_3$-Fe, which was higher under salinity. Correlation analysis revealed significant and depth-dependent relationship among soil properties and Fe fractions. Notably, pH was negatively correlated with ECe and Exch-Fe at the surface, while WS-Fe showed contrasting relationship with other Fe forms. These results highlight complex interactions influencing Fe availability in saline soils.


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## Introduction

Micronutrient deficiency in soils is one of the significant problems at the regional and global level affecting more than two billion people (Suchdev *et al.,* 2011, Bailey *et al.* 2015). Though the chemical fertilizer has made a significant contribution to the continuous supply of nutrients, it has imbalanced the concentrations of micronutrients in the soil (Aulakh *et al.,* 2008). The availability and transformation of micronutrient fractions in the soil are affected by the physicochemical properties of the soil and the cropping system. In soil, essential elements such as copper (Cu), zinc (Zn), iron (Fe), and manganese (Mn) are present in different chemical forms. Fluctuation in micronutrients in soils is a global phenomenon and caused by several governing factors that affect the movement and transformation of these elements in soils such as organic matter content, pH, salinity, and exchangeable capacity (Shukla *et al.,* 2015). It is essential to determine different fractions of nutrients found in the soil since the transformation and bioavailability of these elements are dependent upon the chemical and physical processes in the soil.

In arid and semiarid regions, salinity in soil and water has been considered a severe problem adversely affecting plant growth and nutrient availability. In agricultural productivity, salinity and sodicity reduced the availability of water, uptake of nutrients including both micro and macronutrients, and enhanced the toxicity of Na and Cl ions (Munns, 2002). Salinity and micronutrient deficiency have a complex interaction that has been poorly understood (Tozlu *et al.,* 2000). There is competition between the cations in soil that results in lower uptake of micronutrients in saline soil. The fractionation of micronutrients in saline soils is vital to understanding the micronutrient's behaviour, mobility,

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and bioavailability. Thus, the crops grown on such soils are deficient in micronutrients (Eskandari *et al.,* 2014).

## Material and Methods

Collection of soil samples from saline areas under different villages of Jalalpore taluka in Navsari district was selected for the present study. Navsari district lies between 20.07’ North latitude to 21.00’ North latitude and 72.43’ East longitude to 73.00’ East longitude covering a geographical area of 606.06 ha. Total 60 soil samples were collected from coastal plain (high salt: ECe > 4 dS $m^{-1}$) of South Gujarat from 0-20 cm and 20-40 cm depths with the help of screw-auger. Soil sample collection site of Coastal Soil Salinity Research Station of NAU is located at Danti-Umbhrat of Navsari district and doing research on crops and fertilizer, irrigation and reclamation techniques of salt-affected soils since 1966. The location for each sample area is indicated by the map in **Fig.1.** All the soil sampling areas are under the jurisdiction of Navsari Agricultural University under south Gujarat Heavy Rainfall Zone, AES-III. The samples were air-dried and ground followed by passing through a 2mm sieve and analysed for different soil chemical properties and fractions of Fe.

**Commented [R6]:** The introduction write a general description on micronutrient fractions and availability in saline soil. It lacks to focus on Fe fractions in particular. Improve the ‘Introduction” chapter accordingly. Review the work done on this regard in the similar area.

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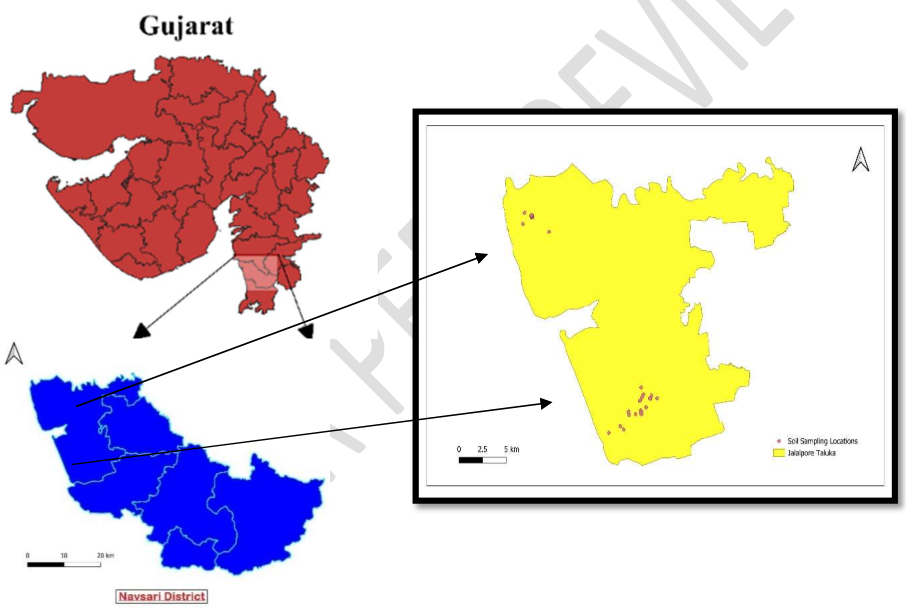


**Fig.1 Geographical location of soil samples**

The soil pH was measured in a 1:2.5 soil-to-water suspension using a glass electrode electric pH meter (Jackson, 1973), while the electrical conductivity of saturated paste ($EC_e$) estimated using an electrical conductivity meter (Jackson, 1973). Calcium carbonate analysed by neutralization with 0.5 N HCl followed by titration with 0.25 N NaOH (Allison and Moodie, 1965). CEC determined by 1N $NH_4OAC$ method (Jackson, 1973). Analytical procedure of sequential extraction of various Fe fractions (Tessier *et al.,* 1979), Water soluble ($F_1$): Samples of soil 1 g were extracted at 20°C for 1 hr with 10 ml distilled water. Exchangeable ($F_2$): The residue of $F_1$ was extracted at room temperature for 1 hour with 10.0 ml of magnesium chloride solution (1.0 M $MgCl_2$) at pH 7. Carbonate bound ($F_3$): The residue of $F_2$ was extracted with 10.0 ml of 1.0 M sodium acetate/acetic acid buffer at pH 5.0 for 5 hours at room temperature. Fe & Mn oxide bound ($F_4$): The residue from $F_3$ was

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## Result and Discussion

### pH and ECe of Soil

The data in Table 1 also demonstrated that Jogeshwar Faliya village had the highest pH in saline areas, with values of 8.65 and 8.85 at depths of 0–20 cm and 20–40 cm, respectively. In contrast, Mandaliya and Danti farm had the lowest pH in high-saline regions, with similar values of 7.84 and 7.94 at 0–20 cm and 20–40 cm depths, respectively. Mirror values of 8.17 and 8.46 were recorded when the mean pH of the soil in saline areas was taken into consideration at depths of 0–20 cm and 20–40 cm. The soil reactions were ranged from neutral to strongly alkaline with a pH ranging from 7.20 to 8.60 with a mean value of 7.90 recorded by Worku and Bedadi (2016).

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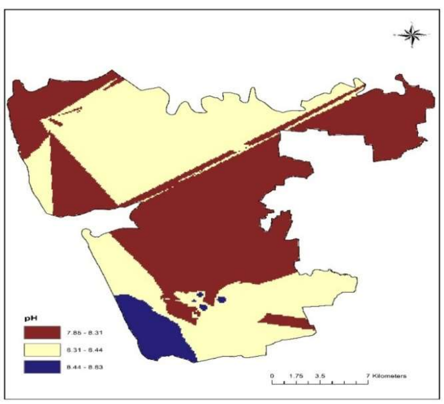
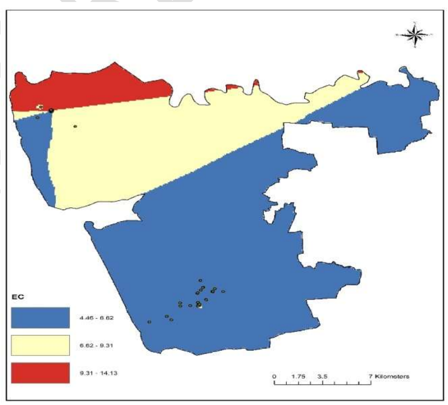



**Spatial Distribution of pH**




**Spatial Distribution of ECe (dS/m)**

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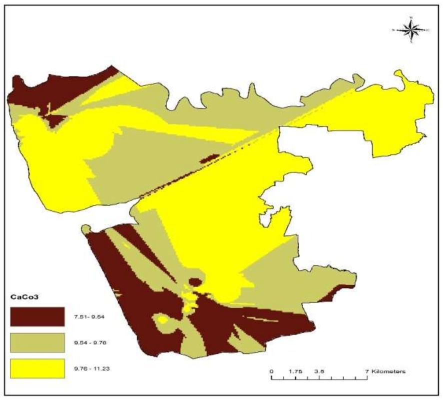
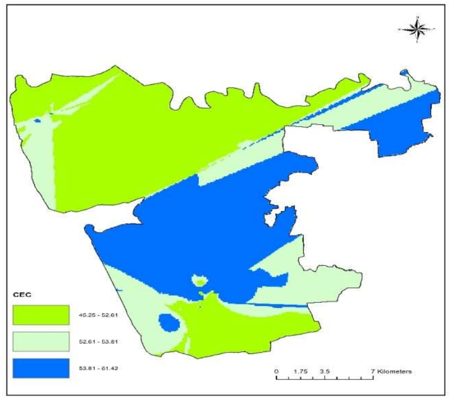
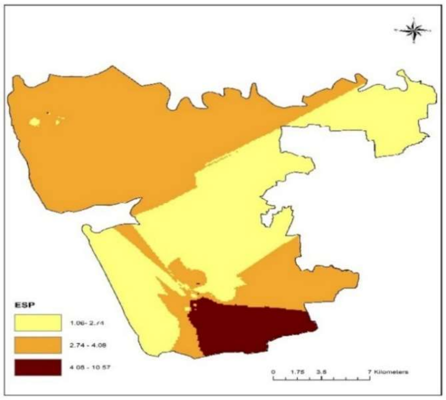


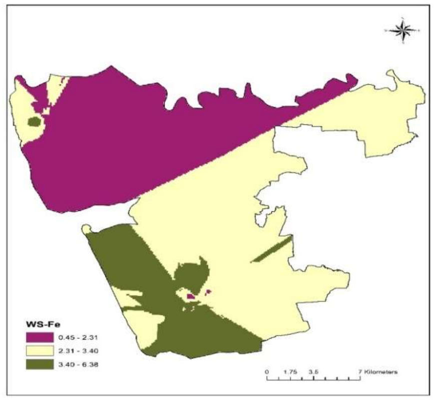

Spatial Distribution of $CaCO_3$ (%)



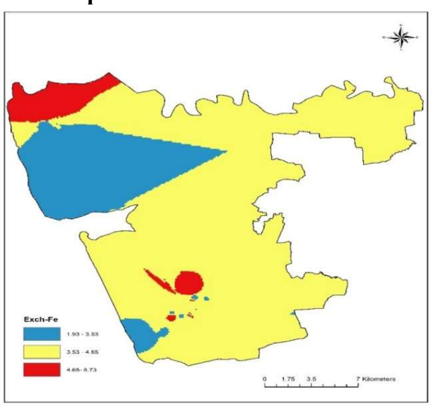

Spatial Distribution of CEC (me 100 $g^{-1}$)



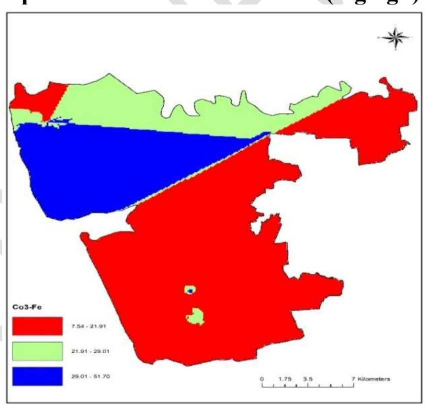

**Spatial Distribution of ESP**



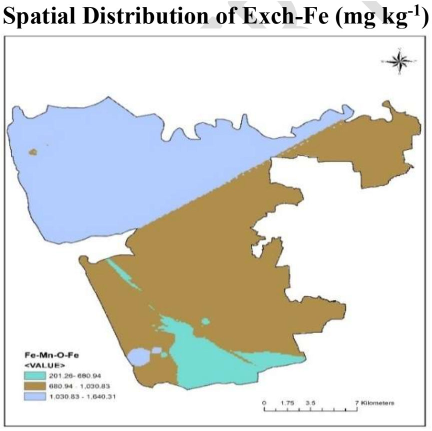

**Spatial Distribution of WS-Fe (mg kg$^{-1}$)**



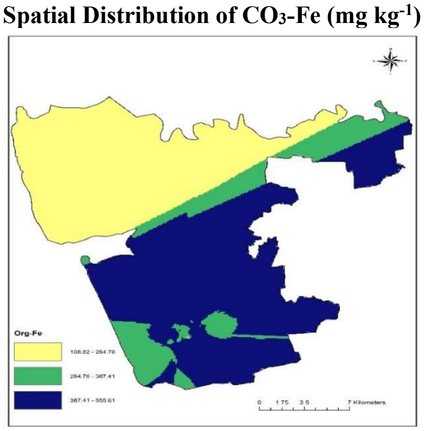

**Spatial Distribution of Exch-Fe (mg kg$^{-1}$)**




**Spatial Distribution of $CO_3$-Fe (mg kg$^{-1}$)**




**Spatial Distribution of Fe-Mn-O-Fe (mg kg$^{-1}$)**




**Spatial Distribution of Org-Fe (mg kg$^{-1}$)**

**Fig. 2. Spatial distribution of soil properties and fractions of Fe**

The maximum ECe of saturated soil paste was measured in Danti farm under saline area, with corresponding values 42.985 and 37.378 at 0-20 cm and 20-40 cm depths. At depths of 0–20 cm and 20–40 cm, Mandaliya village had the lowest ECe, with corresponding

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**Commented [R17]:** Mention the depth of soil values of 4.067 and 4.113 dS $m^{-1}$ (Table 1). Taking into account the average value in the saline regions, the upper depth (0–20 cm) had a higher mean value of ECe (7.227 dS $m^{-1}$) than the lower depth (20–40 cm), which had a value of 6.663 dS $m^{-1}$. In salt-affected soil, ECe ranged from 1.23 to 19.1 dS $m^{-1}$ due to the accumulation of salts recorded by Sandhu *et al.* (2016).

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**$CaCO_3$ (%)**

In Danti farm, the greatest $CaCO_3$ content was 9.25 and 11.25 per cent at 0–20 cm and 20–40 cm depths, respectively (Table 1). Mandaliya and Onjal village had the lowest $CaCO_3$ level in soil from high-saline regions, with 7.25 and 9.25 per cent at 0–20 and 20–40 cm depths, respectively. Taking into account the average $CaCO_3$ concentration, values of 8.40 and 10.44 per cent were found at depths of 0–20 and 20–40 cm, respectively. Higher amount of calcium carbonate at lower depths might be due to the process of leaching of calcium carbonate and subsequently precipitation at lower depths. Similar results were also registered by Gupta *et al.* (2003) and Datta *et al*. (2015).

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**CEC (me 100 $g^{-1}$) and ESP**

In saline areas, maximum CEC was determined with a value of 55.23 me 100 $g^{-1}$ and 61.91 me 100 $g^{-1}$ at 0-20 cm and 20-40 cm depths, respectively (Table 1). However, a minimum value of CEC was recorded in Onjal and Danti farm with respective values of 38.47 me 100 $g^{-1}$ and 45.25 me 100 $g^{-1}$ at 0-20 cm and 20-40 cm depths, respectively under saline areas. In contrast, a higher value of CEC was registered with mean value of CEC at lower depths (20-40 cm) was 14.34 per cent over upper depths (0-20 cm). Data further showed that in saline areas, maximum ESP at 0-20 cm and 20-40 cm depths was recorded in Jogeshwar faliya with respective values of 10.99 and 7.55. The result is in agreement with the findings of Kumar *et al.* (2018).

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## Fractions of Fe

Different fractions of Fe were estimated from soil samples collected under salt-affected soil of Navsari district saline areas at 0-20 cm and 20-40 cm depths. The results related to different fractions of Fe *i.e,* Water Soluble Fe-fraction (WS-Fe), Exchangeable Fe (Exch.-Fe), Carbonate bound Fe ($CO_3$-Fe), Fe and Mn oxide bound Fe (Fe-Mn-O-Fe) and Organic bound Fe (Org-Fe) are presented in Table 2. Spatial distribution of all soil properties and fraction Fe at 0-20 cm and 20-40 depths under Jalalpore Taluka showed in Fig 2.

**Water Soluble Fe (WS-Fe)**

In the case of saline areas (Table 2) the maximum value of WS-Fe was found in Sultanpur with corresponding values of 8.6 and 5.62 mg $kg^{-1}$ at 0-20 cm and 20-40 cm depth, respectively. The result also revealed that the minimum value of WS-Fe was recorded in Danti farm with respective values of 1.23 and 0.45 mg $kg^{-1}$ at 0-20 cm and 20-40 cm depth in saline areas. Similarly in saline areas result showed that mean value of WS-Fe was high at 0-20 cm depth than 20-40 cm depth with a corresponding value of 4.09 mg $kg^{-1}$, respectively. The low value of WS and EX-Fe may also be attributed to the lower amount of organic matter in the soils as studies have reported that the addition of FYM/organic matter tends to increase the WS and EX-Fe content (Maskina *et al.*, 1998 and Hellel, 2007).

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**Exchangeable Fe (Exch-Fe)**

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In saline area, the maximum value of Exch-Fe was recorded in Danti farm and Jogeshwar faliya with corresponding values of 13.01 mg $kg^{-1}$ and 4.96 mg $kg^{-1}$ at 0-20 cm and 20-40 cm depths, respectively (Table 2). Similarly, the minimum value of Exch-Fe was found in Onjal and Danti farm at 0-20 cm and 20-40 cm depths with corresponding values of 1.46 mg $kg^{-1}$ and 0.80 mg $kg^{-1}$ in high saline areas. The results showed that the decrement in the mean value of Exch-Fe content at 20-40 cm depth was 54.91 per cent over 0-20 cm depth in the high saline areas. The exchangeable and acid-extractable fractions of Fe are normally low due to the formation of their respective hydroxide and oxides in certain conditions. Fe fractions and their transformation in the soil is controlled by redox potential and pH were reported by Dhaliwal *et al.* (2019).

**Carbonate Bound Fe ($CO_3$-Fe)**

A perusal of data presented in Table 2 regarding carbonate bound Fe showed that in saline areas showed that the maximum value of $CO_3$-Fe content at 0-20 cm and 20-40 cm depths was found in Onjal and Danti farm with values 40.46 and 51.86 mg $kg^{-1}$, respectively. However, the minimum value of $CO_3$-Fe was found in Danti farm and Jogeshwar faliya with corresponding values of 0.83 and 7.16 mg $kg^{-1}$ at 0-20 cm and 20-40 cm depths, respectively. The result also showed that the magnitude of increase in of $CO_3$-Fe content at lower depths was 57.45 per cent over upper depth in saline areas.

**Fe and Mn oxide Bound Fe (Fe-Mn-O-Fe)**

Maximum value of Fe-Mn-O-Fe in the high saline areas was found in Danti farm with corresponding values of 2067.60 and 1689.60 mg $kg^{-1}$ at 0-20 cm and 20-40 cm depths, respectively (Table 2). While, the minimum value of Fe-Mn-O-Fe content was recorded at 0-20 cm and 20-40 cm depths in Mandaliya and Jogeshwar faliya with a tune of 165.60 and 147.60 mg $kg^{-1}$ in high saline areas. The results further showed the mean value of 0-20 depth is higher than 20-40 cm depth with a value of 1107.22 mg $kg^{-1}$ in saline areas.

**Organic Bound Fe (Org-Fe)**

Looking to the organic bound Fe content in soil of saline areas at 0-20 cm and 20-40 cm depths is presented in Table 2 the maximum values of Org-Fe were found in Jogeshwar faliya with corresponding values of 596.76 and 409.56 mg $kg^{-1}$ at 0-20 cm and 20-40 cm depths. However, the minimum value Org-Fe was recorded at 0-20 cm and 20-40 cm depths with corresponding of 90.00 mg $kg^{-1}$ and 58.80 mg $kg^{-1}$, respectively in high saline areas. The Org-Fe content ranged from 90.00 to 596.76 and 58.80 to -409.56 mg $kg^{-1}$ at 0-20 cm and 20-40 cm depths in high saline areas. Iron fractions differed in saline soils in the order of residual > organic bound > Fe + Mn bound > carbonate bound > exchangeable > water soluble were reported by Mohiddin *et al.* (2022).

**Correlation between different soil properties and Fe fractions**

The data presented in Table 3 shows the association analysis for pH, ECe, $CaCO_3$, CEC, ESP and Fe fractions for 0-20 cm in saline areas. At the 5 per cent significance level, there was a negative and significant correlation between the pH of the soil and both ECe (r = -0.315*) and Exch-Fe (r = -0.293*). At the 5 per cent significance level, there was a positive and significant correlation between CEC and ESP (r= 0.330*). WS-Fe positively and significantly correlated with $CO_3$-Fe (r = 0.335**) and Org-Fe (r = 0.458**) at 1 per cent level of significance. Additionally, at the 1 per cent level of significance, there was a negative and significant correlation between WS-Fe and Fe-Mn-O-Fe (r = -0.358*). $CO_3$-Fe had positive and significant correlation with Org-Fe (r = -0.665**) and negative and significant correlation with Fe-Mn-O-Fe (r = -0.601**) at 1 per cent level of significance. While, Fe-Mn-O-Fe negatively correlated with Org-Fe (r = -0.509**) at 1 per cent level of significance.

In case of 20-40 cm depths (Table 4), soil pH negatively and significantly correlated with $CaCO_3$ (r= -0.435**) at 1 per cent level of significance. EC had positive correlation with $CaCO_3$ (r = 0.284*) and $CO_3$-Fe (r = 0.297*) while, negative correlation with CEC (r = -0.281*) at 5 per cent level of significance. $CaCO_3$ negatively and significantly correlated with Org-Fe (r = -0.263*) at 5 per cent level of significance. Also, negative and significant correlation was found between CEC and ESP (r = -0.292*) at 5 per cent level of significance. WS-Fe positive and significant correlation found with Exch-Fe (r = 0.377*) and Org-Fe (r = 0.444**) at 5 per cent and 1 per cent level of significance and negatively and significantly correlated with $CO_3$-Fe (r = -0.438**) and Fe-Mn-O-Fe (r = -0.404**) at 1 per cent level of significance. Also, Exch-Fe, negatively and significantly correlated with $CO_3$-Fe (r = -0.508**) and Fe-Mn-O-Fe (r = -0.363**) at 1 per cent level of significance and positively

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**Commented [R25]:** 20-40cm?

**Commented [R26]:** Provide justification for negative correlation of soil pH and Ece.

**Commented [R27]:** Justification needed correlated with Org-Fe (r = 0.312*) at 5 per cent level of significance. The $CO_3$-Fe was positively and significantly correlated with Fe-Mn-O-Fe (r = 0.586**) at 1 per cent level of significance. The Fe-Mn-O-Fe negatively and significantly correlated with Org-Fe (r = -0.575**) at 1 per cent level of significance.

**CONCLUSION**

The correlation analysis across 0-20 cm and 20-40 cm depths in saline soils revealed depth-dependent and complex interactions between soil properties and Fe fractions. In the surface layer (0-20 cm), soil pH showed negative associations with salinity (ECe) and exchangeable Fe, while CEC was positively linked with ESP. Interactions among Fe fractions indicated that water-soluble Fe and carbonate-bound Fe were strongly associated with organic Fe, whereas Fe-Mn oxide-bound Fe was negatively related to these fractions, suggesting competition among Fe pools. At the sub-surface layer (20-40 cm), pH was negatively associated with $CaCO_3$, while EC showed opposite trends with $CaCO_3$ and CEC. WS-Fe exhibited positive links with Exch-Fe and Org-Fe, but negative links with $CO_3$-Fe and Fe-Mn-O-Fe. Exch-Fe also showed contrasting relationship with $CO_3$-Fe and Org-Fe. Overall, these results suggest that soil salinity, pH, $CaCO_3$ and CEC strongly influence the distribution and transformation of Fe fractions, with distinct interactions patterns at different soil depths.

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**Table 1: Soil pH, ECe, $CaCO_3$, CEC and ESP in sample of saline area of Navsari district**

| Sr. No. | Name of village | 0-20 cm | | | | | 20-40 cm | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | pH | ECe (dS/m) | CaCO3 (%) | CEC (me 100 $g^{-1}$) | ESP | pH | ECe (dS/m) | CaCO3 (%) | CEC (me 100 $g^{-1}$) | ESP |
| 1 | ONJAL | 8.50 | 4.314 | 8.50 | 47.28 | 2.84 | 8.84 | 4.489 | 9.75 | 55.92 | 1.07 |
| 2 | | 8.21 | 4.586 | 8.00 | 38.47 | 1.61 | 8.59 | 4.816 | 10.00 | 55.52 | 1.08 |
| 3 | | 8.33 | 4.440 | 8.75 | 44.49 | 1.92 | 8.75 | 4.641 | 9.25 | 48.46 | 1.04 |
| 4 | | 8.20 | 4.660 | 8.50 | 42.23 | 1.17 | 8.56 | 4.307 | 9.50 | 57.26 | 1.27 |
| 5 | JOGESHWAR FALIYA | 8.48 | 4.975 | 8.75 | 48.97 | 3.51 | 8.81 | 4.586 | 10.25 | 57.79 | 1.06 |
| 6 | | 8.22 | 4.382 | 9.25 | 45.39 | 3.02 | 8.85 | 4.806 | 10.00 | 50.79 | 1.26 |
| 7 | | 8.17 | 4.625 | 8.50 | 44.94 | 4.58 | 8.35 | 6.634 | 10.75 | 51.41 | 7.55 |
| 8 | | 8.25 | 4.249 | 9.00 | 46.92 | 3.28 | 8.23 | 4.806 | 10.50 | 51.77 | 1.07 |
| 9 | | 8.43 | 4.845 | 8.50 | 47.39 | 8.00 | 8.45 | 4.955 | 10.00 | 60.49 | 1.06 |
| 10 | | 8.08 | 4.596 | 8.00 | 45.20 | 1.86 | 8.14 | 6.304 | 10.75 | 51.37 | 1.03 |
| 11 | | 8.65 | 4.485 | 7.75 | 46.69 | 10.26 | 8.26 | 4.904 | 10.50 | 54.75 | 2.87 |
| 12 | | 8.58 | 5.464 | 7.50 | 47.87 | 10.82 | 8.46 | 4.952 | 10.25 | 57.38 | 3.37 |
| 13 | | 8.12 | 8.611 | 8.75 | 44.33 | 10.74 | 8.78 | 4.887 | 10.00 | 50.17 | 5.04 |
| 14 | | 8.09 | 4.411 | 9.00 | 53.92 | 10.99 | 8.58 | 6.184 | 10.25 | 53.75 | 5.39 |
| 15 | | 8.24 | 4.648 | 8.75 | 55.09 | 6.90 | 8.40 | 5.954 | 10.25 | 58.14 | 5.41 |
| 16 | | 8.11 | 14.737 | 8.75 | 49.48 | 7.28 | 8.48 | 7.030 | 10.50 | 47.39 | 2.47 |
| 17 | MANDALIYA | 8.13 | 4.067 | 7.25 | 55.23 | 8.04 | 8.37 | 6.349 | 10.00 | 54.30 | 2.82 |
| 18 | | 8.02 | 7.892 | 7.75 | 50.47 | 7.25 | 8.25 | 4.113 | 11.00 | 56.67 | 1.74 |
| 19 | | 8.08 | 4.178 | 7.50 | 50.52 | 6.77 | 8.48 | 6.268 | 10.75 | 60.83 | 2.37 |
| 20 | | 8.07 | 5.085 | 7.50 | 53.02 | 6.32 | 8.46 | 4.495 | 10.25 | 61.91 | 2.43 |

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| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | | 7.89 | 5.267 | 8.75 | 54.37 | 5.36 | 8.45 | 6.508 | 10.75 | 59.96 | 1.31 |
| 22 | | 7.84 | 5.882 | 9.00 | 50.75 | 4.29 | 8.05 | 7.736 | 10.50 | 58.09 | 1.58 |
| 23 | | 8.11 | 5.48 | 8.50 | 47.29 | 4.91 | 8.39 | 4.346 | 11.00 | 54.80 | 1.26 |
| 24 | | 8.13 | 4.495 | 8.00 | 50.85 | 4.39 | 8.34 | 6.56 | 10.25 | 54.30 | 3.28 |
| 25 | | 8.12 | 4.748 | 8.25 | 49.04 | 4.51 | 8.00 | 4.524 | 10.75 | 52.29 | 1.65 |
| 26 | | 8.00 | 6.916 | 8.00 | 48.9 | 2.08 | 7.99 | 6.492 | 10.50 | 56.77 | 1.70 |
| 27 | | 8.17 | 6.975 | 7.75 | 51.37 | 3.39 | 8.37 | 5.27 | 10.00 | 56.31 | 0.80 |
| 28 | | 8.32 | 6.213 | 7.50 | 45.20 | 4.99 | 8.65 | 5.286 | 9.75 | 58.27 | 1.51 |
| 29 | **SULTANPUR** | 8.48 | 6.083 | 9.00 | 50.53 | 4.58 | 8.65 | 4.586 | 10.75 | 61.19 | 1.39 |
| 30 | | 8.04 | 4.790 | 8.75 | 53.09 | 3.35 | 8.54 | 4.952 | 11.00 | 59.93 | 0.85 |
| 31 | | 8.33 | 4.622 | 8.50 | 46.88 | 3.08 | 8.66 | 5.743 | 10.25 | 59.63 | 1.78 |
| 32 | | 8.41 | 4.460 | 8.75 | 44.62 | 3.45 | 8.42 | 6.206 | 10.50 | 56.40 | 1.01 |
| 33 | | 7.86 | 22.66 | 7.50 | 46.33 | 3.34 | 8.25 | 12.458 | 10.75 | 58.31 | 1.02 |
| 34 | | 7.98 | 12.876 | 8.00 | 42.77 | 2.24 | 8.56 | 4.628 | 10.25 | 56.69 | 1.47 |
| 35 | | 8.04 | 6.618 | 7.75 | 50.49 | 6.03 | 8.54 | 5.182 | 11.00 | 56.21 | 2.14 |
| 36 | **DANTI** | 8.22 | 4.599 | 8.75 | 51.43 | 5.84 | 7.94 | 5.367 | 11.25 | 54.30 | 1.95 |
| 37 | | 7.99 | 10.595 | 9.25 | 46.82 | 4.12 | 8.3 | 7.467 | 11.00 | 57.67 | 1.51 |
| 38 | | 7.96 | 10.455 | 9.00 | 46.88 | 3.61 | 8.40 | 6.903 | 9.75 | 54.05 | 1.28 |
| 39 | | 8.23 | 4.696 | 9.25 | 47.93 | 7.97 | 8.54 | 5.779 | 11.00 | 56.57 | 2.37 |
| 40 | | 8.20 | 5.429 | 8.50 | 49.05 | 6.27 | 8.47 | 5.169 | 10.00 | 55.48 | 2.09 |
| 41 | | 8.11 | 9.496 | 8.75 | 48.83 | 4.18 | 8.34 | 8.854 | 10.75 | 55.05 | 1.66 |
| 42 | | 8.16 | 7.282 | 8.50 | 49.65 | 6.25 | 8.40 | 7.684 | 10.25 | 55.25 | 2.11 |
| 43 | | 8.16 | 4.09 | 7.75 | 43.30 | 5.96 | 8.57 | 6.54 | 10.75 | 56.60 | 4.55 |
| 44 | | 7.96 | 8.835 | 8.50 | 50.53 | 6.21 | 8.30 | 7.461 | 10.50 | 53.42 | 1.40 |
| 45 | | 8.08 | 9.794 | 8.75 | 52.29 | 4.98 | 8.42 | 9.211 | 11.00 | 49.89 | 3.93 |
| 46 | | 8.21 | 6.754 | 8.25 | 45.59 | 6.19 | 8.52 | 6.200 | 10.00 | 52.09 | 4.06 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 47 | | 8.22 | 5.429 | 8.50 | 47.72 | 4.50 | 8.48 | 5.354 | 10.50 | 58.18 | 3.19 |
| 48 | | 8.24 | 4.472 | 8.00 | 51.45 | 3.17 | 8.76 | 6.077 | 10.25 | 56.40 | 2.43 |
| 49 | | 8.18 | 7.386 | 7.75 | 48.96 | 3.32 | 8.58 | 6.077 | 11.00 | 55.73 | 3.12 |
| 50 | | 8.26 | 4.842 | 9.00 | 46.03 | 3.90 | 8.63 | 4.91 | 10.75 | 50.13 | 2.41 |
| 51 | **DANTI** | 8.15 | 9.127 | 9.25 | 51.52 | 3.76 | 8.6 | 6.508 | 10.00 | 56.37 | 1.79 |
| 52 | | 8.29 | 4.139 | 8.50 | 52.02 | 6.37 | 8.41 | 5.331 | 10.25 | 57.46 | 1.95 |
| 53 | | 8.13 | 9.156 | 8.00 | 44.39 | 4.38 | 8.4 | 8.958 | 11.00 | 60.34 | 2.15 |
| 54 | | 8.18 | 4.129 | 7.50 | 48.05 | 3.64 | 8.64 | 4.826 | 10.00 | 56.33 | 2.86 |
| 55 | | 8.22 | 4.482 | 8.75 | 49.23 | 7.24 | 8.49 | 6.219 | 10.25 | 53.62 | 2.24 |
| 56 | | 8.01 | 4.317 | 9.00 | 46.36 | 4.54 | 8.48 | 6.822 | 11.00 | 59.85 | 1.79 |
| 57 | | 8.14 | 5.600 | 9.25 | 46.01 | 5.09 | 8.53 | 5.218 | 10.5 | 53.48 | 2.36 |
| 58 | | 8.11 | 4.372 | 8.00 | 48.61 | 5.72 | 8.6 | 5.565 | 10.75 | 53.83 | 2.31 |
| 59 | | 8.32 | 23.902 | 7.75 | 52.44 | 4.71 | 8.48 | 17.949 | 10.25 | 45.25 | 3.57 |
| 60 | | 7.95 | 42.985 | 9.25 | 51.13 | 3.40 | 8.37 | 37.378 | 11.25 | 50.63 | 3.73 |
| | **Max.** | **8.65** | **42.985** | **9.25** | **55.23** | **10.99** | **8.85** | **37.378** | **11.25** | **61.91** | **7.55** |
| | **Min.** | **7.84** | **4.067** | **7.25** | **38.47** | **1.17** | **7.94** | **4.113** | **9.25** | **45.25** | **0.8** |
| | **Mean** | **8.17** | **7.227** | **8.40** | **48.44** | **5.04** | **8.46** | **6.663** | **10.44** | **55.39** | **2.28** |

**Table 2: Different fractions of Fe (mg kg$^{-1}$) in soils of saline areas at 0-20 and 20-40 cm depth**

| Sr.no | Name of Village | Depth: 0-20 cm | | | | | Depth: 20-40 cm | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | WS-Fe | Exch-Fe | $CO_3$-Fe | Fe-Mn-O-Fe | Org-Fe | WS-Fe | Exch-Fe | $CO_3$-Fe | Fe-Mn-O-Fe | Org-Fe |
| 1 | ONJAL | 7.54 | 6.48 | 26.44 | 716.40 | 528.84 | 4.55 | 3.00 | 15.90 | 566.40 | 341.64 |
| 2 | | 5.62 | 1.46 | 27.29 | 1449.60 | 545.88 | 2.63 | 4.07 | 21.64 | 1275.60 | 358.68 |
| 3 | | 2.54 | 6.22 | 24.32 | 1678.80 | 486.36 | 2.25 | 3.07 | 25.07 | 1340.40 | 299.16 |
| 4 | | 3.56 | 5.69 | 40.46 | 1174.80 | 570.00 | 2.56 | 2.54 | 9.95 | 973.20 | 382.80 |
| 5 | JOGESHWAR FALIYA | 6.95 | 7.01 | 32.81 | 441.60 | 568.80 | 3.96 | 3.86 | 19.57 | 388.80 | 381.60 |
| 6 | | 5.88 | 8.87 | 29.84 | 991.20 | 596.76 | 2.89 | 4.39 | 19.23 | 841.20 | 409.56 |
| 7 | | 5.81 | 7.80 | 20.07 | 898.80 | 401.40 | 2.82 | 4.65 | 16.48 | 748.80 | 214.20 |
| 8 | | 6.06 | 3.31 | 34.94 | 487.20 | 558.00 | 3.07 | 2.59 | 14.76 | 457.20 | 370.80 |
| 9 | | 7.41 | 6.48 | 31.54 | 762.00 | 511.20 | 4.42 | 3.33 | 13.73 | 612.00 | 324.00 |
| 10 | | 7.00 | 4.37 | 21.35 | 394.80 | 426.96 | 4.01 | 4.81 | 7.16 | 244.80 | 239.76 |
| 11 | | 4.68 | 3.05 | 24.32 | 1174.80 | 486.36 | 1.69 | 3.19 | 17.17 | 781.20 | 299.16 |
| 12 | | 2.09 | 4.10 | 27.71 | 853.20 | 554.28 | 2.10 | 4.96 | 14.42 | 703.20 | 367.08 |
| 13 | | 3.05 | 6.22 | 29.42 | 165.60 | 588.36 | 1.67 | 3.07 | 18.80 | 147.60 | 401.16 |
| 14 | | 7.39 | 4.10 | 21.35 | 427.20 | 426.96 | 4.40 | 3.23 | 18.82 | 277.20 | 239.76 |
| 15 | | 2.68 | 5.42 | 16.67 | 212.40 | 333.48 | 2.12 | 2.27 | 20.36 | 373.20 | 146.28 |
| 16 | | 4.30 | 4.63 | 29.42 | 165.60 | 588.36 | 1.31 | 2.76 | 17.00 | 162.00 | 401.16 |
| 17 | MANDALIYA | 3.12 | 10.45 | 17.10 | 165.60 | 342.00 | 1.14 | 4.71 | 15.97 | 374.40 | 154.80 |
| 18 | | 4.30 | 7.80 | 26.87 | 165.60 | 537.36 | 1.31 | 3.06 | 19.84 | 255.60 | 350.16 |
| 19 | | 4.57 | 9.66 | 20.50 | 441.60 | 409.92 | 1.58 | 3.13 | 18.29 | 291.60 | 222.72 |
| 20 | | 3.15 | 8.34 | 24.32 | 441.60 | 486.36 | 1.01 | 3.46 | 16.22 | 291.60 | 299.16 |
| 21 | | 3.64 | 9.92 | 29.42 | 762.00 | 588.36 | 0.89 | 4.08 | 13.38 | 612.00 | 401.16 |
| 22 | | 5.62 | 8.87 | 32.81 | 898.80 | 548.40 | 2.63 | 2.99 | 13.90 | 748.80 | 361.20 |
| 23 | | 3.45 | 6.22 | 23.05 | 487.20 | 460.92 | 0.46 | 3.07 | 14.68 | 337.20 | 273.72 |
| 24 | | 3.89 | 7.01 | 30.26 | 349.20 | 547.20 | 1.91 | 3.86 | 16.48 | 199.20 | 360.00 |

*Continue…*

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 | **MANDALIYA** | 3.82 | 6.36 | 26.03 | 1214.40 | 520.68 | 1.27 | 3.21 | 14.16 | 1064.40 | 333.48 |
| 26 | | 4.99 | 2.47 | 12.06 | 1328.40 | 539.42 | 2.00 | 3.05 | 13.90 | 1178.40 | 352.22 |
| 27 | **SULTANPUR** | 3.55 | 2.70 | 12.29 | 931.20 | 556.80 | 0.56 | 3.10 | 15.45 | 781.20 | 369.60 |
| 28 | | 5.11 | 5.45 | 11.83 | 760.80 | 496.09 | 2.12 | 2.30 | 14.42 | 610.80 | 308.89 |
| 29 | | 5.12 | 5.45 | 10.68 | 987.60 | 585.60 | 2.13 | 2.40 | 13.12 | 789.60 | 398.40 |
| 30 | | 8.61 | 11.18 | 18.47 | 1214.40 | 540.00 | 5.62 | 3.07 | 10.28 | 975.60 | 352.80 |
| 31 | | 5.55 | 9.34 | 9.77 | 1158.00 | 559.20 | 2.56 | 3.66 | 11.06 | 957.60 | 372.00 |
| 32 | | 6.58 | 8.88 | 4.04 | 1101.60 | 409.43 | 3.59 | 4.24 | 11.57 | 832.80 | 222.23 |
| 33 | **DANTI** | 2.68 | 6.36 | 14.81 | 703.20 | 340.74 | 0.69 | 3.00 | 39.07 | 553.20 | 153.54 |
| 34 | | 2.37 | 9.57 | 19.39 | 1556.40 | 271.46 | 1.34 | 3.07 | 40.10 | 1406.40 | 84.26 |
| 35 | | 3.31 | 13.01 | 15.04 | 1044.00 | 90.00 | 0.92 | 3.66 | 37.01 | 894.00 | 100.80 |
| 36 | | 2.64 | 7.28 | 11.82 | 817.20 | 124.09 | 5.41 | 4.13 | 51.86 | 667.20 | 126.00 |
| 37 | | 2.65 | 10.26 | 13.43 | 1498.80 | 193.37 | 0.97 | 4.78 | 40.66 | 1348.80 | 133.20 |
| 38 | | 3.68 | 9.80 | 8.85 | 1839.60 | 228.13 | 1.05 | 4.65 | 23.81 | 1689.60 | 104.40 |
| 39 | | 3.04 | 10.26 | 12.52 | 1556.40 | 96.00 | 0.91 | 4.27 | 24.84 | 1406.40 | 115.20 |
| 40 | | 1.95 | 5.45 | 13.89 | 1044.00 | 148.80 | 1.18 | 2.30 | 43.85 | 894.00 | 118.80 |
| 41 | | 3.49 | 6.59 | 12.52 | 987.60 | 228.13 | 0.50 | 1.99 | 47.86 | 837.60 | 78.00 |
| 42 | | 4.66 | 4.53 | 13.89 | 1783.20 | 164.40 | 0.67 | 2.52 | 40.66 | 1633.20 | 81.60 |
| 43 | | 3.02 | 3.62 | 12.52 | 1897.20 | 176.11 | 0.71 | 2.32 | 27.02 | 1483.20 | 88.80 |
| 44 | | 2.70 | 2.93 | 11.83 | 1953.60 | 120.00 | 0.76 | 2.45 | 46.25 | 1590.00 | 105.60 |
| 45 | | 4.66 | 6.12 | 9.53 | 1442.40 | 124.09 | 0.45 | 1.93 | 29.42 | 1233.60 | 118.80 |
| 46 | | 2.03 | 7.74 | 8.85 | 1783.20 | 228.13 | 0.81 | 2.18 | 41.45 | 1636.80 | 100.80 |
| 47 | | 1.23 | 6.59 | 9.77 | 1897.20 | 374.40 | 0.91 | 2.79 | 40.66 | 1518.00 | 58.80 |
| 48 | | 2.06 | 2.93 | 8.62 | 1726.80 | 366.00 | 0.61 | 1.62 | 30.24 | 1576.80 | 178.80 |
| 49 | | 2.37 | 4.99 | 9.53 | 1612.80 | 346.80 | 0.96 | 2.61 | 41.45 | 1462.80 | 159.60 |
| 50 | | 3.71 | 7.05 | 7.25 | 987.60 | 292.80 | 0.72 | 2.19 | 37.44 | 837.60 | 105.60 |
| 51 | | 4.01 | 5.67 | 9.53 | 1044.00 | 318.00 | 1.02 | 2.13 | 29.42 | 894.00 | 130.80 |

*Continue…*

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 52 | **DANTI** | 5.60 | 1.55 | 6.56 | 1272.00 | 344.40 | 2.61 | 1.59 | 36.65 | 1122.00 | 157.20 |
| 53 | | 4.22 | 6.36 | 4.04 | 1442.40 | 121.20 | 1.23 | 1.44 | 42.24 | 1292.40 | 109.20 |
| 54 | | 2.88 | 10.49 | 4.96 | 1726.80 | 312.00 | 0.89 | 2.76 | 33.43 | 1576.80 | 124.80 |
| 55 | | 3.14 | 6.36 | 1.75 | 1669.20 | 357.60 | 0.66 | 0.80 | 50.26 | 1519.20 | 170.40 |
| 56 | | 2.36 | 7.51 | 6.56 | 2067.60 | 321.60 | 0.97 | 1.62 | 40.66 | 1627.20 | 134.40 |
| 57 | | 2.58 | 6.14 | 0.83 | 1839.60 | 117.60 | 0.91 | 2.50 | 30.24 | 1689.60 | 99.60 |
| 58 | | 3.65 | 4.53 | 1.75 | 1953.60 | 345.60 | 0.66 | 1.38 | 43.85 | 1563.60 | 158.40 |
| 59 | | 3.03 | 7.74 | 1.97 | 1328.40 | 126.00 | 0.69 | 0.99 | 45.46 | 1178.40 | 187.20 |
| 60 | | 4.02 | 9.80 | 3.12 | 1556.40 | 333.50 | 1.03 | 1.95 | 39.84 | 1406.40 | 146.30 |
| **Max.** | | **8.61** | **13.01** | **40.46** | **2067.60** | **596.76** | **5.62** | **4.96** | **51.86** | **1689.60** | **409.56** |
| **Min.** | | **1.23** | **1.46** | **0.83** | **165.60** | **90.00** | **0.45** | **0.80** | **7.16** | **147.60** | **58.80** |
| **Mean** | | **4.09** | **6.61** | **16.71** | **1107.22** | **381.84** | **1.79** | **2.98** | **26.31** | **945.54** | **229.00** |

**Table 3: Correlation between PH, EC, $CaCO_3$, CEC, ESP and fractions of Fe**

| | 0-20 cm depth | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **PH** | **EC** | **$CaCO_3$** | **CEC** | **ESP** | **WS-Fe** | **Exch-Fe** | **$CO_3$-Fe** | **Fe-Mn-O-Fe** | **Org-Fe** |
| **PH** | 1 | | | | | | | | | |
| **EC** | -0.315* | 1 | | | | | | | | |
| **$CaCO_3$** | -0.068 | 0.070 | 1 | | | | | | | |
| **CEC** | -0.172 | 0.095 | 0.002 | 1 | | | | | | |
| **ESP** | 0.189 | -0.121 | -0.099 | 0.330* | 1 | | | | | |
| **WS-Fe** | 0.204 | -0.154 | 0.186 | -0.002 | -0.119 | 1 | | | | |
| **Exch-Fe** | -0.293* | 0.164 | 0.116 | 0.145 | -0.063 | -0.039 | 1 | | | |
| **$CO_3$-Fe** | 0.077 | -0.249 | -0.015 | -0.115 | 0.073 | 0.335** | -0.053 | 1 | | |
| **Fe-Mn-O-Fe** | -0.077 | 0.089 | 0.133 | -0.284* | -0.276* | -0.358** | -0.045 | -0.601** | 1 | |
| **Org-Fe** | 0.224 | -0.203 | -0.053 | -0.061 | -0.082 | 0.458** | -0.168 | 0.665** | -0.509** | 1 |
| | **20-40 cm depth** | | | | | | | | | |
| **PH** | **1** | | | | | | | | | |
| **EC** | -0.150 | 1 | | | | | | | | |
| **$CaCO_3$** | -0.435** | 0.284* | 1 | | | | | | | |
| **CEC** | 0.004 | -0.281* | 0.100 | 1 | | | | | | |
| **ESP** | 0.057 | 0.199 | 0.100 | -0.292* | 1 | | | | | |
| **WS-Fe** | -0.014 | -0.201 | -0.115 | 0.123 | -0.142 | 1 | | | | |
| **Exch-Fe** | -0.153 | -0.251 | -0.030 | 0.095 | -0.086 | 0.377* | 1 | | | |
| **$CO_3$-Fe** | -0.020 | 0.297* | 0.246 | -0.177 | 0.104 | -0.438** | -0.508** | 1 | | |
| **Fe-Mn-O-Fe** | 0.114 | 0.175 | 0.025 | -0.051 | -0.030 | -0.404** | -0.363** | 0.586** | 1 | |
| **Org-Fe** | 0.080 | -0.223 | -0.263* | 0.070 | -0.249 | 0.444** | 0.312* | -0.775* | -0.575** | 1 |

****. Correlation is significant at the 0.01 level (2-tailed).**

***. Correlation is significant at the 0.05 level (2-tailed).**

**REFERENCE**


Allison, L. E. and Moodie, C. D. (1965). Carbonate. *Methods of Soil Analysis: Part 2 Chemical and Microbiological Properties*, **9**: 1379-1396.

Aulakh, M.S. and Grant, C.A. (Eds.) (2008). Integrated Nutrient Management for Sustainable Crop Production; *The Haworth Press/Taylor & Francis Group: New York*, NY, USA, **2**.

Bailey, R.L.; West, K.P., Jr. and Black, R.E. (2015). The epidemiology of global micronutrient deficiencies. *Annals of nutrition and metabolism*, 66(Suppl. 2): 22-33 [CrossRef]

Datta, A.; Basak, N.; Chaudhari, S. K. and Sharma, D. K. (2015). Effect of horticultural land uses on soil properties and organic carbon distribution in a reclaimed sodic soil. *Journal of the Indian Society of Soil Science*, **63**(3): 294-303.

Dhaliwal, S.; Naresh, R.; Mandal, A.; Singh, R. and Dhaliwal, M. (2019). Dynamics and transformations of micronutrients in agricultural soils as influenced by organic matter build-up. *Environmental and Sustainability Indicators*, **1**: 100007.

Eskandari, S. and Mozaffari, V. (2014). Interactive effect of soil salinity and copper application on growth and chemical composition of pistachio seedlings (cv. Badami). *Communications in Soil Science and Plant Analysis,* **45**: 688–702. [CrossRef]

Gupta, N.; Trivadi, S. K.; Bansal, K. N. and Kaul, R. K. (2003). Vertical distribution of micronutrient cations in some soil series of northern Madhya Pradesh. *Journal of the Indian Society of Soil Science*, **51**: 517-522.

Hellel, F. A. (2007). Composite of rice straw and its influences on Fe availability in calcareous soil. *Journal of Agricultural and Biological Science,* **3**: 105-114.

Jackson, M. L. (1973). *Soil Chemical Analysis.* Prentice Hall of India Pvt. Ltd., New Delhi. pp. 183-192.

Kumar, S.; Salimath, S. B.; Channagouda, R. F. and Gurumurthy, K. T. (2018). Physical and chemical properties of salt affected soils of Vani Vilas command area of Hiriyur taluk, Chitradurga district. *Journal of Pharmacognosy and Phytochemistry*, **7**(1): 1379-1383.

Maskina, M. S.; Singh, B.; Singh, Y.; Baddesha, H. S. and Meelu, O. P. (1998). Fertilizer requirement of rice - wheat and maize - wheat rotation on coarse textured soils amended with farm yard manure. *Fertilizer Research,* **17**: 153-164.

Mohiuddin, M.; Irshad, M.; Sher, S.; Hayat, F.; Ashraf, A.; Masood, S. and Waseem, M. (2022). Relationship of selected soil properties with the micronutrients in salt-affected soils. *Land*, **11**(6): 845.

Munns, R. Comparative physiology of salt and water stress. (2002). *Plant, cell & environment*, **25**(2): 239-250. [CrossRef] [PubMed]

Sandhu, O. P.; Jassal, H. S.; Narender, S. D. and Rolaniya, L. K. (2016). Fractionation and distribution of iron in the salt-affected soils of muktsar district of Punjab. *The Ecoscan*, **10**(2): 33-39.

Shukla, A.K.; Malik, R.; Tiwari, P.K.; Prakash, C.; Behera, S.K.; Yadav, H. and Narwal, R. (2015). Status of micronutrient deficiencies in soils of Haryana. *Indian Journal of Fertilisers,* **11**(5: 16-27.

Suchdev, P.S.; Jefferds, M.E.D.; Ota, E.; da Silva Lopes, K. and De-Regil, L.M. (2011). Home fortification of foods with multiple micronutrient powders for health and nutrition in children under two years of age. *Cochrane database of systematic reviews,* **2**: CD008959. [CrossRef]

Tessier, A.; Campbell, P.G. and Bisson, M. (1979). Sequential extraction procedure for the speciation of particulate trace metals. *Analytical Chemistry*, **51**: 844–851. [CrossRef]

Tozlu, I.; Moore, G.A. and Guy, C.L. (2000). Effects of increasing NaCl concentration on stem elongation, dry mass production, and macro-and micro-nutrient accumulation in Poncirus trifoliata. *Functional Plant Biology*, **27**: 35–42. [CrossRef]
Worku, A. and Bedadi, B. (2016). Studies on soil physical properties of salt affected soil in Amibara area, central rift valley of Ethiopia. *International Journal of Agricultural Sciences and Natural Resources*, **3**(2): 8-17.