Relations between the electrical conductivity and salt content for 1:5 soil-to-water extract: contribution of the salinity chemistry

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INTRODUCTION

Soil salinity severely affects ecosystem quality and crop production. Large amount of data on soil salinity has been collected in the Commonwealth of Independent States (CIS, formerly USSR) and many other countries during > 70 years, but its current use is complicated because in these countries salinity was expressed by (i) total soluble salts (total soluble salts, TSS, %) and (ii) eight salinity types (chemistry) determined by the ratios of the anions and cations (Cl, SO4, HCO3, and Na, Ca, Mg) in diluted 1:5 soil/water extract without assessing electrical conductivity (EC) (Basilevich & Pankova, 1968; Hazelton & Murphy, 2016). Measuring the EC (1:5) is more convenient and can be easily linked to saturated paste extract, ECe (Sonmez et al., 2008; He at al., 2013; Kargas et al., 2020). Yet, EC is not only affected by salt concentration but also by salinity chemistry (Corwin & Scudiero, 2019, Ismayilov et al., 2021). The latter also effects soil physical characteristics, soil-water-plant relations and abiotic stresses (Levy et al., 2005; Rengasamy, 2010). The **objective** of this study was to examine the relationship between EC and TSS of soils in a diluted extract (1:5) for the eight classic salinity types used in CIS.

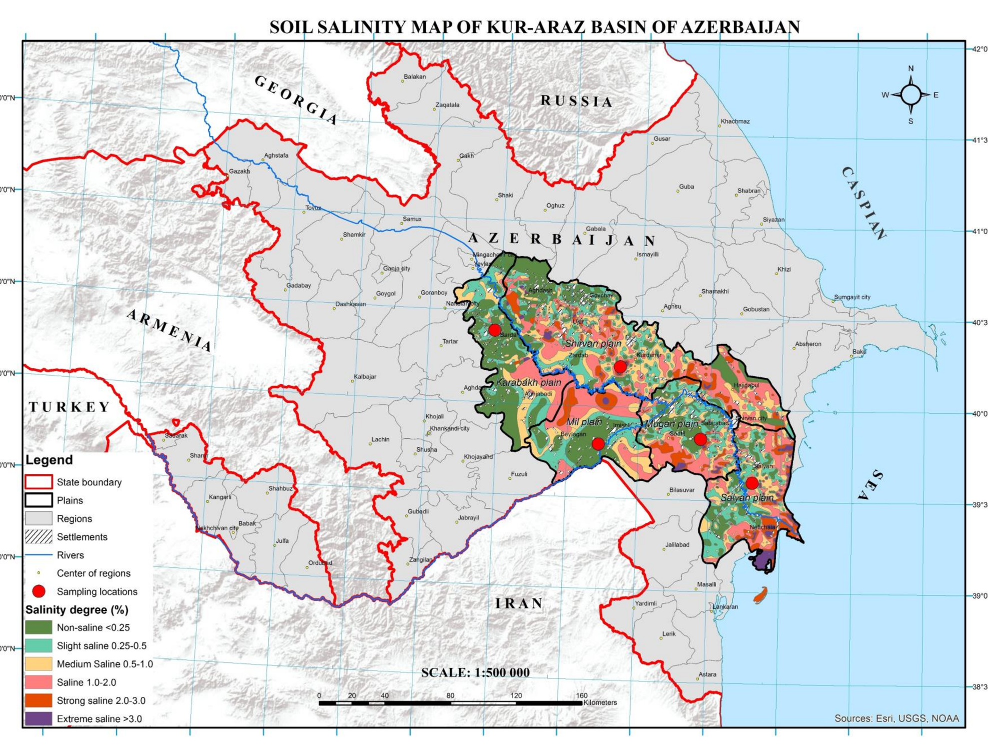

Fig 1. Soil salinity map of Kur–Araz basin of Azerbaijan (Ismayilov et al., 2021). Salinity degree is given by total soluble salts (TSS, %). Salinity area (10^3 ha): non–saline: 495; slightly saline: 382; saline: 415; strongly saline: 449; extremely saline:174.

METHODOLOGY

Extracts (1:5) of 1100 samples of a clayey soil (0–30 cm) collected from cultivated semi-arid and arid regions of the Kur-Araz basin, Azerbaijan (Fig 1), were analysed for EC, TSS, soluble cations (Na, Ca, Mg), and anions (HCO3, Cl, SO4). Eight types of salinity chemistry were formed in light of the geomorphological conditions, irrigation, and drainage history in the basin.

RESULTS

Results revealed that (i) the variation in the proportional relations (R^2=0.91–0.98) between EC (0.12–5.6 dS/m) and TSS (0.05–2.5%), EC=*a* TSS; *a* = 2.217-3.156 could be related to salinity type (Figs 2 and 3). The coefficient of the TSS = *a* EC (*a* = 0.313–0.447) relations decreased in the following salinity chemistry order: SO4 > Cl(SO4)–HCO3 > Cl(HCO3)–SO4 > SO4 (HCO3)–Cl > Cl. Formerly reported international mean value of the coefficient (*a* = 0.336,) was significantly lower than our mean value (*a* = 0.408), but still within the range of coefficients obtained in our study (*a* = 0.313–0.447) (Table 1).

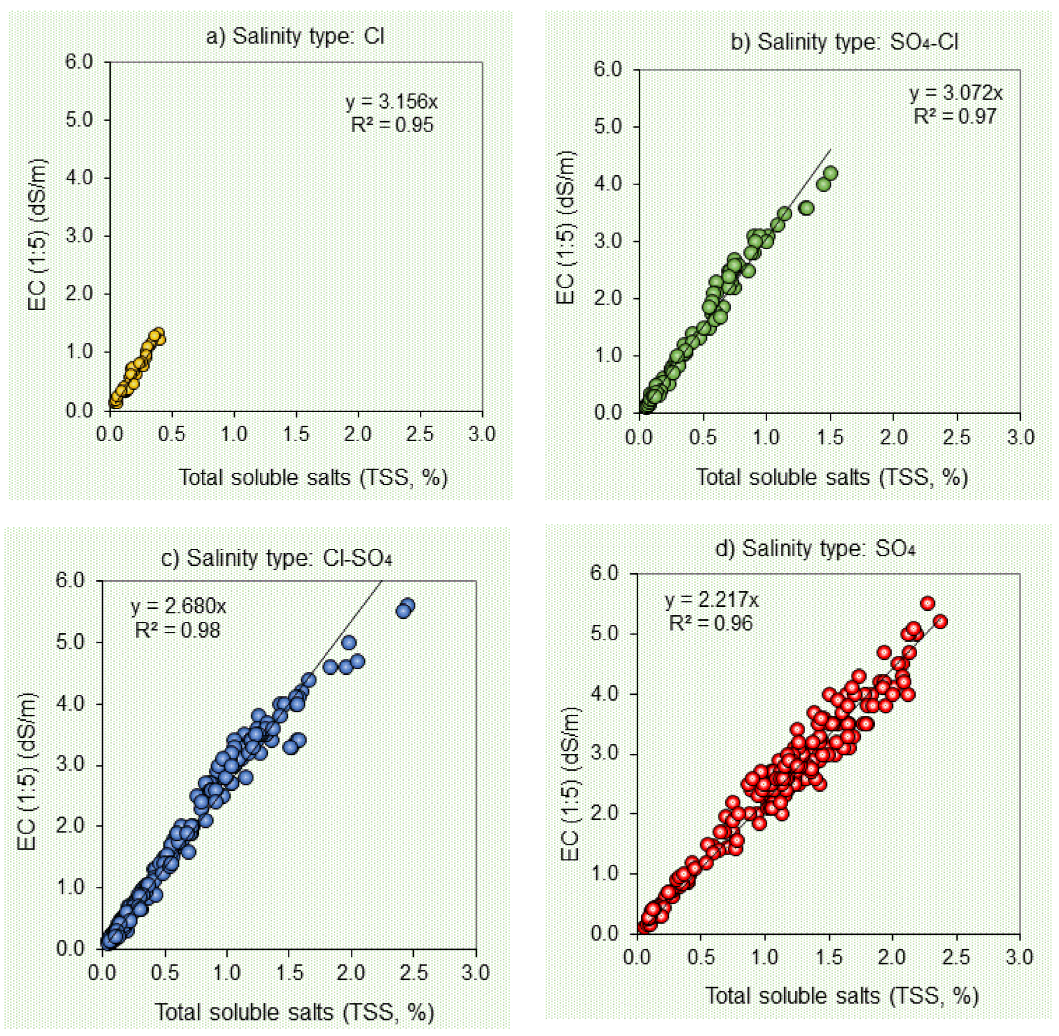

Fig 2. Relations (p < 0.001) between the electrical conductivity (EC 1:5, dS m^{-1}) and total dissolved salt content (TSS, % or g salt/ 100 g soil) for 1:5 soil to water extract as affected by neutral (pH < 8.5) salinity type.

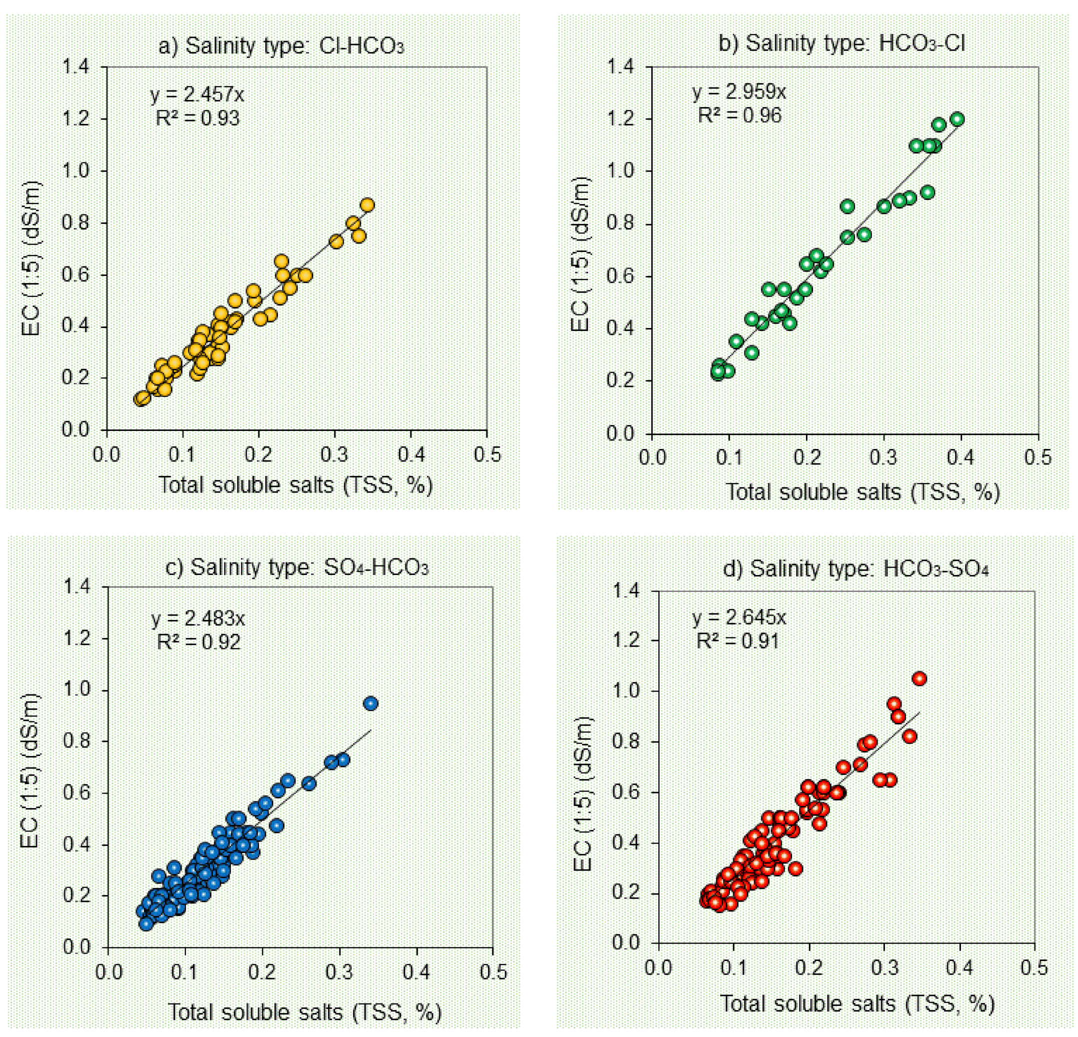

Fig 3. Relations (p < 0.001) between the electrical conductivity (EC 1:5, dS m^{-1}) and total dissolved salt content (TSS, % or g salt/ 100 g soil) for 1:5 soil to water extract as affected by alkaline (pH > 8.5) salinity type.

The traditional reported coefficient (TSS = 0.336 EC) is based on soil salinity dominated by NaCl. This coefficient was (i) comparable for chloride dominant salinity type (0.313, 0.323, and 0.336 for Cl, SO4–Cl, and HCO3–Cl, respectively); (ii) similar but somewhat lower for the sulfate dominant type of salinity (0.369 and 0.371 for Cl–SO4 and HCO3–SO4, respectively); and (iii) lower for sulfate itself and the carbonate and bicarbonate dominant type of salinity (0.447, 0.402, and 0.396 for SO4, Cl–HCO3, and SO4–HCO3, respectively) (Table 1). Thus, new TSS= a EC relation should be determined by ion characteristics or salinity type (conductivity) (Ismayilov et al., 2021).

Table 1. Proportionality coefficients (a) of linear relations between total soluble salts (TSS, %) and electrical conductivity (EC 1:5, dS m^{-1}). The means labelled with same letter are not significant at P<0.05 level.

Salinity type	Samples amount	pH	TSS=*a* EC (1:5)	R^2 P<0.001
Cl	32	<8.5	0.313 e	0.94
SO_4–Cl	96	<8.5	0.323 e	0.97
Cl–SO_4	390	<8.5	0.369 d	0.98
SO_4	246	<8.5	0.447 a	0.96
Cl–HCO_3	56	>8.5	0.402 b	0.93
HCO_3–Cl	32	>8.5	0.336 e	0.95
SO_4–HCO_3	144	>8.5	0.396 c	0.91
HCO_3–SO_4	104	>8.5	0.371 d	0.91
All	1100	>8.5	0.408 b	0.96
International			0.336	

CONCLUSIONS

The findings suggest that once soil salinity type is established, EC (1:5) values can be used for (i) evaluation of salinity degree in irrigated land in the context of sustainable soil and crop management, and (ii) application of advanced precision agriculture management strategies associated with mapping, leaching fraction, salinity stress, selection of cultivars tolerance to salinity level, and soil physical quality.

ACKNOWLEDGEMENTS

The support of Tottori University and ANAS is acknowledged.

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SALT-AFFECTED SOILS
20 - 22 October, 2021