Investigation of short-scale soil spatial variability of a salt-affected land allotment in Maha-Illuppallama, Sri Lanka in support of applying site-specific soil management practices

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INTRODUCTION

Development of salt-affected soils is one of major challenging constraints for sustainable agricultural crop production in many parts of the world including Sri Lanka (FAO, 1994, 2008). Delineation of Potential Management Zones (PMZs) in salt-affected soils provides a strong basis to apply Site-Specific Soil Management (SSSM) practices. This study was conducted to investigate short-scale spatial variability of a salt-affected land allotment in dry zone, Sri Lanka and explore the applicability to delineate PMZs in support of SSSM.

METHODOLOGY

The study site (2.94 ha) was located at Maha-Illupallama in Anuradhapura district of Sri Lanka. Seventy soil samples from a depth of 0-30 cm were randomly collected within the study site. Each sample was analyzed for Electrical Conductivity (EC), pH, Cation Exchange Capacity (CEC), Exchangeable Potassium (Ex.K), Ex.Na. Ex.Mg and Ex.Ca. Sodium Adsorption Ratio (SAR) and Exchangeable Na percentage (ESP), K (EPP), Mg (EMP) and Ca (ECP) percentages were calculated. Exploratory data analysis and variogram analyses were performed for each investigated soil parameter. Digital soil maps of the investigated soil parameters were prepared using ordinary kriging procedure. Spatial addition of the raster layers of ESP, EPP, ECP and EMP was performed to produce the map of Base Saturation (BS). Delineation of PMZs based on the spatial variability of soil pH, EC, SAR, and ESP was performed using Fuzzy *k*-mean classification. Significant differences in the investigated chemical parameters among PMZs were identified using Tukey's post hoc test.

Fig 1. Bird's eye view of the study site

RESULTS

The mean and standard deviation values for pH. EC, CEC, ESP, EPP, EMP, ECP, BS and SAR were 9.11±1.1, 3.18±2.42 dS/m, 8.88±4.15 $cmol_c/kg$, 28.3±25.40%, 1.7±1.63%, 29.69±12.24%, 39.75±16.84%, 99.41±1.93% and 7.06±8.04, respectively. The Coefficient of Variation (CV) of the investigated soil properties ranged from 1.8% and 113.8%. The spherical shape variograms were best fitted with all the investigated soil parameters. The Relative Nugget Effect (RNE) of each variogram was less than 16.2%.

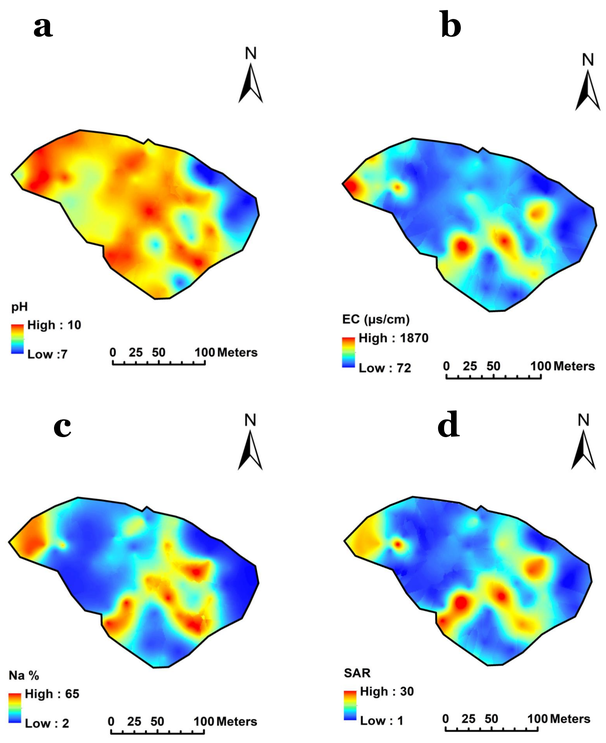

Fig 2. Spatial variability map of (a). Soil pH (b). Soil EC (c). Soil ESP and (d). Soil SAR

Four PMZs i.e., PMZ1 (1.31 ha), PMZ2 (1 ha), PMZ3 (0.4 ha) and PMZ4 (0.23 ha) were delineated using Fuzzy *k*-means classification. Highest EC and SAR mean values were observed in PMZ2 ($p<0.05$). Higher EMP mean values were observed in PMZ 1&3 in comparison to PMZ 2&4 ($p<0.05$). Other investigated soil parameters varied among the delineated PMZs. According to CV classification of (Warrick and Nielsen, 1980), EC, ESP, SAR and EPP showed higher spatial variability (60%<CV) while CEC, EMP & ECP showed moderate spatial variability (12%<CV<60%). Moreover, pH and BS revealed lower spatial variability (12%>CV) within the studies field. According to RNE classification of Cambardella *et al.* (1994), variogram analyses revealed presence of the strong structured (RNE<25%) spatial variability for each investigated soil parameter within the studied site.

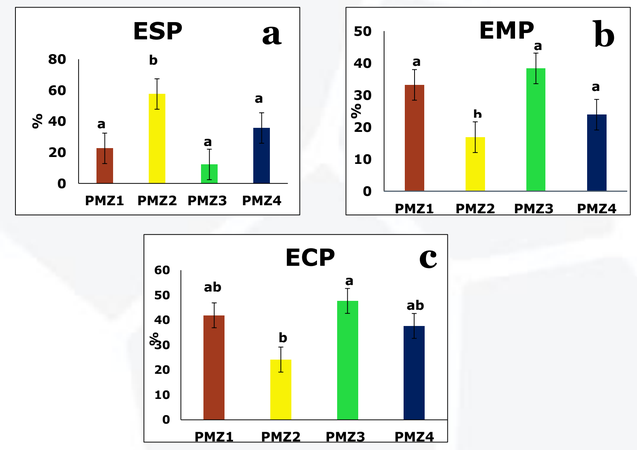

Fig 3. Variation in soil (a).ESP, (b). EMP, and (c). ECP among the delineate PMZs

Soils of some locations showed pH>8.5, EC< 4.5 dS/m, ESP<15% and SAR>13 values indicating an occurrence of sodic soil according to salt-affected soil classification of Richards (1954). The ordinary kriged maps of each investigated soil parameter showed continuous spatial variability within the studied site. The investigated soil parameters were almost uniform within each PMZ and different among the PMZs revealing a high applicability of Fuzzy *k*-mean classification to delineate PMZs in the studied site.

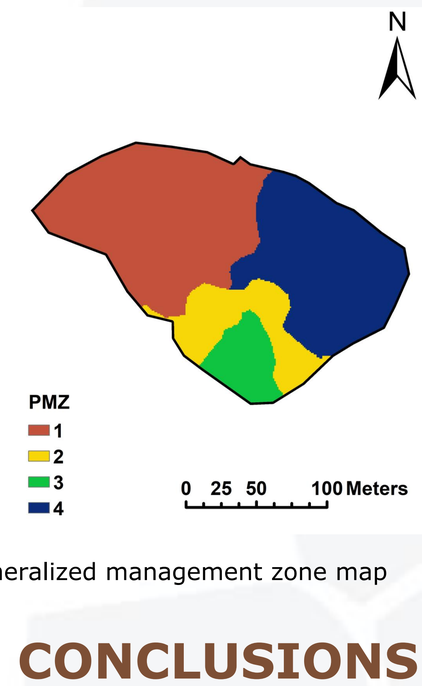

Fig 4. Generalized management zone map

CONCLUSIONS

The continuous spatial variability of each selected soil parameter within the studied field facilitates delineating PMZs. Homogeneity of the studied chemical parameters within each delineated PMZ highlights the applicability for implementing SSSM practices based on the PMZs in the studied salt affected soil.

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