Influence of soil properties on plant density and species richness of saline desert

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Resumen

Influencia de las propiedades del suelo en la densidad de plantas y la riqueza de especies de desierto salino

El ambiente edáfico tiene una significativa influencia en la productividad. La salinidad es uno de los principales factores que afectan negativamente a la vegetación. Se estudió un ecosistema desértico de la India (Pequeño Rann de Kutch; 7020 ha) para medir la influencia de las propiedades del suelo en la vegetación. Tanto la riqueza de especies (SR) como la densidad de hierbas y arbustos/árboles (17.018 plantas m$^{-2}$ y 8.617 plantas 10 m$^{-2}$) fueron mayores en el punto 4, con valores altos de OC, OM, N, P, Ca y Fe (0.684, 1.179, 0.059 %, 42.338 kg ha$^{-1}$, 170.732, 32.016 mg kg$^{-1}$) y bajos niveles de arcilla, EC y Na (33.654%, 9.441 dSm$^{-1}$ y 68.699 mg kg$^{-1}$). Valores altos de arcilla, Na y EC con bajo Ca y Fe resultaron en bajas densidades de SR (lugares 2 y 5). Las bajas SR y densidad se deben a bajas concentraciones de OC, OM, N, P, Fe, Ca y alta concentración de arcilla, Na y EC.

Palabras clave: Calcio, Desierto, Salinidad, Suelo, Sodio, Vegetación.

Abstract

Soil environment have significant influence on the productivity of land. Salinity is one of the major factors which negatively affect the vegetation. To measure the influence of soil properties on vegetation, desert ecosystem in India (Little Rann of Kutch of 7020 ha) was studied. Species richness (SR) as well as density for herbs and shrubs/tree (17.018 plants m$^{-2}$ and 8.617 plants 10m$^{-2}$) was highest in the site 4, with high OC, OM, N, P, Ca and Fe (0.684, 1.179, 0.059 %, 42.338 kg ha$^{-1}$, 170.732 and 32.016 mg kg$^{-1}$) and low clay, EC and Na (33.654%, 9.441 dSm$^{-1}$ and 68.699 mg kg$^{-1}$). High amount of clay, Na and EC with low Ca and Fe results into low density with low SR (site 2 and 5). Low SR and density are due to low concentration of OC, OM, N, P, Fe, Ca and high concentration of clay, Na and EC.

Key words: Calcium, Desert, Salinity, Soil, Sodium, Vegetation.
Introduction

Soil salinization and sodification had been identified as a major cause of land degradation. Salt-affected areas increase at a high rate, by about two million hectares per year (Postel 1996). Soil and vegetation together are vital factors of any ecosystem. The risk of soil degradation depends on the total salt content and on the salt composition; especially in relation to sodium concentration.

Salinization is the augment of the soluble salt in the root zone of the soil while sodification is the increase of exchangeable sodium in the root zone of the soil. The two processes may operate concurrently and form saline-sodic soils. The distribution is relatively more extensive in the arid and semi-arid regions. Soil is a natural resource that is not renewable within a point of petite time scale. Responsiveness of erosion extent and intensity for determining principal strategies and most encouraging soil conservation, as well as control of erosion and sediment yield are matters of concern for researchers, so that they can envisage the spatial pattern and erosion hazards rates (Morgan 1996). The division of plant species in saline soil is closely related with soil water potentials and factors controlling the level of salinity stress, including precipitation, depth of the water table (Ungar et al. 1979). Soils on landscape surfaces and good plant cover conditions may recover with time by accruing organic material, increasing floral and faunal activity, enhancing soil aggregate stability, increasing infiltration capacity, and decreasing erosion potential (Trimble 1990).

Vegetation cover is the chief factor to control soil degradation by water and wind erosion, the efficiency varies greatly with vegetation type and land cover. Soil erosion is expected to be more affected by changes vegetation cover than by run-off (Nearing et al. 2005).

The effect of vegetation on soil parameters have been known since the development of the concept of the factors of soil formation (Jenny 1941). Vegetation influences the soil by recycling different nutrients, which suggests that to increase the productivity of the land both soil and vegetation should be studied simultaneously.

The major goal of this study was to understand the inter-relation of soil (physical and chemical properties) and vegetation of the saline desert. Little Rann of Kutch is highly saline and salinity has negative effects on the vegetation except some salt tolerant species for example Prosopis juliflora (Sw.) DC., Acacia nilotica (Linn.), Salvadora oleoides Decne., Aeluropus lagopoides (Linn.), Cressa cretica Linn. etc. Salt stress is a worldwide problem, but is of special concern in arid and semi-arid regions. High concentrations of salts have harmful effects on plant growth (Mer et al. 2000; Vaghasiya et al. 2015) and excessive concentrations kill growing plants (Donahue et al. 1983). Many investigators have reported retardation of germination and growth of seedlings at high salinity (Garg and Gupta 1997).

Soil and vegetation degradation both are influenced by each other reduction in the perennial cover or vegetation cover is regarded as an indicator of the onset of desertification (Thornes 1996). All kinds of cover that secure against the erosive elements such as runoff, raindrop impacts and wind referred to as land cover. Type of land cover includes vegetation, stone, litter and gravel covers. Generally unnatural land use that diminishes the amount of land cover on an incline may cause severe erosion and sediment construction (Refahi 2006). With this alarm our aim was to study inter-relation of soil and vegetation and to identify the effect of different soil properties on plant density and species richness at the saline desert of western India soil.

Figura 1. Zona de estudio en el Pequeño Rann de Kutch.
Figure 1. Study Area in Little Rann of Kutch.

Material and methods

Study Area

The study was conducted in India at Little Rann of Kutch (22° 55" to 24° 35" North latitudes and
Influence of soil properties on saline desert

70° 30' to 71° 45' East longitudes) known as “The Wild Ass Sanctuary”, named after endangered ghudkhur (*Equus hemionus khur* Lesson, 1827). The Little Rann of Kutch (Fig. 1) occupies an area of 6979 sq km of which the Wild Ass Sanctuary encompassing 4953 sq km.

**Soil Analysis**

**Collection of soil samples**

Collections of samples were done in the months of mid June to October (2014). To represent the harsh condition of this area the ombro-thermic diagram is given (Fig. 2). Samples were randomly collected from five different sites (20, 16, 20, 64 and 36 samples from site one to five respectively), for three depths i.e., 0-15, 15-30 and 30-45 cm respectively. Soil samples were thoroughly mixed depth wise, and from the composite soil, one sample was drawn for each depth and brought to the laboratory. All these soil samples were air dried and stored in polyethylene bags to determine their physical and chemical properties. For soil aggregate analysis, soil samples were collected separately from each site. Due care was taken, specially, in sampling and in transportation to the laboratory, so that the soil aggregate should not be disturbed.

**Analysis of Physical Properties of Soil**

Soil Texture was determined by “Bouyoucos Hydrometer Method” (Bouyoucos 1951). Soil Aggregates was determined by “Wet sieving method” (Yoder 1936) with the help of a Yoder sieve shaker. Soil weight in unit volume was computed to determine bulk density (BD). Particle density (PD) was measured by method given by USDA (Richards 1968). Value of bulk density was used to determine porosity (PO) of soil (Misra 1968) and expressed in percentage.

**Soil Moisture Constants**

Field Capacity (FC) and water holding capacity (WHC) was determined following Misra (1968) and the results are expressed in percentage of oven-dry weight (Oven-drying was done at 105 °C temperature).

**Analysis of Chemical Properties of Soil**

Soil pH was measured by pH meter preparing soil paste with distilled water (1:5 ratio). Electrical Conductivity (EC) was measured by an EC meter (1:2 ratio). As per Jackson (1973), Organic carbon (OC), Organic matter (OM) and Nitrogen (N) were measured by using UV Visible spectrophotometer. Available Phosphorus (P) was measured by the method of Olsen et al. (1954). As per Lindsay and Norvell 1978, Potassium (K), Sodium (Na), Calcium (Ca), Zinc (Zn), Copper (Cu), Iron (Fe), Lead (Pb) and Manganese (Mn) were measured by Atomic Absorbance Spectrophotometer.

**Vegetation analysis**

Vegetation was quantitatively analyzed for density following Curtis and McIntosh (1950). Species richness (SR) was calculated as per Margalef 1958.

**Results**

**Characterization of physical properties of soil**

BD was maximum (Table 1) at site one (2.080 g/cc) while minimum at site four (1.765 g/cc). PD was highest at site two (3.313 g/cc) while lowest at site five (2.612 g/cc). At each site BD and PD was maximum at lower depths except at site two. PO maximum values obtained at upper layer of soil at sites one, three and four. FC and WHC were determined to know the soil moisture content of the soil and expressed in percentage of oven-dry weight. FC was highest at site four (22.935 %) while minimum at site one (20.114 %) and WHC was highest (37.152 %) at site one and lowest (24.254 %) at site four.
Maximum values of sand (35.238 %), clay (44.160 %) and silt (40.335 %) were found at site four, while minimum value for sand (26.067 %) and clay (33.589 %) at site one and for silt (27.569 %) at site two (Table 2). High amount of large macro-aggregate was at lower depths except at site three.

Characterization of soil chemical properties

Correlation of Na and Ca was negative (-0.696) and positive correlation of K and Zn (0.737) (Fig. 3). pH (Table 3) was maximum at site one (9.036) while minimum at site five (7.796). EC was maximum at site two (14.031 dSm\(^{-1}\)) followed by site three (13.171 dSm\(^{-1}\)) while minimum at site four (9.441 dSm\(^{-1}\)). OC (0.684 %), OM (1.179 %), N (0.059 %) and P (42.338 kg ha\(^{-1}\)) were maximum at site four, while OC (0.605 %), OM (1.042 %) and N (0.052 %) were minimum at site two and P (36.031 kg ha\(^{-1}\)) at site five. K was maximum at site one (873.672 mg kg\(^{-1}\)) and minimum at site four (53.118 mg kg\(^{-1}\)). Ca was maximum at site one and four (170.923 and 170.732 mg kg\(^{-1}\)) while minimum at site two and five (53.118 and 53.118 mg kg\(^{-1}\)). Cu was maximum at site two and five (68.699 and 72.380 mg kg\(^{-1}\)). Na was maximum at site two and five (91.120 and 91.120 mg kg\(^{-1}\)). Pb was maximum at site five (48.843 mg kg\(^{-1}\)) and minimum at site three (42.932 mg kg\(^{-1}\)).
Species richness and density for herbs and shrubs/trees with clay (-0.857 and -0.822) were negatively correlated (Fig. 3) while positive correlated with calcium (0.861 and 0.952). Negative correlated (0.903) and sodium (-0.815 and -0.822) were negatively correlated with Fe (19.577 and 25.740 mg kg\(^{-1}\)) and EC (14.031 and 10.466 dSm\(^{-1}\)) and EC (9.441 dSm\(^{-1}\)) was found.

Tabla 2. Descripción de la textura del suelo y agregados en diferentes lugares y profundidades. Se proporcionan la media y rango, por separado, para profundidades de 0-45 cm; tamaño de agregados del suelo en mm.

Table 2. Description of soil texture and aggregate at different sites and soil depths. Separate mean and range is given for 0-45 cm depth; size of soil aggregate in mm.

### Vegetation analysis at different sites

For herbs maximum species richness (Table 4) was found at site four (22) followed by site three while minimum at site two (five). Total density was found to be maximum (17.018 plants m\(^{-2}\)) at site four followed by site one (9.588 plants m\(^{-2}\)). Minimum density was found at site two and five (2.771 and 2.721 plants m\(^{-2}\)). For shrubs/trees maximum species richness was found at site three and four (8 species each) followed by site two and five. Density was maximum at site one and four (8.875 and 8.617 plants 10m\(^{-2}\)) while minimum at site two and five (4.688 and 4.719 plants 10m\(^{-2}\)).

### Inter-relation of Soil and Vegetation

Species richness and density for herbs and shrubs/tree was high at site four, with high amount of OC (0.684 %), OM (1.179 %), N (0.059 %), P (42.338 kg ha\(^{-1}\)), Ca (170.732 mg kg\(^{-1}\)) and Fe (32.016 mg kg\(^{-1}\)) however low amount of clay (33.654 %), EC (9.441 dSm\(^{-1}\)) and Na (68.699 mg kg\(^{-1}\)) was found.

Density of herbs and shrubs/trees was low at site two and five with high amount of clay (44.160 and 44.131 %), Na (166.149 and 141.128 mg kg\(^{-1}\)) and EC (14.031 and 10.466 dSm\(^{-1}\)) while low amount of Ca (51.989 and 91.120 mg kg\(^{-1}\)) and Fe (19.577 and 25.740 mg kg\(^{-1}\)). Density of herbs and shrubs/trees with clay (-0.857 and -0.903) and sodium (-0.815 and -0.822) were negative correlated (Fig. 3) while positive correlated with calcium (0.861 and 0.952).
<table>
<thead>
<tr>
<th>Soil Depth</th>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Site 4</th>
<th>Site 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-15</td>
<td>9.095 ± 0.247</td>
<td>7.828 ± 0.327</td>
<td>8.098 ± 0.072</td>
<td>7.685 ± 0.131</td>
<td>7.754 ± 0.155</td>
</tr>
<tr>
<td>15-30</td>
<td>9.215 ± 0.203</td>
<td>7.817 ± 0.400</td>
<td>8.254 ± 0.033</td>
<td>7.811 ± 0.129</td>
<td>7.769 ± 0.174</td>
</tr>
<tr>
<td>30-45</td>
<td>8.799 ± 0.039</td>
<td>8.442 ± 0.473</td>
<td>8.295 ± 0.042</td>
<td>7.977 ± 0.148</td>
<td>7.864 ± 0.187</td>
</tr>
<tr>
<td>Combined</td>
<td>Mean: 9.036 ± 0.103</td>
<td>Range: 8.557 to 9.977</td>
<td>8.209 ± 0.212</td>
<td>8.216 ± 0.034</td>
<td>7.824 ± 0.077</td>
</tr>
<tr>
<td>0-45</td>
<td>10.449 ± 0.590</td>
<td>9.441 ± 0.337</td>
<td>9.642 ± 0.078</td>
<td>9.642 ± 0.083</td>
<td>9.876 ± 0.143</td>
</tr>
<tr>
<td>Combined</td>
<td>Mean: 0.606 ± 0.075</td>
<td>Range: 0.130 to 0.945</td>
<td>0.605 ± 0.024</td>
<td>0.607 ± 0.019</td>
<td>0.684 ± 0.010</td>
</tr>
<tr>
<td>0-45</td>
<td>1.109 ± 0.241</td>
<td>0.947 ± 0.074</td>
<td>1.090 ± 0.037</td>
<td>1.141 ± 0.030</td>
<td>1.135 ± 0.088</td>
</tr>
<tr>
<td>30-45</td>
<td>3.533 to 15.067</td>
<td>5.133 to 18.067</td>
<td>7.800 to 25.067</td>
<td>0.593 to 21.000</td>
<td>2.980 to 19.033</td>
</tr>
<tr>
<td>Combined</td>
<td>Mean: 0.643 ± 0.540</td>
<td>Range: 0.549 to 0.634</td>
<td>0.632 ± 0.021</td>
<td>0.662 ± 0.018</td>
<td>0.658 ± 0.051</td>
</tr>
<tr>
<td>0-15</td>
<td>7.457 ± 0.359</td>
<td>11.876 ± 0.542</td>
<td>15.642 ± 1.224</td>
<td>8.246 ± 1.688</td>
<td>10.037 ± 2.196</td>
</tr>
<tr>
<td>10.449 ± 0.590</td>
<td>Range: 9.441 ± 0.337</td>
<td>9.642 ± 0.078</td>
<td>9.642 ± 0.083</td>
<td>9.876 ± 0.143</td>
<td>9.876 ± 0.143</td>
</tr>
<tr>
<td>0-45</td>
<td>0.595 ± 0.113</td>
<td>0.622 ± 0.025</td>
<td>0.672 ± 0.041</td>
<td>0.684 ± 0.019</td>
<td>0.637 ± 0.006</td>
</tr>
<tr>
<td>0-15</td>
<td>2.263 ± 0.976</td>
<td>4.386 ± 1.401</td>
<td>4.376 ± 0.879</td>
<td>4.376 ± 0.879</td>
<td>4.376 ± 0.879</td>
</tr>
<tr>
<td>Combined</td>
<td>Mean: 72.380 ± 2.164</td>
<td>Range: 63.417 to 92.001</td>
<td>74.612 ± 7.467</td>
<td>78.216 ± 7.629</td>
<td>88.750 ± 7.882</td>
</tr>
<tr>
<td>0-15</td>
<td>108.669 to 201.986</td>
<td>147.232 to 182.733</td>
<td>147.232 to 182.733</td>
<td>147.232 to 182.733</td>
<td>147.232 to 182.733</td>
</tr>
<tr>
<td>Combined</td>
<td>Mean: 7.227 ± 0.796</td>
<td>Range: 6.538 to 0.034</td>
<td>6.538 ± 0.205</td>
<td>6.538 ± 0.205</td>
<td>6.538 ± 0.205</td>
</tr>
<tr>
<td>0-15</td>
<td>20.620 ± 0.070</td>
<td>17.085 ± 1.737</td>
<td>20.549 ± 3.761</td>
<td>20.865 ± 2.469</td>
<td>16.523 ± 2.573</td>
</tr>
<tr>
<td>30-45</td>
<td>20.620 ± 0.064</td>
<td>19.404 ± 1.102</td>
<td>25.854 ± 1.599</td>
<td>23.017 ± 2.065</td>
<td>21.913 ± 2.744</td>
</tr>
<tr>
<td>Combined</td>
<td>Mean: 20.620 ± 0.041</td>
<td>Range: 18.061 to 0.711</td>
<td>22.460 ± 1.704</td>
<td>22.323 ± 1.232</td>
<td>18.069 ± 1.541</td>
</tr>
</tbody>
</table>

**Table 3 (cont.)**. Description of chemical properties of soil at different sites and soil depths. EC= Electrical conductivity, OC= Organic carbon, OM= Organic matter, N= Total nitrogen, P= Phosphorous, K= Potassium, Ca= Calcium total, Na= Sodium, Zn= Zinc, Cu= Copper, Fe= Iron, Pb= Lead, Mn =Manganese; separate mean and Range is given for 0-45 cm depth.
of the monsoon the desert springs up into life. Supply from the deep soil and with the first rains deeper parts of its roots are sustained by moisture soon has a positive effect on the vegetation and rainfall affects the salinity and vegetation of this area BD and PD were found to be high due to high content of clay and sodium. Highly saline and sodium induced soil reduces amount of water to pass through the root zone regardless of the high Na concentration of a sodic soil not only to pass through the root zone but also to pass through the soil water infiltration and retention (Salihi and Norton 1987). In this area BD and PD were found to be high due to high content of clay and sodium. Highly saline and sodium induced soil reduces amount of water to pass through the root zone regardless of the amount of water actually in the root zone. The high Na concentration of a sodic soil not only injures plants directly but also degrades the soil. Due to salinity fine particles bind into aggregates. Due to high concentration of sodium in soil, clay platelet, soil dispersion and aggregate swelling takes place. This soil dispersion causes clay particles to close soil pores, which results to reduce soil permeability. Soil dispersion hardens soil and blocks water infiltration, making it difficult for water to penetrate the soil.

Discussion

Plant species differ in their sensitivity or tolerance to salts (Brady and Weil 1996). According to Roy et al. (1973) in the soil of Thar Desert of Rajasthan (India) clay content varies from 2 to 6 % in the surface soil and 4 to 8 % in the sub soil. Organic carbon content is very low, ranging from 0.08 to 0.20 % in the surface layer. Moisture retention capacity is very low and the soils are highly pervious. The surface, however, has a tendency to form a crust resulting in reduced infiltration. In this region calcium carbonate increases with the depth. In present study average clay content (38.303 %) was higher than silt (31.249 %) and sand (30.283 %) content. Organic carbon content ranges from 0.130 to 1.966 % and mean value were 0.633 %, this shows that saline (Little Rann of Kutch) and Thar Desert are not similar in soil texture and chemical constitutes.

At earlier study it was found that temperature and rainfall affects the salinity and vegetation of the soil (Pilania & Panchal 2013) of an area. Monsoon has a positive effect on the vegetation and soil properties. While natural hardy vegetation near the surface soil dries up in the dry season, deeper parts of its roots are sustained by moisture supply from the deep soil and with the first rains of the monsoon the desert springs up into life.

Ramakrishna et al. (1966) have discussed in detail about the annual moisture regime variability and its impact on agriculture in Rajasthan desert. Carbon and nitrogen decreases with the depth which shows conformation with the findings of Charley and West (2010) at semi desert of Utah; because more litter is added from the canopy and surface roots to the surface soil.

In this study plant density was found to be low with respect to high bulk density. The increase of soil bulk density is considered as an important early indicator of ecosystem degradation (Rubio and Bochet 1998) because it leads to further alteration of soil properties such as soil water infiltration and retention (Salihi and Norton 1987). In this area BD and PD were found to be high due to high content of clay and sodium. Highly saline and sodium induced soil reduces amount of water to pass through the root zone regardless of the amount of water actually in the root zone. The high Na concentration of a sodic soil not only injures plants directly but also degrades the soil. Due to salinity fine particles bind into aggregates. Due to high concentration of sodium in soil, clay platelet, soil dispersion and aggregate swelling takes place. This soil dispersion causes clay particles to close soil pores, which results to reduce soil permeability. Soil dispersion hardens soil and blocks water infiltration, making it difficult for water to penetrate the soil.

### Table 3

Table 3. Descripción de propiedades químicas del suelo en diferentes lugares y profundidades. EC= Conductividad eléctrica, OC= Carbono orgánico, OM= Materia orgánica, N= Nitrógeno total, P= Fósforo disponible, K= Potasio, Ca= Calcium total, Na= Sodio, Zn= Zinc, Cu= Cobre, Fe= Hierro, Pb= plomo, Mn= Manganese; se proporcionan la media y rango, por separado, para profundidades de 0-45 cm.

**Table 3 (continued).** Description of chemical properties of soil at different sites and soil depths. EC= Electrical conductivity, OC= Organic carbon, OM= Organic matter, N= Total nitrogen, P= Available phosphorus, K= Potassium, Ca= Total calcium, Na= Sodium, Zn= Zinc, Cu= Copper, Fe= Iron, Pb= Lead, Mn =Manganese; separate mean and Range is given for 0-45 cm depth.

<table>
<thead>
<tr>
<th>Site Depth</th>
<th>Fe (mg kg⁻¹)</th>
<th>Pb (mg kg⁻¹)</th>
<th>Mn (mg kg⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-15</td>
<td>25.868 ± 0.504</td>
<td>40.476 ± 9.607</td>
<td>30.124 ± 1.385</td>
</tr>
<tr>
<td>15-30</td>
<td>27.184 ± 1.760</td>
<td>49.732 ± 5.654</td>
<td>30.124 ± 1.385</td>
</tr>
<tr>
<td>30-45</td>
<td>24.983 ± 0.296</td>
<td>40.280 ± 5.484</td>
<td>30.124 ± 1.385</td>
</tr>
<tr>
<td>Combined 0-45</td>
<td>Mean 26.012 ± 0.584</td>
<td>Mean 40.476 ± 9.607</td>
<td>Mean 30.124 ± 1.385</td>
</tr>
<tr>
<td>Range</td>
<td>19.577 ± 1.692</td>
<td>27.198 ± 3.129</td>
<td>25.868 ± 1.385</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fe (mg kg⁻¹)</th>
<th>Pb (mg kg⁻¹)</th>
<th>Mn (mg kg⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-15</td>
<td>24.428 to 34.200</td>
<td>43.486 to 54.200</td>
</tr>
<tr>
<td>15-30</td>
<td>20.769 to 34.428</td>
<td>43.396 to 54.200</td>
</tr>
<tr>
<td>30-45</td>
<td>20.976 to 34.428</td>
<td>47.640 to 54.200</td>
</tr>
<tr>
<td>Combined 0-45</td>
<td>Mean 24.799 ± 1.329</td>
<td>Mean 45.788 ± 5.266</td>
</tr>
<tr>
<td>Range</td>
<td>15.083 to 34.496</td>
<td>24.524 to 97.829</td>
</tr>
</tbody>
</table>

**Discussion**

Plant species differ in their sensitivity or tolerance to salts (Brady and Weil 1996). According to Roy et al. (1973) in the soil of Thar Desert of Rajasthan (India) clay content varies from 2 to 6 % in the surface soil and 4 to 8 % in the sub soil. Organic carbon content is very low, ranging from 0.08 to 0.20 % in the surface layer. Moisture retention capacity is very low and the soils are highly pervious. The surface, however, has a tendency to form a crust resulting in reduced infiltration. In this region calcium carbonate increases with the depth. In present study average clay content (38.303 %) was higher than silt (31.249 %) and sand (30.283 %) content. Organic carbon content ranges from 0.130 to 1.966 % and mean value were 0.633 %, this shows that saline (Little Rann of Kutch) and Thar Desert are not similar in soil texture and chemical constitutes.

At earlier study it was found that temperature and rainfall affects the salinity and vegetation of the soil (Pilania & Panchal 2013) of an area. Monsoon has a positive effect on the vegetation and soil properties. While natural hardy vegetation near the surface soil dries up in the dry season, deeper parts of its roots are sustained by moisture supply from the deep soil and with the first rains of the monsoon the desert springs up into life.
cult for plants to establish and grow (Pilania et al. 2014c).

EC is the outcomes of the ions and it rises according to the content of soluble salts. EC is directly related to the soluble salts concentration of the soil like Na and Mg (Maiti 2003). High value of EC and high percentage of clay affects vegetation negatively and are harmful for vegetation (Pilania & Panchal 2014) and the same type of negative effect were found during this study. Panchal & Pandey (2002) mentioned that soil salinity increases with soil degradation or desertification. Spatial variability of soil physical and chemical properties at a large scale is mainly due to geological, geomorphological and pedological soil forming factors that could be altered and induced by other factors such as land use management. Parejiya et al. (2015) found approx 20 species for each studied site at Bandiyabedi forest grassland of Surendranagar district in Gujarat (India); Pilania et al. (2014a) documented 65 species of 57 genera belonging to 31 families at Tropical dry deciduous forest of Dahod district of Gujarat and Pilania et al. (2014b) documented 80
species belonging to 37 families at home gardens of South Gujarat; which shows that this saline desert have low species richness so major steps are required to increase the vegetation.

At site one and four high concentration of Ca (170.923 and 170.732 mg kg\(^{-1}\)) and low Na (72.380 and 68.699 mg kg\(^{-1}\)) was found with maximum plant density, which suggests that Na have negative effects on salinity. The application of gypsum has long been considered a common exercise in reclamation of saline sodic and sodic soils (Marschner 1995). The addition of calcium to the soil (as lime or gypsum) displaces Na\(^+\) from clay particles. This prevents the clay from swelling and dispersing (Sumner 1993) and also makes it possible for Na\(^+\) to be leached deeper into the soil. Thus, exogenously supplied calcium not only improves soil structure, but also alters soil properties in various ways (Shabala et al. 2003) that benefit the plant growth. Moreover, an improved Ca/Na ratio in the soil solution enhances the capacity of roots to restrict Na\(^+\) influx (Marschner 1995). Importance of interaction between Na and Ca was recognized after LaHaye and Epstein (1969) reported that exogenously supplied calcium may significantly alleviate detrimental effects of Na\(^+\) on the physiological performance of hydroponically grown plants.

**Conclusion**

Soil with low concentration of OC, OM, N, P, Fe, Ca and high concentration of clay, Na and EC cause low species richness and density. Emergent of native and dominant species like *Cressa cretica* Linn., *Capparis deciduas* (Forsk.) Edgew., *Acacia nilotica* (Linn.) Del, etc. at fringe vicinity with furnishing necessary nutrients can facilitate to enhance green belt, improve soil structure and help to control the extension of desert condition.

**References**


