Evaluation of Salinity and Sodicity of Irrigated Land with their Amelioration and management in Keshorai Patan Area, Kota (Rajasthan)

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ABSTRACT
In order to study the soil status of Keshorai Patan area which is irrigated and highly potential, ten sites were selected to collect the soil samples for analysis. The samples were collected from the root zone (0-30 cm depth). The samples were dried and properly ground to get analyzed. Salinity of soils was measured in terms of soluble salts i.e. electrical conductivity of soil and sodicity is measured as Sodium Adsorption Ratio i.e. Sodium content is the soil.

After soil analysis it may be concluded that out of ten sites two sites were found saline- non sodic. These sites are the soils of Mangilal’s field and Om Prakash’s field No. 1. This type of salinity can be removed by simple leaching with irrigation water. One site i.e. the soil of Om Prakash’s field No.2 is saline - sodic. This type of soil isameleriorated by leaching with water then application of gypsum as per G.R. of soil followed by 2-3 leaching with water. Addition of organic manures to maintain the nutrient status of soil is necessary. In the last but not least there should be provision of proper drainage otherwise, with the lapse of time again salinity and/or sodicity will develop.

Keywords-- AR, SSP, EC, Ca²⁺, Mg²⁺ etc

I. INTRODUCTION
The development and maintenance of successful irrigation project, involve not only supplying the irrigation water to the land but also the control of salinity and sodicity / Alkalinity. The quality of irrigation water, irrigation practices and drainage conditions are involved in salinity and sodicity control. In establishing the irrigation project, soils that are initially saline require the removal of excess salts and may require chemical amendments in addition to an adequate supply of irrigation water. On the other hand, soils that are non-saline may become unproductive, if excess soluble salts or exchangeable sodium are allowed to accumulate because of improper irrigation and soil management practices or inadequate drainage.

Soluble salts in soil are transported by water. This is an obvious but basic principle pertaining to the control of salinity. Salinity therefore can be controlled if the quality of irrigation water is satisfactory and if the flow of water through the soil can be controlled. The salt balance in soil as affected by the quantity and quality of irrigation water and the effectiveness of leaching and the drainage is of paramount importance. If irrigation agriculture is to remain successful, soil salinity must be controlled (scofield, 1940).

Adsorption of excessive amount of Sodium is detrimental to the physical status of the soil and may be toxic to plants. Therefore, to remove the excessive exchangeable Sodium, special amendments, leaching and management practices are required to improve and maintain favorable soil conditions for plant growth. Whether soil particles are flocculated or dispersed depends to some extent upon exchangeable cation status of the soil and also upon the ionic concentration of the soil solution. Soils that are flocculated and permeable when saline may become deflocculated when leached.

Saline, sodic and saline-sodic soils can be distinguished as per norms of United States department of agriculture which is accepted all over the world. The soil which is having electrical conductivity in saturation extracts more than 4.0 m.mhos/cm. and Sodium Adsorption Ratio (SAR) below 15 is called saline soils [Kearney & scofield, (1936)]. These soils are recognized by the presence of white crusts of the salts on the soil surface. Owing to the presence of excess salts and absence of significant amount of exchangeable sodium, saline soils generally are flocculated and as a consequence the permeability equal to or higher than that of similar non-saline soils.

The soils which are having SAR or ESP values more than 15 and the EC values less than 4.0 mmhos/cm are called sodic soils. Presence of higher amount of exchangeable sodium in soils may have marked influence on the physical and chemical properties of soils. As the proportion of exchangeable sodium increases the soils tend to become
more dispersed [Mc. George& Breazeale, (1983)] and pH value may increase.

The soils which are having EC and SAR values more than 4.0 mmhos/cm and 15 respectively are called saline-sodic soils [De Sigmond, (1938)]. These soils are similar to saline soils in appearance and the soil particles remain flocculated.

South-East part of Rajasthan state in India i.e. Kota Division comprises of clay to clay-loam soils of high fertility with adequate amount of irrigation water resulting good agriculture production, but some area are salt affected with low production due to over irrigation resulting high water-table and poor drainage conditions.

Keeping above facts in view the present study was undertaken to evaluate the soil status of various fields in K. Patan area, Kota (Rajasthan).

II. MATERIAL AND METHODS

In the K. Patan area different sites were selected for collection of representative soil samples. Form one site 8-10 surface soil sample (0-30 cms depth) were collected and ground up to the size of 2mm and mixed them properly to make one sample. From this 500 gm. of the soil sample was filled in cotton bag and tagged properly to represent one site. Thus almost 10 sites were covered. The soil samples were collected in the month of May, 2016 after harvesting Rabi crops in the field and before on set of monsoon. All these samples were sent to soil testing laboratory.

In the laboratory all soil sample were treated for moisture percentage determination by heating at temperature 105°C to 110°C in the electric oven. Then treated for soil-paste preparation and on word for extraction of water from soil, so called soil-water extracts or saturation extract.

The Electrical conductivity of saturation extracts was measured by digital conductivity meter at room temperature and Sodium Adsorption Ratio (SAR) was calculated by the formula:

\[ SAR = \frac{Na}{\sqrt{(Ca+Mg)^2}} \]

The value of Ca+Mg (Combined) was determined in milli equivalent per liter (meq./l) by the Versanate method [Chen of bray, (1951) and Diehl andcoworker, (1950)], using disodium salt of Ethylene diamine tetra acetic acid (EDTA) as titrant and Erichromeblack T (EBT) as an indicator.

The sodium content of the saturation extract of soil was also measured in meq./l by Flame photometric method as mentioned in hand book-60 (U.S.D.A.)

<table>
<thead>
<tr>
<th>S. No</th>
<th>Field No.1 of narayana cultivator</th>
<th>10.30</th>
<th>2.14</th>
<th>10.40</th>
<th>11.0</th>
<th>4.52</th>
<th>51.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Field No.2 of narayana cultivator</td>
<td>10.00</td>
<td>1.46</td>
<td>10.40</td>
<td>4.20</td>
<td>1.84</td>
<td>28.76</td>
</tr>
<tr>
<td>3</td>
<td>Field No.3 of narayana cultivator</td>
<td>10.21</td>
<td>1.91</td>
<td>10.40</td>
<td>8.70</td>
<td>3.82</td>
<td>45.55</td>
</tr>
<tr>
<td>4</td>
<td>Field of mangilal cultivator</td>
<td>10.70</td>
<td>4.14</td>
<td>14.00</td>
<td>27.4</td>
<td>10.3</td>
<td>68.18</td>
</tr>
<tr>
<td>5</td>
<td>Field of chitter lal cultivator</td>
<td>10.22</td>
<td>1.49</td>
<td>7.80</td>
<td>7.10</td>
<td>3.60</td>
<td>47.65</td>
</tr>
<tr>
<td>6</td>
<td>Field No.1 omprakas cultivator</td>
<td>10.11</td>
<td>13.9</td>
<td>93.60</td>
<td>45.6</td>
<td>6.67</td>
<td>32.76</td>
</tr>
<tr>
<td>7</td>
<td>Field No.2 omprakas cultivator</td>
<td>11.21</td>
<td>4.16</td>
<td>7.28</td>
<td>34.3</td>
<td>17.9</td>
<td>82.49</td>
</tr>
<tr>
<td>8</td>
<td>Field of mangilal cultivator</td>
<td>10.92</td>
<td>2.64</td>
<td>5.20</td>
<td>21.2</td>
<td>13.1</td>
<td>80.30</td>
</tr>
<tr>
<td>9</td>
<td>Field of durgalal cultivator</td>
<td>10.55</td>
<td>2.24</td>
<td>9.36</td>
<td>13.0</td>
<td>6.02</td>
<td>58.14</td>
</tr>
<tr>
<td>10</td>
<td>Field of navjot cultivator</td>
<td>10.73</td>
<td>1.88</td>
<td>6.76</td>
<td>12.0</td>
<td>6.52</td>
<td>63.96</td>
</tr>
</tbody>
</table>

The soluble sodium percentage (S.S.P.) was determined in saturation extract of soil by the formula:

\[ SSP = \frac{Na \times 100}{total\ cations} \]

EC = Electrical conductivity
Ca + Mg = Calcium + Magnesium
S.A.R. = Sodium adsorption ratio
S.S.P. = Soluble sodium percentage

III. RESULT AND DISCUSSION

Parameter wise soil analytical data for salinity and sodicity as given in table-1 are discussed as under.

E.C. of soils

Soil analysis as given in table-1 indicates that out of 10 sites in study areas the soils of Mangalal’s field (sample No.4) and to that of Om Prakash’s field (sample No.6&7) are saline (EC>4.0 m.mhos/cm). Sample no.7 is highly saline (EC 13.92 mmhos/cm). Rests of the soils of study area are normal. In these soils which are normal we can grow any crops if fertility level is up to the mark. In saline and highly saline soils sensitive crops cannot be grown. Salt tolerant crops like Radish, celery, Green beans, field beans cucumber, onion, carrot etc. can be

<table>
<thead>
<tr>
<th>S. No</th>
<th>Particulars of Soil samples</th>
<th>Moisture %</th>
<th>E.C. dS/m</th>
<th>Ca+Mg meq/l</th>
<th>Na meq/l</th>
<th>SAR</th>
<th>S.S.P</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Specific Gravity of Soils</td>
<td>1.50</td>
<td>1.40</td>
<td>1.20</td>
<td>0.60</td>
<td>0.90</td>
<td>1.80</td>
</tr>
</tbody>
</table>
grown successfully. For growing salt sensitive crops like wheat, beans, vegetables etc. soluble salts present in the soils are to be leached out so that ECₑ may come down below 4.0 mmhos/cm. Sample No.6 which is having very high ECₑ i.e. 13.92 dS/m is not useful for growing cereals and other sensitive crops. For growing crops in these soils 3to4 leaching by irrigation water are necessary to remove all the soluble salts so that ECₑ (dS/m) of soil may come down below 4.0 dS/m. after leaching addition of organic matter or Green manuring not only increase the nutrient status of soil but also increase the porosity and water retention capacity of soil. When soil become normal, then it can be used for growing any sort of crops and vegetables [Bower & Associates, (1951)].

Beside this the irrigation water that we are using should be normal and it’s electrical conductivity should be below 0.25 dS/m.

**SAR of soils**

Soil analytical data as given in table -1 show that in the study area the maximum SAR values found is 17.96 and to that of minimum is 1.84. The critical limit of sodicity is above 15 SAR. Therefore, only one sample from the field No.2 of Om Prakash cultivator is found sodic. This soil is bearing SAR values of 17.96 may suffer the proper crop production if suitable management practices are not adopted. Rest all the soil samples collected from different field of study area are found normal from SAR (sodicity) point of view, although soil samples collected from the field of Mangial (Sample No.4) and to that of Om Prakash field No.1 and 2 (Sample No.6 and 7 respectively) are found to be saline but their salt concentration can be removed by simple leaching with irrigation water.

Exchangeable sodium percentage (ESP) which is the major cause of soil sodicity cannot be removed by simple leaching with water. It can only be removed by addition of calcium through gypsum [Bower &turk, (1946)] which can be applied after soil testing for gypsum requirement [schoonover, (1952)].otherwise, if added in access, it will creat soil salinity. After addition of desired gypsum in root zone then 2 or 3 leaching with water should be given. The exchangeable sodium will be replaced by calcium ion and sodium will be leached out below the rootzone in the soil profile. Proper drainage system should be there around the cultivated field to lower down the water table. Higher water table below the surface of soil is the major cause of soil salinization and alkalinization.

After reclamation of saline and/or sodic soils it is necessary to apply organic or green manures to recover or maintain the nutrients status as well water retention capacity of the soil.

**S.S.P. of soils**

The soluble sodium percentage (SSP) of soils represents the soil salinity which can be removed by simple leaching with irrigation water. In the study area the SSP values ranged from 28.76 to 82.49 in the various soils which can be lowered down by lowering the underground water table of the soil by improving the drainage system of the cultivated field.

**IV. CONCLUSION**

In the study area out of 10 sites selected only 3 sites were found saline and only one site was found sodic alone. One of the samples i.e. sample no.7 alone was found affected from salinity and sodicity both. Salinity can be removed by simple leaching with water while sodicity can only be removed by addition of gypsum followed by leaching (2or3) with irrigation water.

After reclamation of soil one should not forget, addition of organic matter to maintain the nutrient status and water retention capacity of soil. It is worthwhile to note that proper drainage should be there around the field to have lower water table below the soil surface.

**REFERENCES**