Application Effect of Domestic Sewage on Available Iron Concentration in Different Soil Depths

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ABSTRACT

As more than 90 percent of water is used in agriculture, experts were made to turn to non-conventional waters, among which sewage is of significant importance due to having high amounts of plants required elements. The study was conducted with the objective of reviewing the impact of the application of raw and treated sewage on the trend of changes of iron in different soil depths. An experiment was performed three times to this end in the form of a CRD (Completely Randomized Design) with three treatments including tap water, treated sewage, and raw sewage. Soil sampling was done as composites at the soil depths of 0-30 and 30-60 cm. The available iron was determined in soil by DTPA method. The data experimented was analyzed at two probability levels of 1 and 5 percent by SPSS statistical software to determine the level of significance, and the Duncan test was used to compare the averages. The results from the statistical analysis showed that the use of raw and treated domestic sewage has stimulated an increasing trend in available iron concentration.

Key words: Available iron concentration, Domestic sewage, Soil depths, Completely Randomized Design (CRD).

Introduction

The developments of the cities and wrong consumption patterns have caused an increase in the domestic sewage (Gholami et al. 2011). Environmental pollution has unpleasant changes on physical, chemical and biological characters of main sources such as water, air and soil which has dangerous effect in health and survival of human and other living organs or limit their activities (Gholami et al. 2012). Given the use of more than 90 percent of water in agriculture, the necessity of irrigation water conservation prompted the experts to promote the use pressurized irrigation methods widely. Concentration of population and industrial centers in different areas causes production of a high amount of sewage effluent, which will bring lots of environmental problems around the areas with the current trend of sewage disposal. In this relation, The best way of sewage wastewater disposal is its application in agriculture after conventional treatment processes. The optimal use of municipal sewage in plant nutrition can help to a great extent prevent undesirable environmental impacts due to its discharge (Ebrahimizadeh, 2007). Irrigation and artificial recharging of aquifers are among the most important methods of sewage disposal in soil and the further use of sewage. The use of wastewater for irrigation not only lets soil properties benefit from its positive impacts, but also it makes wastewater as a water resource. During non-farming season also, through sewage disposal on soil, soil can treat sewage more and also make the increase in water conservation in aquifers with non-potable agricultural use possible.

Materials and Methods

The Study Area:

The study was conducted to investigate the application of raw and treated sewage on the trend of the changes of available iron on a farm located in Khuzestan province. The average annual rainfall was 244 millimeters and the temperature average also was 22 degrees centigrade.

Statistical design:

As the research was carried out in a greenhouse, it was with three replications in a completely randomized design which, including invoices consisted of 18 pilot plants altogether.

<table>
<thead>
<tr>
<th>Replication</th>
<th>Treatment</th>
<th>Soil Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1S1I1</td>
<td>R1S1I2</td>
<td>R1S2I1</td>
</tr>
<tr>
<td>R2S1I1</td>
<td>R2S1I2</td>
<td>R2S2I1</td>
</tr>
<tr>
<td>R3S1I1</td>
<td>R3S1I2</td>
<td>R3S2I1</td>
</tr>
</tbody>
</table>

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For performing an experiment for each treatment, a P.V.C tube with 100 centimeters height and 15 centimeters diameter, altogether 9 P.V.C tubes were considered in each run. To prevent the preferable penetration, the inner surface of the tubes was impregnated with paraffin oil. The end part of the tubes was blocked by a non-metal mesh and then the tubes were filled with soil. From Karun River and the raw and treated sewage in the same area, the water required was temporarily saved. Moreover, irrigation with water treatments was done on the base of 70 percent of the moisture limit of the field capacity once a week for 3 months. Prior to irrigation, which was manually done, its amount was calculated by measuring the percentage of the soil weight moisture through monitoring methods.

Soil Sampling and Analysis:

First, soil samples were prepared from the depths of 0-30 and 30-60 cm of the soil surface by a ruler and after the design implementation, each sample was put in a plastic sac and sent to the central laboratory of ScienceandResearchBranch, Islamic Azad University,Khuzestan, Alivaz, Iran. After drying at 105 degrees centigrade in an oven, all soil samples were passed through a 2 millimeter sieve in the laboratory and prepared todetermine of available iron concentration.

Determine of Available Iron Concentration:

The iron absorbency of the soil was measuredby extracting using DTPA (0.005 M) which was readby the atomic absorbency device known as Perkin -Elmer type model 3030 in specific waves (Panahpour et al. 2011).

Results and discussion:

Statistical computations and analysis:

The data achieved from the study was saved in Excel software database. After that, drawing the diagrams and the initial review and study of the data were done. The data experimented was analyzed at two probability levels of 1 and 5 percent by SPSS statistical software to determine the level of significance, and the Duncan test was used to compare the averages. The final interpretation and conclusion were on the base of the data at the end.

The properties of the soil under study:

The results related to the chemical properties of the soil experimented were presented in Table (1) before the use of the study treatments. Accordingly, silt loam soil texture was without salt, containing %0.57 organic carbon.

<table>
<thead>
<tr>
<th>Clay %</th>
<th>Sand %</th>
<th>Silt %</th>
<th>Cd mg kg⁻¹</th>
<th>Cl mg L⁻¹</th>
<th>K mg kg⁻¹</th>
<th>P mg kg⁻¹</th>
<th>OC %</th>
<th>pH</th>
<th>EC dsm⁻¹</th>
<th>depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>46</td>
<td>8</td>
<td>46</td>
<td>1.63</td>
<td>18.8</td>
<td>244</td>
<td>6.9</td>
<td>0.57</td>
<td>7.58</td>
<td>3.85</td>
<td>0-30</td>
</tr>
</tbody>
</table>

The chemical properties of the tap water and raw and treated sewage used:

Some chemical properties like salinity, pH, the concentration of some of main and low-consumed nutrients and also heavy metals of tap water and treated sewage were measured and the results were displayed in Table (2). The standards suggested by The World Food Organization were used to evaluate the quality of the tap water and treated sewage used for irrigation. On the base of these standards of the quality of the treated sewage, the electrical conductivity is a little exceeded. This can be followed by salinity stress and poisoning of the plants sensitive to salinity. But the sewage pH was within the allowable range. The concentration of chloride ion, micronutrients and heavy metals also was detected more than the standard limit in the sewage. Therefore, due to the application of sewage, probably, the concentration of these elements in soil ought to be considered in the long term. Additionally, according to the mentioned standard in the tap water, except for manganese, the concentration of micronutrients (heavy metals) was detected more than the standard boundary. The comparison of the analyses results of the treated and raw sewage, and the tap water showed that the concentration of the nutrients and heavy metals in the treated and raw sewage is more than that in the tap water.
**Table 2:** The chemical properties of the tap water, treated and raw sewage used.

<table>
<thead>
<tr>
<th></th>
<th>Cu mg/l</th>
<th>Zn mg/l</th>
<th>Mn mg/l</th>
<th>Fe mg/l</th>
<th>Cd mg/l</th>
<th>Cl mg/l</th>
<th>pH</th>
<th>EC dsm-</th>
</tr>
</thead>
<tbody>
<tr>
<td>raw sewage</td>
<td>17.9</td>
<td>56.8</td>
<td>0.34</td>
<td>30</td>
<td>4.72</td>
<td>27.5</td>
<td>7.7</td>
<td>3.99</td>
</tr>
<tr>
<td>tap water</td>
<td>12.6</td>
<td>49.3</td>
<td>0.21</td>
<td>20</td>
<td>1.01</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>treated sewage</td>
<td>19.4</td>
<td>56.5</td>
<td>0.062</td>
<td>35</td>
<td>4.91</td>
<td>30.3</td>
<td>8.2</td>
<td>4.5</td>
</tr>
</tbody>
</table>

**Statistical description of the data measured:**

To determine the level of significance of the impact of the raw and treated sewage on properties under study, variance analysis was used on the base of mean squares and the results were presented in Table (3).

**Table 3:** The variance analysis of iron in the soil.

<table>
<thead>
<tr>
<th>Source</th>
<th>Random freedom</th>
<th>Fe</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7.055ns*</td>
<td>5</td>
<td>treatment</td>
</tr>
<tr>
<td></td>
<td>0.016</td>
<td>12</td>
<td>Error</td>
</tr>
<tr>
<td></td>
<td>7.033</td>
<td>17</td>
<td>total</td>
</tr>
</tbody>
</table>

*There is not a significant difference.

Based on the Table results, there is not a significant difference between iron at the levels of 5 and 1 percent.

**Investigation of different parameters changes under experimental treatments:**

Average comparison of the properties under study was done at the levels of %5 and %1 through Duncan test and the results achieved were displayed in a diagram.

Experimental treatments include:
- S1I1: The tap water at the depth of 0-30
- S2I1: The tap water at the depth of 30-60
- S1I2: The treated sewage at the depth of 0-30
- S2I2: The treated sewage at the depth of 30-60
- S1I3: The raw sewage at the depth of 0-30
- S2I3: The raw sewage at the depth of 30-60

**The trend of changes of iron under the impact of the experimental treatments:**

![Fig. 1](image)

Fig. 1: The comparison of different treatments average on the amount of Fe (Similar letters indicate lack of significance among the treatments considered).

The above diagram shows the trend of iron changes in the treatments used in the study. Due to averages comparison, it was specified that irrigation with treated and raw wastewater had increased iron amount in different treatments at a constant depth of 0-30. Statistically speaking, at the probability levels of 5 and 1 percent, among different treatments, there is a significant difference, whose reason is a higher amount of iron in
the treated and raw wastewater than that in the initial soil and the tap water. Iron-rich wastewater irrigation increased absorbable iron in soil (figure E; \( p<0.05 \)). Our findings are consistent with those of Feizi (2001) where he indicated that wastewater irrigation has a significant effect on accumulation of certain elements in soil and plants over eight years; he also measured higher values of iron and magnesium in maize crop irrigated using wastewater (Omidbakhsh et al. 2012).

Conclusion and Recommendations:

By using domestic sewage, the concentration of available iron in soil would increase. As the time goes by, the density of the absorbable iron increased accidentally. Generally, the high evaporation and other environmental conditions in the region under the study, the salt concentration and other elements at the height of 0-30 cm and 30-60 cm were the main reasons for this to happen (Gholami et al. 2011). Due to the acceptable density of iron within the soil as a result of the employed treatment, the researcher arrives at this conclusion that using the alternation treatment was the best beneficial one. Due to water shortage in the country and the necessity of using non-conventional water, it is suggested to carry out similar research in other parts of the country for more understanding and the optimal use of non-conventional waters such as effluents. In the present state of water resources, using wastewater is absolutely inevitable. On the other hand, the increase in the volume of wastewater is a problem, which caused treatment plants not to have the necessary capacity for treating total wastewaters. Thus, it is required to use low quality wastewaters also through practicing new management.

References


