Impact of tannery effluent on physical properties of soils of Dindigul district of Tamil Nadu state

R Yuvarani, Narendra Swarrop, P Smriti Rao and Tarence Thomas

Abstract

Industrial activities are one of the major sources of soil, water and air pollution in India. Tanning industry is a potential polluting industry of considerable threat to the environment. The continuous application of tannery effluent to the soil alter the physical properties of soil. This study was focused to determine the effect of tannery effluent on physical parameters of soil such as bulk density, particle density, pore space and water holding capacity. Soil samples were collected near discharge sites of tanneries in Dindigul district, Tamil Nadu. Bulk density of soil varies from 1.37 (Mg m\(^{-3}\)) in 0-15 cm to 1.27 (Mg m\(^{-3}\)) in 15-30 cm. Bulk density of soil decreases with increasing depth. Particle density of soil remain unchanged in most of the soil. Pore space (%) of soil decreases with depth (59.09% for 0-15 cm and 53.47% for 15-30 cm). Water holding capacity increases with depth (35.53% for 0-15 cm and 40.23% for 15-30 cm). The results indicated that due discharge of tannery effluent to soil on long run will affect physical properties of soil.

Keywords: tannery effluent, physical properties of soil, bulk density, water holding capacity

Introduction

Tanneries are industries which process hides of animals to leather by different processes. Among all the industries tannery effluents are ranked as highest pollutants. In India 88% of tannery units are present in Tamil Nadu, West Bengal and Uttar Pradesh. Leather sector in Tamil Nadu accounts for 60% of India’s production. In Tamil Nadu tanneries were located in Chennai, Vellore, Trichy, Erode and Dindigul districts. Dindigul is a municipality in Tamil Nadu state and known for its leather tanning industry. In Dindigul district all of the 68 tanneries were located within 5 km from the centre of the town for the past thirty to forty years. Tanning requires large quantities of chemical like sodium chloride, chromium sulphate, calcium salt, ammonium salt, sodium sulphide, acids, alkalies, fat liquor and organic dyes. Tanneries generate huge volumes of waste water because the process of leather manufacturing consumes enormous quantity of fresh water. In general, for every 100 kilogram of hide/skin processed, 3000 to 4000 liters of waste water is generated. Effluents from the skin processing are discharged into streams which drain into ponds thereby polluting the ground water source and cultivable land. By keeping in view of the above mentioned constrains and problems, the experiment entitled “Impact of Tannery effluent on physical properties of soils of Dindigul District of Tamil Nadu State” will be carried out with the following objective: assessment of physical properties of tannery effluent affected soils in dindigul district, Tamil Nadu

Materials and Method

Site specification and sampling

The experiment was conducted near tannery industries in Dindigul district. Soil samples collected from three different villages (Kutiyapatti, Ponnimandurai and Begampur) where tanneries in Dindigul district discharge the tannery effluent to land areas for the past thirty to forty years. Control soil sample was collected 15 km away from tannery effluent discharge area in Dindigul district. Soil sampling was done from two depths i.e. 0-15 cm and 15-30 cm. control soil sampling also done for two different depths.

Analysis of physical parameters

The soil samples were dried, powdered and passed through 2 mm sieve. The sieved soil samples were taken for analysis. Physical parameters such as bulk density, particle density, pore space and water holding capacity were determined.
pore space and water holding capacity were analysed for both tannery effluent affected soil and control soil. All these parameters were calculated from the 100ml graduated measuring cylinder method.

Results and Discussion

Bulk density and particle density (Mg m\(^{-3}\))

Table 1 depicts the statistical analysis on bulk density and particle density of tannery effluent affected soils. In soil depth the highest mean bulk density was found at 0-15 cm (1.37Mg m\(^{-3}\)) which is significantly higher than 15-30 cm (1.27 Mg m\(^{-3}\)). According to effect of tannery effluent maximum bulk density was found in Ponnimandurai site 01 & 02 (S3 &S4) (1.385 Mg m\(^{-3}\)) and minimum bulk density was found in Begampur site 01 (S5) (1.25 Mg m\(^{-3}\)). Accumulation of tannery effluent in soil affect the physical properties of soil by decreasing the water holding capacity. Similar results were reported by Singaram (1994)\(^\text{[5]}\) and Raniperumal and Singaram, (1996)\(^\text{[1]}\). The bulk density decreases with increase in depth of soil. The low values of bulk density are due to high organic matter content in soils due to discharge of tannery effluent in soil. Samia et al. (2013)\(^\text{[4]}\) in soil depth the highest mean particle density was found at 15-30 cm (2.86 Mg m\(^{-3}\)) depth which is significantly higher than 0-15 cm (2.56 Mg m\(^{-3}\)). According to effect of tannery effluent maximum mean particle density was found in Kutiyapatti site 01(S1) (2.815 Mg m\(^{-3}\)) and minimum mean particle density was found in Kutiyapatti site 02(S2) (2.635 Mg m\(^{-3}\)).Particle density increases with increase in depth. Particle density varies according to the mineral content of the soil particles. In most soils the particle density is about 2.65 Mg m\(^{-3}\) and the readings does not vary a lot, similarly reported by Brady & Weil (1996).

Percent pore space and water holding capacity (%)

Table 2 depicts the statistical analysis on percent pore space and water holding capacity of tannery effluent affected soils. In soil depth the highest mean percent pore space was found at 15-30 cm (59.09%) which is significantly higher than 0-15 cm (53.47%). According to effect of tannery effluent maximum mean percent pore space was found in Begampur site 01 (S5) (57.41%) and minimum mean percent pore space was found in Kutiyapatti site 02(S2) (54.5%). The pore space (%) decreases abruptly with increase in depth Sahu et al. (2014). In soil depth the highest mean water holding capacity was found at 15-30cm (40.23%) which is significantly higher than 0-15 cm (35.53 %). According to effect of tannery effluent maximum mean water holding capacity was found in Begampur site 02 (S6) (45.33%) and minimum mean water holding capacity was found in Kutiyapatti site 02(S2) (33.69%). Addition of tannery effluent to the soil affects the physical properties of the soil by decreasing the water holding capacity. Similar reports were reported by Singaram (1994)\(^\text{[5]}\) and Raniperumal and Singaram, (1996).

Table 1: Evaluation of bulk density and particle density (Mg m\(^{-3}\)) at different depths (0-15 cm and 15-30 cm) of tannery effluent affected soil of Dindigul district

<table>
<thead>
<tr>
<th>Samples</th>
<th>Bulk density (Mg m(^{-3}))</th>
<th>Particle density (Mg m(^{-3}))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-15cm</td>
<td>15-30cm</td>
</tr>
<tr>
<td>Kutiyapatti site 01</td>
<td>1.36</td>
<td>1.2</td>
</tr>
<tr>
<td>Kutiyapatti site 02</td>
<td>1.32</td>
<td>1.23</td>
</tr>
<tr>
<td>Ponnimandurai site 01</td>
<td>1.43</td>
<td>1.34</td>
</tr>
<tr>
<td>Ponnimandurai site 02</td>
<td>1.4</td>
<td>1.37</td>
</tr>
<tr>
<td>Begampur site 01</td>
<td>1.29</td>
<td>1.21</td>
</tr>
<tr>
<td>Begampur site 02</td>
<td>1.42</td>
<td>1.28</td>
</tr>
<tr>
<td>Mean</td>
<td>1.37</td>
<td>1.27</td>
</tr>
</tbody>
</table>

S.Ed (±) C.D 5%  S.Ed (±) C.D 5%

Due to depth 0.069 0.003 0.21 0.819
Due to site 0.059 0.028 0.60 0.09

Fig 1: Bulk density (Mg m\(^{-3}\)) at different depths, 0-15 cm and 15-30 cm of tannery effluent affected soils of Dindigul district

Fig 2: Particle density (Mg m\(^{-3}\)) at different depths, 0-15 cm and 15-30 cm of tannery effluent affected soils of Dindigul district
Table 2: Evaluation of percent pore space and water holding capacity (%) at different depths (0-15 and 15-30) of tannery effluent affected soil of Dindigul district

<table>
<thead>
<tr>
<th>Samples</th>
<th>Pore space (%)</th>
<th></th>
<th>Water holding capacity (%)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-15 cm</td>
<td>15-30 cm</td>
<td>0-15 cm</td>
<td>15-30 cm</td>
</tr>
<tr>
<td>Kutiyapatti site 01</td>
<td>57.5</td>
<td>50</td>
<td>34.56</td>
<td>37.78</td>
</tr>
<tr>
<td>Kutiyapatti site 02</td>
<td>57</td>
<td>52</td>
<td>30.55</td>
<td>36.84</td>
</tr>
<tr>
<td>Ponnimandauri site 01</td>
<td>58.8</td>
<td>53.12</td>
<td>35.54</td>
<td>39.56</td>
</tr>
<tr>
<td>Ponnimandauri site 02</td>
<td>58.8</td>
<td>55.55</td>
<td>34.14</td>
<td>38.44</td>
</tr>
<tr>
<td>Begampur site 01</td>
<td>57.6</td>
<td>54.2</td>
<td>36.34</td>
<td>40.23</td>
</tr>
<tr>
<td>Begampur site 02</td>
<td>58.8</td>
<td>52</td>
<td>36.34</td>
<td>40.23</td>
</tr>
<tr>
<td>Mean</td>
<td>59.09</td>
<td>53.47</td>
<td>35.53</td>
<td>40.23</td>
</tr>
</tbody>
</table>

S. Ed(±) C.D 5% S. Ed(±) C.D 5%
Due to depth 3.26 0.001 3.22 0.0003
Due to site 1.44 0.16 3.58 0.0007

Fig 3: pore space(%) at different depths, 0-15 cm and 15-30 cm of tannery effluent affected soils of Dindigul district

Fig 4: water holding capacity (%) at different depths, 0-15 cm and 15-30 cm of tannery effluent affected soils of Dindigul district

Conclusion

Tanning Industry is considered to be a major source of pollution and tannery wastewater in particular, is a potential environmental concern. Tannery waste characteristically contains a complex mixture of both organic and inorganic pollutants. By analyzing the soil samples it is concluded that tannery effluent has some effect on physical properties of soil by increasing in bulk density and reducing the water holding capacity of soil. Addition of tannery effluent to soil without any treatment will affect the soil physical properties.

References

2. Sahu VK, David AA. Soil health assessment of research farm of Allahabad school of agriculture SHIATS-DU Allahabad, the Allahabad farmer. 2014; 2.