Impact of Dyeing Unit Effluent on Nutrient Content of Index Leaf of *Arachis hypogaea* L. and *Sacharum officinarum* L.

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Abstract

Effluents from dyeing industrial units of Nagari in Andhra Pradesh, India were sampled at different distances along the effluent drain. The analysis of nutrients in dyeing effluent revealed that the concentration of Zn, Cu, Fe, Mn and Mg were conspicuously high near the effluent drain compared to those away from it. The nutrients Ca, Mg and K were abundant in these effluents. It is observed that metal and nutrient contents in the index leaves of commercial crops groundnut and sugarcane. Nutrients are N, P, K, Ca, Mg, Zn, Cu, Mn and Fe were row in the immediate vicinity of the streams as compared to Satravada and Ekambarakupam respectively. The lower nutrient content of index leaves in respect of all the crops might be due to unfavorable physical and chemical environment in the soils which would have resulted in less absorption of the nutrients by the plants.

Keywords: dye-effluent, *Arachis hypogaea*, *Sacharum officinarum*, metals, nutrient content

Introduction

There has been a strong global awakening during the last few decades regarding the proper management of existing natural resources. Among them, irrigation water is one which becoming costlier due to increasing demands of human population. Simultaneously the demand for food is also increasing, which has brought more and more land under cultivation and focused the attention on fertilizer and irrigation water (Saravanamoorthy and Ranjitha Kumari, 2007). Industrial waters whether applied to generally agricultural land in amounts determined by nutrient demand. Spread, dumped sprayed, injected, or into the soil carries the heavy metals into the soil environment. It is well known that industrialization has its inevitable effects on pollution of water and soil based on the type of industry, nature of raw materials and the manufacturing process involved (Abdul Baki and Anderson, 1973). Owing to rapid development of dyeing and textile processing units in India, the disposal of effluents has become a serious problem. It has been estimated that several industries release effluents at the rate of 1.5 mgd (7 million liters day⁻¹). The release of these effluents without proper treatment into the nearby rivers, irrigation canals, streams adjacent to agricultural fields cause serious hazards intensifying the adverse effects on ecosystems like water, soils and plants (Prabhakaran and Lakshmanan, 1999). There are nearly 120 small scale cotton yarn dyeing industries scattered over five villages in Nagari region of Chittoor district, Andhra Pradesh. The release of effluents from these dyeing units is posing serious problems to the surrounding ecosystems which are strongly supported by the complaints made by the farmers in daily newspaper reports (Eeenadu, 2000). An estimate shows that textiles account for 14% of India’s industrial production and around
27% of its export earnings (Ministry of Textiles, 2004). There are about 10,000 garment manufacturers and 2100 bleaching and dyeing industries in India. In the present study attempts have been made to practically prove the impacts posed to the environmental ecosystems in terms of nutrients and heavy metal concentrations in the vicinity of the dyeing units located in Nagari region, Chittoor district of Andhra Pradesh.

**Materials and Methods**

**Analysis of Dyeing Effluent Samples**

Effluent samples were collected from outlets of dyeing industries at Satravada and Ekamabarakupam. Since sampling forms the initial source of error almost precaution was taken. Effluent samples were collected in well cleaned polythene bottles. Before collection each bottle was washed with fresh water. Finally bottles were rinsed with distilled water. Immediately after collection the bottles were tightly stoppered. After filter the effluent samples, the pH and EC (Electrical Conductivity) of the samples were immediately measured in the laboratory and afterwards the samples were stored at 4°C for further analysis.

Turbidity using turbidity meter, pH using glass electrode pH meter (Jackson, 1967) and EC using conductivity meter (Jackson, 1967). Calcium and Mg were estimated volumetrically using EDTA rapid titration method (Vogel, 1978). Carbonate and bicarbonate titrated with standard sulphuric acid using phenolphthalein and methyl orange as indicator (Piper, 1966). Chloride was estimated volumetrically by titrating the water with standard silver nitrate as indicator by Mores method (Reitemeier, 1943). Sulphate was estimated by turbidometric method at wavelength 440 nm using spectronic 20 Bausch and Lomb Spectrophotometer (Massoumi and Cornfield, 1963). Sodium and potassium was estimated with the aid of flame photometer systronics model 121 (Jackson, 1967). Micronutrients (Fe, Mn, Cu and Zn) and Heavy metals (Cd, Pb, Ni and Cr) using atomic absorption spectrometer (Model 170–0036, Japan at air pressure of 1.6 kg cm$^{-2}$) using acetylene gas (Lindsay and Norvell, 1978).

**Collection of Leaf Samples and Analysis**

Index leaf samples of Sugarcane (*Saccharum officinarum* L.), Groundnut (*Arachis hypogaea* L.) grown adjacent to stream at different distances 0, 10, 25, 50, 75, 100, 150 and 200 m were collected. All these plant samples were washed thoroughly first with 0.1% dilute hydrochloric acid then with tap water and washed finally with distilled water. These samples were dried under shade and finally in a hot air oven at 60°C. The samples were ground to pass through 40 mesh sieve. Ground samples were stored in butter paper bags till analysis (in these samples micro nutrients were estimated through standard procedure). Nitrogen was estimated by Microkjeldhal method (AOAC, 1980). Phosphorus was estimated by Vando molybdosphoric yellow color method (Jackson, 1967). Potassium was estimated by flame photometry (Jackson, 1967). Calcium and Mg were estimated by AAS using lanthanum solution as interference eliminating reagent (Jackson, 1967). Micronutrients (Zn, Cu, Mn and Fe) estimated by atomic absorption spectra photometry (Lindsay and Norvell, 1978).

**Results and Discussion**

The physicochemical characteristics of effluent are presented in Table 1. The effluent discharge from the dyeing units at all the two locations were having different colors but not having offensive odor. Red, green, yellow and blue colors of effluent discharge from the dyeing units located at satravada and Ekamabarakupam might be due to the nature of dyes used from time to time during the dyeing process involved in the dyeing unit technology. The effluents of the two sampling sites were alkaline having pH range 8.9-9.2 which was slightly higher than the limits (pH 5.5-9.0) prescribed by Indian standard institution (1981). The effluent contained significant amount of Ca (5.0±0.3 to 5.3±0.06 cmol L$^{-1}$), Mg (3.0±0.23 to 3.5±0.05 cmol L$^{-1}$), Na (31.0±0.2 to 34.3±0.03 cmol L$^{-1}$), K (4.0±0.1 to 4.1±0.03 cmol L$^{-1}$), Cl$^-$ (31.0±0.16 to 32.0±0.03 cmol L$^{-1}$), SO$_4^{2-}$ (6.7±0.7 to 7.1±0.06 cmol L$^{-1}$), CO$_3^{2-}$ (0.8±0.06 to 0.6±0.003 cmol L$^{-1}$) and HCO$_3^-$ (7.7±0.03 to 7.0±0.03 cmol L$^{-1}$). The soluble salt content sodium and chlorides of effluents were very
Table 1 Characteristics of effluent discharged from dying units at Satravada and Ekamabarakupam.

<table>
<thead>
<tr>
<th>No.</th>
<th>Parameter</th>
<th>Unit</th>
<th>Satravada</th>
<th>Ekamabarakupam</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Color</td>
<td>-</td>
<td>Red, green, yellow and blue dependent on the dye used</td>
<td>Odorless</td>
</tr>
<tr>
<td>2</td>
<td>Odor</td>
<td>-</td>
<td>Odorless</td>
<td>Odorless</td>
</tr>
<tr>
<td>3</td>
<td>Suspended solids</td>
<td>mg L⁻¹</td>
<td>118±0.7</td>
<td>119±0.6</td>
</tr>
<tr>
<td>4</td>
<td>Turbidity</td>
<td>mg L⁻¹</td>
<td>351±0.7</td>
<td>358±0.6</td>
</tr>
<tr>
<td>5</td>
<td>pH</td>
<td>-</td>
<td>8.9±0.03</td>
<td>9.2±0.03</td>
</tr>
<tr>
<td>6</td>
<td>EC</td>
<td>dS m⁻¹</td>
<td>5.0±0.06</td>
<td>5.3±0.03</td>
</tr>
<tr>
<td>7</td>
<td>Organic carbon (%)</td>
<td></td>
<td>2.1±0.06</td>
<td>2.0±0.06</td>
</tr>
<tr>
<td>8</td>
<td>Calcium</td>
<td>cmol L⁻¹</td>
<td>5.0±0.3</td>
<td>5.3±0.06</td>
</tr>
<tr>
<td>9</td>
<td>Magnesium</td>
<td>cmol L⁻¹</td>
<td>3.0±0.23</td>
<td>3.5±0.05</td>
</tr>
<tr>
<td>10</td>
<td>Sodium</td>
<td>cmol L⁻¹</td>
<td>31.0±0.2</td>
<td>34.3±0.03</td>
</tr>
<tr>
<td>11</td>
<td>Potassium</td>
<td>cmol L⁻¹</td>
<td>4.0±0.1</td>
<td>4.1±0.03</td>
</tr>
<tr>
<td>12</td>
<td>Chlorides</td>
<td>cmol L⁻¹</td>
<td>31.0±0.16</td>
<td>32.0±0.03</td>
</tr>
<tr>
<td>13</td>
<td>Sulphates</td>
<td>cmol L⁻¹</td>
<td>6.7±0.7</td>
<td>7.1±0.06</td>
</tr>
<tr>
<td>14</td>
<td>Carbonates</td>
<td>cmol L⁻¹</td>
<td>0.8±0.06</td>
<td>0.6±0.03</td>
</tr>
<tr>
<td>15</td>
<td>Bicarbonates</td>
<td>cmol L⁻¹</td>
<td>7.7±0.53</td>
<td>7.0±0.03</td>
</tr>
<tr>
<td>16</td>
<td>Cadmium</td>
<td>mg L⁻¹</td>
<td>0.021±0.0003</td>
<td>0.030±0.0006</td>
</tr>
<tr>
<td>17</td>
<td>Lead</td>
<td>mg L⁻¹</td>
<td>0.10±0.006</td>
<td>0.13±0.006</td>
</tr>
<tr>
<td>18</td>
<td>Nickel</td>
<td>mg L⁻¹</td>
<td>0.172±0.0003</td>
<td>0.178±0.0003</td>
</tr>
<tr>
<td>19</td>
<td>Chromium</td>
<td>mg L⁻¹</td>
<td>0.330±0.0006</td>
<td>0.333±0.0003</td>
</tr>
</tbody>
</table>

Values are arithmetic mean ±SE of three replicates.

The data on nutrient content of index leaf of groundnut are presented in Table 2. In general all the nutrient studied in the index leaf of groundnut at 10 and 25 m distance were slightly lower as compared to that farther distance where as all the values obtained beyond 25 m distance were almost identical. The N, P, K, Ca and Mg contest between 10 and 25 m distance ranged from 2.55 ± 0.003 to 2.71±0.003%, 0.20±0.006 to 0.26±0.003%, 1.71±0.006 to 1.72±0.003%, 0.80±0.003 to 0.81±0.006%, 0.32±0.003 to 0.4±0.003% respectively. Zinc, Cu, Fe and Mn contents varied from 23.0±0.03 to 32.0±0.06 mg kg⁻¹, 7.1±0.03 to 7.6±0.03 mg kg⁻¹, 75.0±0.06 to 78.2±0.06 mg kg⁻¹, 35.5±0.03 to 41±0.06 mg kg⁻¹, respectively at yield effected area 10 and 25 m distance from the effluent stream. Beyond 25 m distance and up to 200 m distance the N, P, K, Ca and Mg ranged from 2.70±0.003 to 2.76±0.003%, 0.24±0.006 to 0.31±0.006%, 1.94±0.003 to 1.97±0.006%, 0.80±0.006 to 0.84±0.006%, 0.41±0.003 to 0.42±0.003% respectively. While the Zn, Cu, Fe and Mn content ranged from 30.5±0.003 to 31.4±0.03 mg kg⁻¹, 7.6±0.06 to 7.8±0.06 mg kg⁻¹, 78.1±0.03 to 78.4±0.06 mg kg⁻¹, 40.0±0.06 to 40.8±0.03 mg kg⁻¹, respectively. All the nutrients N, P, K, Ca, Mg, Zn, Cu, Fe and Mn in the index leaf of groundnut grown at 10, 25, 75, 100, 150 and 200 m distance were above the critical limits (P-20, K-1.7, Ca-75, Mg-3.0, Zn-20 mg kg⁻¹, Cu-6 mg kg⁻¹, Mn-25 mg kg⁻¹, and Fe-68 mg kg⁻¹ proposed by Kanwar (1976) and Indian council of agricultural research.
Table 2 Effect of dyeing unit effluent on nutrient content of index leaf of groundnut at Satravada.

<table>
<thead>
<tr>
<th>Element</th>
<th>Distance (m)</th>
<th>10</th>
<th>25</th>
<th>50</th>
<th>75</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>N (%)</td>
<td></td>
<td>2.55±0.003</td>
<td>2.71±0.003</td>
<td>2.70±0.003</td>
<td>2.74±0.003</td>
<td>2.71±0.006</td>
<td>2.73±0.003</td>
<td>2.76±0.003</td>
</tr>
<tr>
<td>P (%)</td>
<td></td>
<td>0.20±0.006</td>
<td>0.26±0.003</td>
<td>0.24±0.003</td>
<td>0.25±0.003</td>
<td>0.31±0.006</td>
<td>0.25±0.006</td>
<td>0.28±0.003</td>
</tr>
<tr>
<td>K (%)</td>
<td></td>
<td>1.71±0.006</td>
<td>1.72±0.003</td>
<td>1.94±0.003</td>
<td>1.95±0.003</td>
<td>1.96±0.006</td>
<td>1.97±0.006</td>
<td>1.96±0.003</td>
</tr>
<tr>
<td>Ca (%)</td>
<td></td>
<td>0.80±0.003</td>
<td>0.81±0.006</td>
<td>0.80±0.006</td>
<td>0.81±0.003</td>
<td>0.82±0.003</td>
<td>0.84±0.006</td>
<td>0.81±0.006</td>
</tr>
<tr>
<td>Mg (%)</td>
<td></td>
<td>0.32±0.003</td>
<td>0.40±0.003</td>
<td>0.41±0.003</td>
<td>0.42±0.006</td>
<td>0.41±0.006</td>
<td>0.41±0.006</td>
<td>0.42±0.003</td>
</tr>
<tr>
<td>Zn (mg kg⁻¹)</td>
<td>23.0±0.03</td>
<td>32.0±0.06</td>
<td>31.4±0.03</td>
<td>30.5±0.03</td>
<td>31.4±0.06</td>
<td>31.2±0.03</td>
<td>31.1±0.03</td>
<td></td>
</tr>
<tr>
<td>Cu (mg kg⁻¹)</td>
<td>7.1±0.03</td>
<td>7.6±0.03</td>
<td>7.7±0.06</td>
<td>7.6±0.06</td>
<td>7.6±0.06</td>
<td>7.8±0.06</td>
<td>7.7±0.03</td>
<td></td>
</tr>
<tr>
<td>Fe (mg kg⁻¹)</td>
<td>75.0±0.06</td>
<td>78.2±0.06</td>
<td>78.4±0.03</td>
<td>78.3±0.03</td>
<td>78.2±0.06</td>
<td>78.4±0.06</td>
<td>78.1±0.03</td>
<td></td>
</tr>
<tr>
<td>Mn (mg kg⁻¹)</td>
<td>35.5±0.03</td>
<td>41±0.06</td>
<td>40.4±0.03</td>
<td>40.6±0.03</td>
<td>40.2±0.06</td>
<td>40.0±0.06</td>
<td>40.8±0.03</td>
<td></td>
</tr>
</tbody>
</table>

Values are arithmetic mean ± SE of three replicates.

Table 3 Effect of dyeing unit effluent on nutrient content of index leaf of sugarcane at Ekamabarakupam.

<table>
<thead>
<tr>
<th>Element</th>
<th>Distance (m)</th>
<th>10</th>
<th>25</th>
<th>50</th>
<th>75</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>N (%)</td>
<td></td>
<td>2.16±0.03</td>
<td>2.15±0.003</td>
<td>2.58±0.006</td>
<td>2.55±0.003</td>
<td>2.57±0.003</td>
<td>2.54±0.003</td>
<td>2.53±0.003</td>
</tr>
<tr>
<td>P (%)</td>
<td></td>
<td>0.21±0.06</td>
<td>0.23±0.003</td>
<td>0.26±0.006</td>
<td>0.25±0.006</td>
<td>0.27±0.003</td>
<td>0.26±0.003</td>
<td>0.27±0.003</td>
</tr>
<tr>
<td>K (%)</td>
<td></td>
<td>1.22±0.003</td>
<td>1.22±0.003</td>
<td>1.83±0.006</td>
<td>1.80±0.003</td>
<td>1.82±0.003</td>
<td>1.84±0.006</td>
<td>1.83±0.003</td>
</tr>
<tr>
<td>Ca (%)</td>
<td></td>
<td>0.32±0.003</td>
<td>0.31±0.003</td>
<td>0.45±0.003</td>
<td>0.47±0.003</td>
<td>0.45±0.003</td>
<td>0.47±0.006</td>
<td>0.46±0.006</td>
</tr>
<tr>
<td>Mg (%)</td>
<td></td>
<td>0.22±0.003</td>
<td>0.25±0.003</td>
<td>0.29±0.003</td>
<td>0.30±0.006</td>
<td>0.32±0.003</td>
<td>0.29±0.006</td>
<td>0.31±0.006</td>
</tr>
<tr>
<td>Zn (mg kg⁻¹)</td>
<td>38.5±0.003</td>
<td>38.7±0.03</td>
<td>46.2±0.03</td>
<td>48.5±0.06</td>
<td>48.2±0.03</td>
<td>48.4±0.03</td>
<td>48.4±0.03</td>
<td></td>
</tr>
<tr>
<td>Cu (mg kg⁻¹)</td>
<td>7.3±0.06</td>
<td>7.2±0.03</td>
<td>10.1±0.06</td>
<td>10.5±0.03</td>
<td>10.03±0.003</td>
<td>9.7±0.06</td>
<td>10.3±0.06</td>
<td></td>
</tr>
<tr>
<td>Fe (mg kg⁻¹)</td>
<td>236.4±0.23</td>
<td>232.6±0.03</td>
<td>246.3±0.03</td>
<td>245.6±0.06</td>
<td>246.0±0.06</td>
<td>246.2±0.7</td>
<td>245.5±0.03</td>
<td></td>
</tr>
<tr>
<td>Mn (mg kg⁻¹)</td>
<td>60±0.016</td>
<td>60.6±0.03</td>
<td>74.2±0.06</td>
<td>74.6±0.03</td>
<td>74.3±0.03</td>
<td>75.1±0.03</td>
<td>74.5±0.06</td>
<td></td>
</tr>
</tbody>
</table>

Values are arithmetic mean ± SE of three replicates.

The data on nutrient content of N, P, K, Ca, Mg, Zn, Cu, Fe and Mn in index leaf of sugarcane was presented in Table 3, it was noticed that all nutrients in the index leaf of sugarcane studied at 10 and 25 m distance were slightly lower as compared to that of farther distances whereas all the nutrient values obtained beyond 25 m distance were almost identical. The N, P, K, Ca, and Mg content between 10 and 25 m distance ranged from 2.15±0.003 to 2.16±0.003%, 0.21±0.06 to 0.23±0.003%, 1.22±0.003 to 1.23±0.003%, 0.32±0.003 to 0.32±0.003% and 0.22±0.003 to 0.25±0.003% respectively, while the Zn, Cu, Fe, and Mn contents varied from 38.5±0.003 to 38.7±0.03 mg kg⁻¹, 7.2±0.03 to 7.3±0.06 mg kg⁻¹, 236.4±0.23 to 236±0.03 mg kg⁻¹, 60±0.016 to 60.6±0.03 mg kg⁻¹, respectively at yield effected area of 10 and 25 m distance from effluent stream. Beyond 25 m distance and up to 200 m distance the N, P, K, Ca and Mg ranged from 2.53±0.003 to 2.58±0.006%, 0.25±0.006 to 0.27±0.003%, 1.80±0.003 to 1.84±0.006%, 0.45±0.003 to 0.47±0.003% and 0.29±0.003 to 0.32±0.003% respectively. While the Zn, Cu, Fe, Mn contents ranged from 46.2±0.03 to 48.5±0.06 mg kg⁻¹, 7.9±0.06 to 10.5±0.03 mg kg⁻¹, 245.5±0.03 to 246±0.7 mg kg⁻¹, and 74.2±0.06 to 75.1±0.03 mg kg⁻¹, respectively considering the critical limits N-2.0%, P-0.18%, K 0.10%, Ca 0.20%, Mg-0.10%, Zn-40 mg kg⁻¹, Cu-7 mg kg⁻¹, Mn-25 mg kg⁻¹, Fe-40 mg kg⁻¹ in sugarcane index leaf proposed by Tandon et al. (1993) and plant samples analyzed during this study at the all distances were found sufficient.

The nutrients content of groundnut and sugarcane index leaves namely N, P, K, Ca, Mg, Zn, Cu, Mn and Fe were row in the immediate vicinity of the
streams as compared to farther distances at Satravada, Ekambarakupam respectively (Tables 2 and 3). However the nutrients values obtained from the index leaves of groundnut, sugarcane were well above critical limits for rice and sugarcane proposed by Kanwar (1976). The lower nutrient content of index leaves in respect of all the crops might be due to unfavorable.

Addition of effluent to the soil affects the physical properties of the soil by increasing the bulk density and decreasing the hydraulic conduction and porosity (Raniperumal and Singaram 1996). When EC values exceed 3000 µS cm\(^{-1}\), the germination of almost all the crops would be affected and result in much reduced yield (Lokhande et al., 1996). Irrigation with industrial effluent may cause salinity, specific ion toxicity or infiltration problems in soils which may adversely affect crop production. Use of poor quality water with high pH and EC has a negative influence on germination, root growth, absorption of water and nutrients (Solaimalai and Saravanakumar, 2004).

**Conclusions**

It was evident that accumulation of considerable amounts of soluble salts was observed in the immediate vicinity of the effluent stream as compared the distances far away from the effluent stream. Application of effluent to agricultural fields reduces the quantity of water required for irrigation and helps in water conservation and provides nutrients to the fields and plants. Equally important that proper care should be taken in disposal of dyeing effluent to avoid soil pollution.

**References**


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