Evaluation of Treated Textile Effluent for Irrigation and its Effects on Growth of *Zea mays* L. CV C1415

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ABSTRACT

Conventional methods used for treating textile effluent are very expensive, whereas biological treatment is cost-effective, efficient and environment friendly, but its evaluation is needed. For this purpose in the present study, treated and untreated textile effluent along control were applied to the maize (*Zea mays* L. CV C1415) crop to check their effects on its growth. Plant height, number of leaves, number of nodes and internodes were monitored. Photosynthesis, transpiration rate and fresh and dry weights were also measured. The results clearly indicated that all the parameters were significantly affected by untreated textile effluent as compared to control but treated effluent improved all the parameters. This study proves that treated water may be used as irrigation water on large scale to overcome water crisis.

**Key words:** Biotreated, Textile dyes, Maize crop, Irrigation, Physiological growth

INTRODUCTION

Textile industrial effluents are causing a detrimental effect on the living systems (Gomes *et al*., 2013; Hayyat *et al*., 2013). Textile processes release large volume of waste water, its disposal without treatment to environment causes adverse effects to terrestrial life, aquatic biota, crops and livestock. Untreated textile effluents in water bodies cause serious environmental and health hazards. Land irrigated with textile effluents act as a sink for heavy metals and other resistant chemicals consequently reducing soil fertility. Pollutants leach down and cause contamination of ground water. These contaminants enter in the food chain and become health risk for plants, animals and ultimately to humans (Ross, 1994; Jadhav *et al*., 2010). Crops irrigated with water containing textile effluents show remarkable reduction in yield (Hayyat *et al*., 2013).

Conventional methods (ozonation, photooxidation, electrocoagulation, adsorption, activated carbon, froth flotation, reverse osmosis, ion exchange, membrane filtration and flocculation) used in past (Daneshvar *et al*., 2004) to treat textile effluents are now proved insufficient and are very expensive (Sagehashi *et al*., 2009). Presently, biological treatment has gained much importance and is cost-effective, efficient and environment friendly, but the suitability of the treated effluents in this way is still to be ascertained finally for the crops. Thus, it is of great concern to assess the phytotoxicity of the textile effluents before and after treatment. Phytotoxicity tests in relation to different plants demonstrated that the biodegraded products did not interfere with the germination of plant seeds. The phytotoxicity studies have revealed that the metabolites generated after the biodegradation are non toxic than the original dye (Telke *et al*., 2010; Saratale *et al*., 2013). Researchers around the globe indicated the importance of effluent’s phytotoxicity (Tigni *et al*., 2011). Effects of effluents and detoxified textile dyes have been studied on germination of crops (Saratale *et al*., 2009; Khandare *et al*., 2013). But for the assessment of comprehensive consequences, there is a need to check the toxicity of treated effluents on complete life cycle of crops. The objective of the current study was to use the textile effluent treated with consortium BMP1/SDSC/01 and to investigate its effects on growth of maize in order to find the efficiency of treated effluents.

MATERIALS AND METHODS

Sample collection

Textile effluents were collected in screw capped sterilized plastic cans from main channel of Nishat Mills Pvt. Limited 5Km Off - 22Km Ferozepur Road Lahore, Pakistan (APHA, 2005; Mahmood *et al*., 2012). The treated effluents by consortium BMP1/SDSC-01 (Mahmood *et al*., 2013) were collected from Sustainable Development Study Centre, GC University Lahore.
Effect of treated and untreated textile effluents on physiological growth parameters of Maize

Experiment was conducted at Botanic Garden, GC University Lahore on Zea mays L. CV C1415 (Maize) to check efficacy of treated textile effluents. Thoroughly cleaned and polyethylene lined earthen pots of 30 cm diameter filled with botanic garden soil were used in experiment. The holes at the bottom of the pots were closed with pebbles in order to prevent excessive drainage. Overnight soaked seeds of maize (4 in each pot) were grown. After one week of germination, two plants of same size in each pot were selected after thinning. Experiment comprised of three replicates for each; control, untreated and treated textile effluent. After one week of thinning, plants were irrigated with untreated and treated textile effluent while the control plants were irrigated with tap water for whole experiment at regular time intervals. Plant height, number of leaves and number of nodes & internodes were monitored on weekly basis for a period of 12 weeks. Photosynthesis and transpiration rates were also monitored monthly and recorded by IRGA (Infra Red Gas Analyzer LCA4). At the time of harvest the plant fresh and dry weights were also determined (Aslam et al., 2007).

Statistical analysis

Data was analyzed by one-way analysis of variance (ANOVA) using software package Co-stat version 3.03 to check the significance of treatments (Steel et al., 1997).

RESULTS

Effect of treated and untreated textile effluents on plant height of maize

Effect of biotreated and untreated textile effluents on plant height of maize was monitored for a period of 12 weeks. The plants irrigated with untreated effluents showed significantly less growth as compared to the control as after one week of the experiment the height of former plant was 57.51% less than the latter plants, whereas the plants irrigated with biotreated effluents showed significantly more growth than those irrigated with untreated effluent. The height of former plants was 72.32% more than the latter plants, respectively but as compared to control plants the biotreated plants had 26.78% less height after the same time period. Similar trend was observed throughout the experiment (Table 1).

Effect of treated and untreated textile effluents on number of leaves of maize

Effect of biotreated and untreated textile effluents on number of leaves of maize was also observed throughout the monitoring period on weekly basis. The results clearly indicated that the highest number of leaves was present in control plants which were significantly reduced (P ≤ 0.05) in plants irrigated with untreated textile effluent, while in plants irrigated with biotreated effluents the number of leaves was almost same as in case of control. At the end of monitoring period, it was noticed that 11.49±0.721, 7.62±0.176 and 9.41±0.862 number of leaves were present on control plants, plants irrigated with untreated and plants irrigated with biotreated textile effluent respectively (Table 2).

Effect of treated and untreated textile effluents on number of nodes and internodes of maize

Effect of biotreated and untreated textile effluents on nodes and internodes of maize was observed for 12 weeks. It was found that number of nodes in first week 30.59% less in plants irrigated with untreated effluents as compared to plants irrigated with control whereas plants irrigated with biotreated effluents showed 23.22% more. But the number of nodes in plants irrigated with biotreated effluents was 14.47% less than that of plants irrigated with control. Similar trend was observed throughout the experiment. Similarly, the number of internodes was 32.06% less in plants irrigated with untreated effluents than that of plants irrigated with control. And improvement in number of nodes was 43.63% in plants irrigated with biotreated effluents than that of plants irrigated with untreated effluents. The results indicated maize plants growing in textile effluents showed decrease in number of nodes and internodes throughout the growing season (Table 3 & 4).

Effect of treated and untreated textiles effluent on transpiration and photosynthesis rate of maize

Photosynthesis rate in maize plants irrigated with untreated effluents was reduced to 53.32% than that of plants irrigated with control. Whereas photosynthesis rate was improved to 86.05% in plants irrigated with biotreated effluents. Likewise in transpiration rate 57.29% was reduced in plants irrigated with untreated effluents than that of plants irrigated with control. Whereas, it was improved to 104% in plants irrigated with biotreated effluents but it was 12.5% less than plants irrigated with control (Figure 1 a & b).

Effect of treated and untreated textile effluents on fresh and dry weight of maize

Total fresh and dry weight in maize was reduced to 41.2% and 23.60% of plants irrigated with untreated effluents than that of plants irrigated
with control, respectively. While on applying biotreated textile effluents fresh and dry weights of plants were improved (Figure 2a). The results indicated that textile effluent had toxic effects on maize. Results denoted the reduction in dry and fresh weight of root, shoot and leaves of plants treated with textile effluent in contrast to control. Biological treatment of effluent indicated significance in results of dry and fresh weights of root, shoot and leaves (Figure 2b).

DISCUSSION

Water scarcity has a great impact on human life as it becomes one of the most pressing problems. The global challenges to meet future demand are constrained by sustainable freshwater availability (Manez et al., 2012). Reuse of treated effluents in irrigation is a good idea. The untreated textile effluents impose high load of complex dyes which diminishes the quality of water bodies used for irrigation. This practice reduces the soil fertility and crop yield (Khan et al., 2010). The toxicity of effluents in plants causes growth inhibition, reduces photosynthesis and transpiration, decreases root and shoots length (Mallick et al., 2010). Stomatal conductance in most of plants is affected by toxic pollutants present in effluents. It was also reported that toxic effluents reduced fresh and dry weight of plant (Hayyat et al., 2013; Singh et al., 2013).

The textile effluents treated by isolated indigenous bacteria may lead to the generation of variety of products (Saratale et al., 2013). Therefore, it is important to study the toxicity impact of these degraded products on the life stages of crops in order to overcome yield reduction. Phytotoxicity impact of textile effluents and treated effluents on plant height, number of leaves, photosynthesis and transpiration rate and biomass of Zea mays L. CV C1415 (Maize) a common crop of Punjab, Pakistan were studied. The result clearly indicated that treated textile effluents are less toxic as compared to untreated effluents which are in agreement with the results reported by Phugare et al. (2011). The study revealed that reuse potential of effluents for irrigation as current source are depleting day by day, but it requires regular monitoring (Augustine, 2009). The results have highlighted the benefits of reuse of textile effluents after treatment. This study proves that treated water may be used as irrigation water at large scale to overcome water crisis.

ACKNOWLEDGEMENTS

The authors admiringly acknowledge the Sustainable Development Study Centre, Government College University Lahore for providing the support to carry out this research.

REFERENCES


Table 1: Effect of treated and untreated textile effluent on plant height (cm) of Zea mays L. CV C1415

<table>
<thead>
<tr>
<th>Treatment</th>
<th>1st week</th>
<th>2nd week</th>
<th>3rd week</th>
<th>4th week</th>
<th>5th week</th>
<th>6th week</th>
<th>7th week</th>
<th>8th week</th>
<th>9th week</th>
<th>10th week</th>
<th>11th week</th>
<th>12th week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>33.26± 0.374a</td>
<td>44.10± 1.265a</td>
<td>56.96± 0.049a</td>
<td>67.37± 0.883a</td>
<td>79.51± 0.721a</td>
<td>89.18± 1.152a</td>
<td>102.27± 1.803a</td>
<td>108.11± 1.251a</td>
<td>115.48± 0.735a</td>
<td>121.11± 1.258a</td>
<td>127.17± 1.654a</td>
<td>131.47± 0.671a</td>
</tr>
<tr>
<td>Un-treated</td>
<td>14.13± 1.223c</td>
<td>23.4± 0.848b</td>
<td>32.03± 1.371c</td>
<td>40.95± 1.477c</td>
<td>54.11± 0.035c</td>
<td>65.85± 0.212c</td>
<td>73.77± 0.319c</td>
<td>80.51± 0.142b</td>
<td>87.47± 0.07b</td>
<td>89.98± 0.393c</td>
<td>93.2± 1.781c</td>
<td></td>
</tr>
<tr>
<td>Treated</td>
<td>24.35± 0.912b</td>
<td>37.99± 1.407a</td>
<td>47.84± 0.219b</td>
<td>57.93± 1.506b</td>
<td>71.51± 2.13b</td>
<td>82.39± 2.276b</td>
<td>91.33± 0.195b</td>
<td>101.15± 0.883a</td>
<td>114.34± 0.933a</td>
<td>117.6± 0.979b</td>
<td>124.41± 2.00b</td>
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</tr>
<tr>
<td>LSD</td>
<td>3.65</td>
<td>6.19</td>
<td>3.10</td>
<td>1.51</td>
<td>3.06</td>
<td>4.82</td>
<td>6.13</td>
<td>2.25</td>
<td>7.34</td>
<td>7.91</td>
<td>8.72</td>
<td>3.07</td>
</tr>
</tbody>
</table>

Mean followed by different letters in the table are significantly different at P=0.05 according to Duncan’s multiple range test, ± standard deviation, LSD: least significance difference

Table 2: Effect of treated and untreated textile effluent on number of leaves of Zea mays L. CV C1415

<table>
<thead>
<tr>
<th>Treatment</th>
<th>1st week</th>
<th>2nd week</th>
<th>3rd week</th>
<th>4th week</th>
<th>5th week</th>
<th>6th week</th>
<th>7th week</th>
<th>8th week</th>
<th>9th week</th>
<th>10th week</th>
<th>11th week</th>
<th>12th week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>2.74± 0.226a</td>
<td>3.86± 0.084a</td>
<td>4.88± 0.021a</td>
<td>5.48± 0.169a</td>
<td>6.17± 0.106a</td>
<td>5.94± 0.926a</td>
<td>7.23± 0.190a</td>
<td>8.77± 0.233a</td>
<td>9.66± 0.098a</td>
<td>10.65± 0.205a</td>
<td>10.97± 0.176a</td>
<td>11.4± 0.721a</td>
</tr>
<tr>
<td>Un-treated</td>
<td>1.86± 0.084b</td>
<td>2.63± 0.098b</td>
<td>3.34± 0.197b</td>
<td>3.94± 0.219b</td>
<td>4.27± 0.176b</td>
<td>4.82± 0.169a</td>
<td>5.14± 0.219b</td>
<td>5.53± 0.091c</td>
<td>5.96± 0.19c</td>
<td>6.36± 0.042b</td>
<td>7.13± 0.042b</td>
<td>7.62± 0.176b</td>
</tr>
<tr>
<td>Treated</td>
<td>2.03± 0.091b</td>
<td>2.78± 0.169b</td>
<td>3.59± 0.155b</td>
<td>4.47± 0.106b</td>
<td>5.17± 0.240b</td>
<td>5.36± 0.197a</td>
<td>6.03± 0.190b</td>
<td>6.44± 0.077b</td>
<td>6.95± 0.205b</td>
<td>7.66± 0.233b</td>
<td>±0.247b</td>
<td>9.41± 0.862ab</td>
</tr>
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<td>0.67</td>
<td>0.57</td>
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<td>0.75</td>
<td>0.92</td>
<td>2.40</td>
<td>1.02</td>
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<td>0.96</td>
<td>1.08</td>
<td>0.65</td>
<td>3.42</td>
</tr>
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Mean followed by different letters in the table are significantly different at P=0.05 according to Duncan’s multiple range test, ± standard deviation, LSD: least significance difference
Table 3: Effect of treated and untreated textile effluent on number of nodes of *Zea mays* L. CV C1415

<table>
<thead>
<tr>
<th>Treatment</th>
<th>1st week</th>
<th>2nd week</th>
<th>3rd week</th>
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<th>12th week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>3.04 ± 0.077a</td>
<td>4.01 ± 0.127a</td>
<td>5.14 ± 0.197a</td>
<td>5.73 ± 0.240a</td>
<td>6.10 ± 0.148a</td>
<td>7.00 ± 0.148a</td>
<td>7.61 ± 0.155a</td>
<td>8.13 ± 0.190a</td>
<td>8.48 ± 0.028a</td>
<td>9.01 ± 0.155a</td>
<td>9.38 ± 0.021a</td>
<td>9.89 ± 0.148a</td>
</tr>
<tr>
<td>Un-treated</td>
<td>2.11 ± 0.155b</td>
<td>2.47 ± 0.035b</td>
<td>3.09 ± 0.148b</td>
<td>4.04 ± 0.056</td>
<td>4.53 ± 0.098b</td>
<td>4.74 ± 0.219b</td>
<td>5.03 ± 0.091c</td>
<td>5.47 ± 0.106c</td>
<td>5.76 ± 0.056c</td>
<td>6.17 ± 0.020c</td>
<td>6.09 ± 0.014c</td>
<td>6.62 ± 0.176c</td>
</tr>
<tr>
<td>Treated</td>
<td>2.60 ± 0.148a</td>
<td>3.14 ± 0.077b</td>
<td>3.44 ± 0.148b</td>
<td>4.30 ± 0.148b</td>
<td>4.69 ± 0.049b</td>
<td>5.33 ± 0.113b</td>
<td>5.98 ± 0.106b</td>
<td>6.27 ± 0.091b</td>
<td>6.43 ± 0.176b</td>
<td>7.02 ± 0.162b</td>
<td>7.21 ± 0.098b</td>
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<tr>
<td>LSD</td>
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<td>0.74</td>
<td>0.79</td>
<td>0.87</td>
<td>0.68</td>
<td>0.82</td>
<td>0.57</td>
<td>0.21</td>
<td>0.14</td>
<td>0.19</td>
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<td>0.73</td>
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Mean followed by different letters in the table are significantly different at P=0.05 according to Duncan’s multiple range test, ± standard deviation, LSD: least significance difference

Table 4: Effect of treated and untreated textile effluent on number of internodes of *Zea mays* L. CV C1415

<table>
<thead>
<tr>
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<td>7.00 ± 0.148a</td>
<td>7.61 ± 0.155a</td>
<td>8.13 ± 0.190a</td>
<td>8.48 ± 0.028a</td>
<td>9.01 ± 0.155a</td>
<td>9.38 ± 0.021a</td>
<td>9.89 ± 0.148a</td>
</tr>
<tr>
<td>Un-treated</td>
<td>2.11 ± 0.155b</td>
<td>2.47 ± 0.035b</td>
<td>3.09 ± 0.148b</td>
<td>4.04 ± 0.056</td>
<td>4.53 ± 0.098b</td>
<td>4.74 ± 0.219b</td>
<td>5.03 ± 0.091c</td>
<td>5.47 ± 0.106c</td>
<td>5.76 ± 0.056c</td>
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<td>0.87</td>
<td>0.68</td>
<td>0.82</td>
<td>0.57</td>
<td>0.21</td>
<td>0.14</td>
<td>0.19</td>
<td>0.45</td>
<td>0.73</td>
</tr>
</tbody>
</table>

Mean followed by different letters in the table are significantly different at P=0.05 according to Duncan’s multiple range test, ± standard deviation, LSD: Least Significance Difference
Fig. 1: Effect of treated and untreated textile effluent on transpiration (a) and photosynthesis (b) of *Zea mays* L. CV C1415

Fig. 2: Effect of treated and untreated textile effluent on total fresh and dry weights (a), root, shoot and leaves fresh and dry weights (b) of *Zea mays* L. CV C1415