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Short Communication

Effect of dyeing industry effluent on nucleic acids and stress compounds in Brinjal

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Chinnalapatti town is a well known dyeing industrial place. These industries produce several tones of effluents containing toxic dyes and chemicals, which are discharged into the river and land resources without proper treatment. These water sources are used for irrigation in the agricultural sector, facing great problems of crop loss and low yield. The present investigation was carried out to study the adverse impact of dyeing industry effluent when it is irrigated to the crop plants. Changes in nucleic acids (DNA and RNA) and stress compounds such as peroxidase, catalase, phenol and thiol content, proline and ascorbic acid of Brinjal and observed that leaves of the effluent treated plants showed drastic alteration in the all such nucleic acids and stress compounds. The deviation of all these biochemical constituents indicates the adverse effect of these pollutants on the normal physiology. Hence, measures can be taken to restrict the practice of irrigating untreated dyeing industry effluent on the most significant vegetable.

Key words: Nucleic acids, Stress compounds, Brinjal, Heavy metal pollution, Dyeing industry effluent

Environmental pollution is one of the major problems of the world and it is increasing day by day due to urbanization and industrialization. Of the various sources of pollutants, industrial effluents containing heavy metals pose a threat to the ecosystem. Industrial effluents are used to irrigate the crop plants as it is the repository of macro and micronutrients. The use of dyeing effluents for irrigation may be an alternate for recycling if used rationally and in appropriate concentration (Kumawat *et al.*, 2001). On the other hand such practice can also cause detrimental to the plants as these effluents contain inorganic wastes like heavy metals pose a great threat, as they cannot be completely removed or degraded from the ecosystem. Heavy metal pollution is one of the serious environmental problems due to wide spread use of metal for industrial and agricultural purpose. The widespread contamination of heavy metals in the last decades has alarmed the public and the world due to their toxic effects even at very low concentrations. Hazardous heavy metals such as lead, mercury, cadmium, arsenic, copper, zinc and chromium are very toxic and carcinogenic in nature. Some metal ions are cumulative poisons, capable of being assimilated and stored in the tissues of organisms causing noticeable adverse physiological effects. Toxic chemicals like cyanides, chlorine, hypochlorites, phenols and heavy metals accumulated in living cells causing a reduction of cell activities, inhibition of growth and various deficiencies and diseases in plants. Textile waste is used for irrigation of agricultural crops where is poses serious stress problems causing the plants to wilt early or making them more susceptible to pests and finally reducing the yield. Continuous use of effluent containing water for crop irrigation would result in deposit of toxic chemicals in the soil, which will become unsuitable for cultivation of agricultural crops. Under exposure to high concentration, plants suffer acute injury with extremely visible symptoms, such as chlorisis, decolourisation, necrosis and death of entire plant. Plants grown at high textile effluent had very leaky root system as evidenced by high K efflux (Priya and Chellaram, 2012). Accumulation of toxic heavy metals leads to stress conditions in the plant system by interfering with the metabolic activities and physiological functioning of the plants. Heavy metals are known to cause membrane damage, structural disorganization of organelles impairment in the physiological functioning of the plants and ultimately growth retardation (Kimbrough *et al*., 1999; Chien and Kao, 2000). The present study was conducted to evaluate the effect of dyeing industry effluent on nucleic acids and stress compounds in Brinjal.

Materials and Methods

The effluent samples were collected from dyeing industry located at Chinnalapatti, Dindigul district, Tamil Nadu in plastic containers (20L). After collection, the effluent was immediately transported to the laboratory for analysis. Physico-chemical parameters such as pH, electrical conductivity, total solids, total dissolved solids, chloride, sulphate, biological oxygen demand and chemical oxygen demand were analyzed as per the standard methods (APHA, 2012). The healthy and uniform seeds were selected and surface sterilized with 0.1% $Hgcl_2$ solution for 3 minutes, rinsed with distilled water, dried and stored in polythene bags and used for experiments under laboratory conditions. The surface sterilized seed were sown to depth of 4 cm in plastic bags, filled with sand, cow dung and soil mixed in uniform proportion (1:1:1). After sowing the seeds were allowed to germinate for 15 days. After 15 days of germination, dyeing industry effluent at various concentrations such as 25, 50, 75 and 100% was irrigated to the growing seedlings of Brinjal while tap water was taken as control. Triplets of each concentration of effluent and control were maintained. The analysis of plants was made after each treatment to study the changes after the induction of effluent stress.

Result and Discussion

Table 1: Physico-chemical parameters of dyeing industry effluent

Parameters	Values
pH	7.3
Electrical conductivity (mS/cm)	2,900
Total Solids (mg l^{-1})	4301
Total Dissolved Solids (mg l^{-1})	3745
Chloride (mg l^{-1})	3158
Sulphate (mg l^{-1})	0.322
BOD (mg l^{-1})	24.01
COD (mg l^{-1})	201

The Physico-chemical parameters of dyeing industry effluent are discussed in Table 1. The pH value of the dyeing industry effluent was 7.3 that ranges within the permissible limit (6.5-8.5) prescribed by BIS. Ahmad *et al.,* (2012) reported the pH of dye industry effluent ranged between 8.2 and 9.0. Electrical conductivity (EC) of effluent is a direct function of its total dissolved salts. EC and TDS are important parameters to measure the salinity hazard of water (David Noel and Rajan, 2015). The EC found in the effluent (2,900 mS/cm) was greater than that of the permissible limit of BIS (300 mS/cm) this may be due to the continuous discharge of the chemicals and salts used along with dyes in the industries. The effluent recorded a Total Solids of 4301 mg l^{-1} beyond the standard value of BIS (1200 mg l^{-1}). Saravanan *et al.*, (2012) reported that the distillery effluent contained high values of total solids, Total dissolved solids (TDS) are due to soluble materials. TDS in the present study were recorded 3,745 mg l^{-1} that is beyond the standard value of BIS (1000 mg l^{-1}). Devarajan and Hameed Sulaiman, (2008) also observed that the untreated dye effluent total dissolved solids were not within the permissible limits for disposal into the inland surface water and unsuitable for land application. Biological oxygen demand in the present study was recorded 24.01 mg l^{-1} within the permissible limit prescribed by BIS (100 mg l^{-1}). Smrithi *et al.*, (2012) recorded BOD of textile effluent was 19 mg l^{-1} and within the permissible limit prescribed by BIS. COD recorded in the effluent was 402 mg l^{-1} exceeded the permissible limit prescribed by BIS (350 mg l^{-1}). Saravanan *et al.*, (2012) recorded that chemical oxygen demand of tannery industry effluent was above the accepted limits.

Table 2: Biochemical compounds in Brinjal responding to stress in relation to various concentrations (25, 50, 75, and 100 %) of dyeing industry effluent

Parameters	control	25%	50%	75%	100%
Peroxidase activity (Km purpurogallin min-1 g-1 fresh leaf)	11.2±0.1	16.4±0.03	18.5±0.03	22.2±0.01	26.1±0.05
Catalase(mg/g fw)	2.5±0.01	3.6±0.01	5.3±0.01	6.1±0.04	8.5±0.08
Phenol content (mg g^{-1} fresh leaf)	1.2±0.02	1.4±0.04	1.7±0.04	2.2±0.02	2.5±0.1
Thiol content (K mol g^{-1} fresh leaf)	3.4±0.11	4.5±0.02	6.3±0.02	6.9±0.03	8.1±0.2
Proline content (mg g^{-1} fresh leaf)	0.8±0.03	1.5±0.05	1.9±0.04	2.8±0.02	3.1±0.06
Ascorbic acid content (mg g^{-1} fresh leaf)	0.21±0.05	0.32±0.01	0.42±0.02	0.54±0.1	0.67±0.01

Table 3: Biochemical compounds in Brinjal responding to stress in relation to various concentrations (25, 50, 75, and 100 %) of dyeing industry effluent

Parameters	control	25%	50%	75%	100%
Deoxyribonucleic acid	1.23 ±0.06	2.1±0.02	2.87 ±0.01	3.76 ±0.7	4.3 ±0.05
Ribonucleic acid	1.5 ±0.3	1.9±0.06	2.4 ±0.1	2.7 ±0.07	2.9 ±0.06

Various biochemical compounds in plants responding to stress are given in Table 2. The activity of antioxidative enzyme Peroxidase showed positive correlation with the increasing concentration of dyeing effluent. Positive relationship suggests that with increase in the heavy metal concentrations, there was an increase in the oxidative modifications to cellular components of the plants (Moller *et al*., 2007). Another antioxidative enzyme such as catalase was also observed to increase with the increasing concentration of dyeing industry effluent. Sureshkumar and Mariappan, (2013) reported the increase in enzyme catalase with increasing concentration of sugarcane mill effluent. Phenol and thiol contents were also higher with increasing concentration of dyeing industry effluent in Brinjal (Table 2). This may be attributed to the increasing concentration of heavy metals in dyeing industry effluent. Similar findings were reported by Singh and Agrawal, (2010). Ascorbic acid, a natural antioxidant scavenges free radicals generated by heavy metals. Proline and ascorbic acid content in Brinjal and dyeing effluent was positively correlated (Table 2). Sinha *et al*., (2007) have also reported higher production of ascorbic acid in fenugreek plants grown in soil amended with tannery sludge to nullify the adverse effects of heavy metals.

The DNA and RNA content in the leaves of Brinjal was found to be increased with the increasing concentration of dyeing effluent when compared to the control (Table 3). The DNA and RNA content in the stress leaves of effluent treated plants such as Tomato, Ladies finger, Cucumber, Fenugreek and Gogu increased when compared to the normal leaves whereas Sureshkumar and Mariappan, (2013) reported that both the nucleic acids (DNA and RNA) in *Chloroxylon swietenia* were found to decrease with the increasing concentration when treated with sugarcane mill effluent.

Conclusion

From this study it is inferred that untreated dyeing industry effluent can cause stress to the crop plants which affects crop yield subsequently economic loss for the farmers. In Chinnalapatti many dyeing industries discharge the untreated effluent into the river. These water sources are used for irrigation in the agricultural sector, facing great problems of crop loss and low yield. Therefore this issue must be taken as a matter of concern and proper treatment technologies even low cost bio remediation by means of plants with phytoremediating potential and heavy metal resistant microbes.

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