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EFFECT OF DYE INDUSTRY EFFLUENT ON GROWTH AND SOME BIO-CHEMICAL CHARACTERISTICS OF CERTAIN TREE SPECIES

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ABSTRACT

The present study deals with the effect of Dye industry effluent on growth and some biochemical characteristics of certain tree species grown for a period of 60 days. Physico- chemical characteristics of dye industry effluent such as pH, electrical conductivity, total solids, total dissolved solids, total suspended solids, hardness, alkalinity, sodium, potassium, calcium, chloride, dissolved oxygen, dissolved carbon dioxide, BOD and COD were estimated. Three tree species such as *Delonix regia*, *Albizzia amara* and *Acacia auriculiformis* were grown in different concentrations of dye industry effluent (10, 20, 30, 40 and 50%) along with organic amendments. Among the treatments the germination percentage of *Delonix regia* was higher in T0 (Control) and lower in *Acacia auriculiformis* (T_5 – 50%). Growth characteristics such as shoot length, root length, fresh weight and dry weight were higher in *Delonix regia* and lower in *Acacia auriculiformis*. Biochemical characteristics such as chlorophyll a, b, total chlorophyll and carotenoid content were higher *Delonix Regis* followed by *Acacia auricliformis*.

INTRODUCTION

Industrialization and urbanization coupled with alarming rate of population growth have resulted in the large scale pollution of the environment. The indiscriminate disposal of industrial, municipal and agricultural wastes in to aquatic systems is responsible for the environmental pollution. Industrial effluents are normally considered as toxicants due to the presence of organic compounds, acids, alkaloids and suspended solids, heavy metals, phenols, ammonia, toxic chemicals and radio nuclides. These toxicants are entering in to the food chain beyond their permissible limits, directly or indirectly affect the entire life on the planet earth (Jamode, 2003). Disposal of industrial and urban waste in to soil and water bodies has led to disastrous consequences in the ecosystem (Smith, 1974). Among the major industries, Dye industries release large quantities of inorganic pollutants like chloride, sulphate, nitrate, organic compounds and heavy metals. Various conventional methods like precipitation, ion exchange, adsorption, reverse osmosis, evaporation and crystallization (Dean *et al*., 1972) were used for the removal of toxic pollutants from waste waters. These techniques may be technologically inapplicable or very expensive from the economic point of view. Varied biological techniques are identified as effective technology for the utilization or re-

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moval of toxicants from waste waters (Holan and Volesky, 1995). Among the biological techniques, phytoremediation is a novel technique used for the removal of pollutants from the environment. Certain non- edible, multi purpose tree species have the capacity to grow in polluted waters. Hence an attempt has been made to study the effect of dye industry effluent on growth and some biochemical characteristics of certain tree species.

MATERIALS AND METHOD

For the present study Dye industry effluent was collected from Chinnalapati, Dindigul District, Tamil Nadu, India, in plastic containers (20 L). After collection, the effluent was immediately transported to the laboratory for analysis.

Preservation of dye industry effluent

Polythene bottles for sample preservation were thoroughly cleaned by rinsing with 8M HNO_3 followed by repeated washing with distilled water. The bottles were rinsed thrice with dye industry effluent before the preservation. During the period of analysis the dye industry effluent was preserved as per the preservation technique(APHA,1990) (Table 1). The physico-chemical characteristics such as pH, electrical conductivity, total solids, total dissolved solids, total suspended solids, hardness, alkalinity, sodium, potassium, calcium, chloride, dissolved oxygen, dissolved carbon dioxide, BOD and COD were estimated using standard methods(APHA, 1990). Tree species such *Delonix regia*, *Albizzia amara* and *Acacia auriculiformis* were selected for pot culture studies. Healthy, uniform and dried seeds were collected from Palni Hills Conservation Council, Odukkam Seed Centre, Nallampatti, Dindigul, Tamil Nadu, India.

Pot culture studies

The design of experiments is presented in Table 2. Seeds were sown in various plastic pots. Control (T_0) was regularly irrigated with ground water and T_1, T_2,

Table 1. Preservation techniques of the effluent sample for chemical analysis.

S.No.	Parameters	Recommended Sample volume (mL)	Type of Container	Preservation	Allowable holding time
1.	Alkalinity	100	P,G	Refrigerate -4° C	24 hr
2.	BOD	1000	P,G	Refrigerate -4° C	6 hr
3.	COD	50	P,G	CH_2SO_4 to pH >2	7 days
4.	Chloride	50	P,G	Not required	7 days
5.	Dissolved Oxygen	300	G	Fix on site	6 hr
6.	Hardness	100	P,G	Refrigerate -4° C	7 days
7.	pH	100	P,G	Determine on site	-
8.	Specific Conductance	100	P,G	Refrigerate -4° C	24 hr
9.	Solids (total, dissolved)	100	P,G	Refrigerate -4° C	7 days

P – Plastics, G – Borosilicate Glass.

Table 2. Design of Experiments

S.No.	Treatment	Red Soil	Sand	Farmyard Manure
1.	T_0	2 kg	2 kg	2 kg
2.	T_1	2 kg	2 kg	2 kg
3.	T_2	2 kg	2 kg	2 kg
4.	T_3	2 kg	2 kg	2 kg
5.	T_4	2 kg	2 kg	2 kg
6.	T_5	2 kg	2 kg	2 kg

T_0 – Red soil +Sand + FYM (1:1:1) (control)
T_1 - Red soil +Sand + FYM (1:1:1) + 10% Dye industry effluent
T_2 - Red soil +Sand + FYM (1:1:1) + 20% Dye industry effluent
T_3 - Red soil +Sand + FYM (1:1:1) + 30% Dye industry effluent
T_4 - Red soil +Sand + FYM (1:1:1) + 40% Dye industry effluent
T_5 - Red soil +Sand + FYM (1:1:1) + 50% Dye industry effluent

T_3, T_4 and T_5 were irrigated with 10, 20, 30, 40 and 50% of dye industry effluent respectively. The seedlings were allowed to grow in the respective pots for a period of 60 days. The growth and biochemical characteristics of selected tree species were measured after 30th and 60th day. The procedure followed for the analysis of growth and biochemical characteristics of tree species are presented in Table 3.

Table 3. Procedure followed for the Growth and Biochemical characteristics of Tree species.

S.No.	Parameters	References
1.	Germination Efficiency (%)	Carley and Watson (1968)
2.	Shoot Length (cm)	Arts & Marks (1969)
3.	Root Length (cm)	Buris *et al.* (1969)
4.	Total Fresh weight (g)	"
5.	Total Dry weight (g)	"
6.	Chlorophyll a (mg/g f w)	Arnon (1949)
7.	Chlorophyll b	"
8.	Total Chlorophyll	"
9.	Carotenoides (µ mole g f w)	"

Table 4. Physico- chemical characteristics of Dye industry effluent

S.No.	Parameters	Values
1.	Colour	Reddish Brown
2.	pH	8.2
3.	Electrical conductivity	33800 m S/cm
4.	Total Solids	16000
5.	Total Dissolved Solids	14950
6.	Total Suspended Solids	1050
7.	Chloride	630
8.	Hardness	560
9.	Alkalinity	6400
10.	Dissolved Oxygen	3.232
11.	Dissolved Carbon Dioxide	44
12.	Biological Oxygen Demand	65
13.	Chemical Oxygen Demand	744
14.	Sodium	9.29
15.	Potassium	0.21
16.	Calcium	5.34

Not : Values in mg/L except pH, otherwise stated.

RESULTS AND DISCUSSION

The physico- chemical characteristics of dye industry effluent is presented in Table 4. The pH of dye industry effluent was 8.2. Khobragade *et al.* (2001) reported higher value of pH (9.1) in sugar industry effluent. The EC of dye industry effluent was 3800 mS/cm. Mariappan and Rajan (2002) reported higher value of EC (11,575 mS/cm) in tannery industry effluent. The BIS permits only 400mS/ cm of EC for disposal of effluent into the environment. The total dissolved solids of the dye industry effluent was 14950 mg/L. Periyasamy and Rajan (2009) reported higher value of total dissolved solids (9700 mg/L) in electroplating industry effluent. The BIS permits only 2100 mg/ L. of total dissolved solids for disposal of effluent into the environment. The Chemical Oxygen Demand (COD) was 744 mg/L. Mariappan and Rajan (2002) reported the COD value of 272 mg/L. The chloride content of the effluent was 630 mg/L. Khobragade *et al.* (2001) reported lower chloride (197.38mg/L) content in sugar industry effluent.

Effect of different concentrations of dye industry effluent along with organic amendments on seed germination percentage of selected three tree species is presented in Table 5. In the present study the germination percentage of selected three tree species was higher in T_0 (100) in *Delonix regia* followed by T_1(98) and lower in T_5(50) in *Acacia auriculiformis*. Higher concentration of the dye industry effluent (50%) inhibited the seed germination. Mariappan and Rajan (2002) reported that in the lower concentration (10%) of the tannery effluent the seed germination was higher in *Parkinsonia aculeata* and *Caesalpinia coriaria*.

Effect of different concentrations of dye industry effluent along with organic amendment on shoot and root length and fresh and dry weight of selected three tree species after 30th and 60th day is presented in Table 6. In the present study shoot length, root length,

Table 5. Effect of different concentrations (10, 20, 30, 40 and 50%) of dye industry effluent along with organic amendment on seed germination (%) of Selected three tree species (pot culture).

S.No.	Name of Tree species	T_0	T_1	T_2	T_3	T_4	T_5
1.	*Delonix regia*	100	98	96	94	90	88
2.	*Albizzia amara*	100	86	80	78	72	68
3.	*Acacia auriculiformis*	100	74	68	62	56	50

Table 6. Effect of different concentrations (10, 20, 30, 40 and 50%) of dye industry effluent along with organic amendment on Shoot and Root Length (cm) and fresh and dry weight (g) of selected three tree species (pot culture).

Name of Tree species	Days	T_0	T_1	T_2	T_3	T_4	T_5
Shoot Length							
Delonix regia	30	13.5	12	10.2	10	9.5	9
	60	16.5	16	13.9	13.2	11.8	10.5
Albizzia amara	30	8.8	8.5	7.5	7.5	6.8	6
	60	10.5	10.2	9.8	9.4	7.9	7.5
Acacia auriculiformis	30	7.2	6.4	6.1	5.2	4.5	3.9
	60	8.7	8.3	7.4	7.1	6.5	5.3
Root Length							
Delonix regia	30	25.5	24.2	21.7	20.2	19.8	17.5
	60	28.4	26.9	25.4	23.8	21.5	20.1
Albizzia amara	30	20	18.2	17.3	16.5	14.3	13.5
	60	23	21.8	20.7	19	17.2	16.4
Acacia auriculiformis	30	15.5	14.3	13.3	12.4	11.2	9.8
	60	19	17.9	17.2	16.3	15.4	13.2
Fresh Weight							
Delonix regia	30	2.94	2.90	1.88	1.75	1.43	1.38
	60	5.05	4.85	4.20	3.86	3.19	2.98
Albizzia amara	30	0.72	0.68	0.57	0.48	0.32	0.21
	60	2.73	2.20	1.98	1.75	1.35	1.02
Acacia auriculiformis	30	0.60	0.54	0.38	0.29	0.18	0.11
	60	2.02	1.85	1.50	1.21	0.98	0.82
Dry Weight							
Delonix regia	30	1.14	1.08	0.99	0.98	0.73	0.68
	60	2.05	1.98	1.72	1.53	1.31	1.02
Albizzia amara	30	0.25	0.24	0.21	0.11	0.04	0.03
	60	1.23	1.12	0.98	0.83	0.51	0.49
Acacia auriculiformis	30	0.19	0.17	0.15	0.07	0.03	0.01
	60	1.05	0.98	0.63	0.42	0.35	0.30

fresh weight and dry weight was higher in T_0 (control) in *Delonix regia* followed by T_1 (10% dye industry effluent) in *Delonix regia*. The higher concentration of dye industry effluent had negative effect on shoot length, root length, fresh and dry weight. Similar study was reported in *Parkinsonia aculeata* and *Caesalpinia coriaria* grown in 10% of tannery industry effluent (Mariappan and Rajan, 2002). Effect of different concentrations of dye industry effluent along with organic amendments on chlorophyll a, b, total chlorophyll and carotenoid content is presented in Table 7. The chlorophyll a, b, total chlorophyll and carotenoid content was higher in *Delonix regia* grown in control (T_0) followed by T_1. The total chlorophyll content was decreased with increasing concentration of dye industry effluent when compared to control. This may be due to the increasing concentration of total dissolved solids, chloride, sulphate and nitrate which diabolise the chloroplast pigment, which in turn reduces the leaf chlorophyll content (Khan and Jain, 1995).

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Table 7. Effect of different concentrations (10, 20, 30, 40 and 50%) of dye industry effluent along with organic amendment on Chlorophyll a,b, total chlorophyll (mg/g f w) and Carotenoid content (µ mole g f w) of Selected three tree species (pot culture).

Name of Tree species	Days	T_0	T_1	T_2	T_3	T_4	T_5
Chlorophyll a							
Delonix regia	30	4.798	3.713	3.595	3.055	2.938	2.702
	60	5.956	4.813	4.634	4.250	3.718	3.696
Albizzia amara	30	3.452	2.975	2.678	2.412	1.895	1.710
	60	4.218	3.531	3.425	3.368	2.450	2.148
Acacia auriculiformis	30	3.210	2.813	2.517	2.285	1.715	1.630
	60	4.134	3.949	3.482	3.392	2.862	2.540
Chlorophyll b							
Delonix regia	30	3.453	2.972	2.763	2.642	2.330	2.219
	60	4.350	3.294	3.184	3.053	2.975	2.842
Albizzia amara	30	2.879	2.762	2.546	2.330	1.217	1.128
	60	3.256	3.194	3.067	2.956	1.975	1.762
Acacia auriculiformis	30	2.560	2.424	2.203	1.896	1.624	1.568
	60	3.043	2.998	2.865	2.562	2.327	2.215
Total Chlorophyll							
Delonix regia	30	8.251	6.685	6.385	5.697	5.268	4.921
	60	10.306	8.107	7.818	7.303	6.693	6.538
Albizzia amara	30	6.331	5.737	5.224	4.742	4.023	3.627
	60	7.474	67.725	6.492	6.324	5.212	4.691
Acacia auriculiformis	30	5.770	5.237	4.720	4.181	3.339	3.198
	60	7.177	6.947	6.347	5.954	5.189	4.665
Carotenoid							
Delonix regia	30	2.198	2.072	1.953	1.847	1.732	1.649
	60	2.875	2.749	2.540	2.435	2.349	2.118
Albizzia amara	30	1.975	1.823	1.679	1.578	1.423	1.287
	60	2.643	2.561	2.248	2.045	1.992	1.865
Acacia auriculiformis	30	1.753	1.642	1.563	1.465	1.320	1.156
	60	2.412	2.292	2.135	1.976	1.865	1.763

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