Jr. of Industrial Pollution Control 23 (1)(2007) pp 31-36

SURVEY OF VEGETATION IN AND AROUND TANNERY POLLUTED SOIL AND ISOLATION OF BIO-INDICATORS FOR PHYTOREMEDIATION

M. R. RAJAN AND K.S. MANOJ

Department of Biology, Gandhigram Rural Institute -Deemed University
Gandhigram 624 302, T.N., India.

Key words : Tannery polluted soil, Bio-indicators, Phytoremediation.

ABSTRACT

The present study deals with the survey of vegetation in and around Tannery polluted soil and isolation of bioindicators for phytoremediation. Few species of plants such *as Chenopodium martima* and *Heliotropium curassavicum* exhibit comparatively higher growth than other species in tannery affected soil. Chemical analysis shows that the species have high chloride content. Comparative study on decontamination capacity shows that *Chenopodium martima* has higher ability to remove chlorides from the soil than *Heliotropium curassavicum*.

INTRODUCTION

In India, tannery industries serve as a potential source of foreign exchange and are mainly concentrated in few states like Tamilnadu, Karnataka, Uttar pradesh, Andhra pradesh and West Bengal. But the same industry remains as a major source of soil and groundwater pollution, which leads to the degradation of soil and in turn formation of wasteland. The tannery industries discharge large quantity of common salt during the process of tanning and deposition of these salt into the soil takes place when the effluent come in contact with soil. Besides chlorides, toxic substances like chromium, sodium sulphide, sodium carbonate, H_2SO_4 and ammonium sulphate were present in the discharged effluent which manifolds the soil pollution. It is estimated that 3500 to 4000 L of waste water is discharged per 100kg of processed skin with high BOD and COD value and leads to the destruction of the ecosystem (Bho-

sale, 1985 and Apparao and Karthikeyan (1990) by divesting the plant community present. However few species show a flash growth in highly affected areas. Phytoremediation is a new concept in environmental management in which micro flora as well as higher plants are used for decontamination of the polluted environment. Benneau *et al*. (1997) advocated the utilization of higher plants for the decontamination of lead affected soils. There is a higher soil stress due to the accumulation of toxic nutrients of tannery effluent. The present study highlights the application of phytoremediation using bioindicators as the remedial measures for decontamination.

MATERIALS AND METHODS

Study site

TALCO, Dindigul (Pvt) Ltd. and its vicinity was taken for conducting the present study. Tamilnadu Govt. established a common effluent treatment plant in Dindigul, Tamilnadu with a joint venture of Tamilnadu Leather Development Corporation and Dindigul Tanner's Association to treat the effluents from tannery industries.

Quadrat sampling method has been followed for the present study. Six quadrats were made in the TALCO campus for the enlistment of plants present and a quadrate were located outside the campus to facilitate comparative study in the distribution of vegetation. Enlistment of plants was done in the different consecutive seasons.

Physico-chemical parameters of soil such as pH, moisture, chloride, potassium, phosphorus, calcium, Total nitrogen and carbon were estimated. Parameters like total nitrogen, chloride, potassium, sodium and phosphorus were estimated in the plant samples. Plant samples were dried in a hot air oven for 48 hrs at 60 to 80°C, powdered and estimated (APHA, 1990). Growth parameters such as shoot length, root length, fresh and dry weight were estimated. To facilitate comparison, selected species were grown in tannery polluted soil with a pH of 8.5 and garden soil with a pH of 7.1. Variation in species diversity were carried out during two consequtive seasons i.e. rainy (November) and in summer (March). To facilitate this study 2X2m quadrates

Table 1. Physio-Chemical characteristics of tannery affected soil

Parameters	Samples				Garden
	S1	S2	S3	S4	soil
pH	8.50	8.2	7.7	7.5	7.1
Moisture	5.5.	4.6	4.3	3.0	6.2
Chloride	4.86	3.88	3.28	1.23	0.08
Calcium	0.0096	0.0103	0.0075	0.0066	0.0012
Nitrogen	0.18	0.19	0.11	0.16	0.089
Phosphorus	0.05	0.05	0.15	0.07	0.28
Potassium	0.53	0.27	0.29	0.17	0.89
Carbon	0.28	0.32	0.08	0.32	0.38
Sodium	0.73	0.44	0.58	0.63	0.08

All the values are indicated in percentage except pH.

Table 2. Vegetation in tannery polluted soil

Species	No. of Plants	Density (%)
Arundo donax (Linn)	23	7.17
Altrnanthera triandra (R.Br)	08	2.49
Altrnanthera echioides (Linn)	10	3.86
Chenopodium martima	68	21.18
Cynodon dactylon (Pers)	34	10.59
Eclipta alba (Hassk)	08	2.49
Gompherena globosa (Jacq)	06	1.88
Gomphrena decumbens (Jacq)	04	1.28
Heliotropium curassavicum (Lin)	40	11.69
Physalis minima (Linn)	21	6.54
Setaria intermedia, (Roem.et.sch)	07	2.18
Spheranthus indicus, (Linn)	16	4.98
Sonchus arvensis (Linn)	3	0.93
Trianthema portulacastrum (Linn)	13	4.04

Table 3. Introduced species in TALCO campus

S.No.	Species Name	S.No.	Species Name
1.	Morinda tinctoris., (Robx)	12.	Caesalpinia coriaria (Jacq)
2.	Alangium lamarcki–(L.F) Wangerin	13.	Terminalia arjuna (W)
3.	Ceila pendandra (Linn)	14.	Syzygium cummi (Linn)
4.	Thespesia populanea (Linn)	15.	Albizia samara. (Roxb)
5.	Bambusa arudinacea (Linn)	16.	Hardwickia binata (Roxb)
6.	Tamarindus indica (Linn)	17.	Murraya exotica (Linn)
7.	Eucalyptus globules (Labill)	18.	Acacia leucopholea (Roxb)
8.	Melia azadirachta (Linn)	19.	Pungamia globra (Vert)
9.	Holoptelia integrifolia (Roxb)	20.	Derris Indica (Benth)
10.	Wightia tinctoria (R.Br)	21.	Eucalyptus tercticornis, (Linn)
11.	Acacia suma (Buch) Ham	22.	Enterolobium saman, (Prain)
		23.	Casuarina equisetifolia, (Frist)

Table 4. Chemical characteristics of plants grown in tannery soil

Samples	Chloride	Nitrogen	Phosphorus	Potassium
Chenopodium martima	4.28	0.13	0.08	0.18
Arundo donax	3.83	0.07	0.03	0.13
Heliotropium curassvium	4.12	0.13	0.07	0.13
Setaria Intermedia	1.72	0.11	0.04	0.09
Physalis minima	2.19	0.12	0.06	0.09

Values are averages of 10 samples

Table 5. Growth performance of selected species in garden soil and Tannery soil.

Species	Shoot length		Root length		Fresh weight		Dry weight	
	I	II	I	II	I	II	I	II
Chenopodium martima	35.8	22	11.2	8.7	85	60	48	38
Arundo donax	24	18.5	8.3	8.2	78	72	62	48
Physalis minima	18.8	12	7.3	7.3	60	70	39	34
Heliotropium curassvium	21	11.5	9.8	7.5	72	68	48	40

I. Garden soil , II. Tannery soil.

Table 6. Variation in species diversity in relation to soil pH

Species	No.of plants		
	pH7.5	pH8	pH8.5
Arundo donax	*18*	*9*	*0*
Alternanthera echioids	9	0	0
Chenopodium martima	12	18	12
Cynadon dactylon	3	0	0
Physalis minima	8	3	0
Heliotropium curassavicum	9	12	6
Spheranthus indicus	4	0	0
Trianthema portulacastrum	3	0	0

Table 7. Variation in species diversity in relation to seasons

Species	No. of plants	
	Rainy season	Summer season
Chenopodium martima	38	39
Arundo donax	27	21
Heliotropium curassavicum	32	30
Eclipta alba	13	8
Physalis minima	17	08
Gompherina globosa	7	0
Alternanthera triandra	6	0
Setaira intermedia	13	0
Sonchus arvensis	7	0
Cynodon dactylon	8	2

Table 8. Physico-Chemical characteristics of tannery soil after decontamination capacity

Parameters	Samples			
	Initial	Final		
		P_1	P_2	P_3
pH	8.5	7.4	7.6	8.0
Chloride	3.83	2.02	2.53	3.09
Calcium	0.0096	0.0086	0.0078	0.0090
Nitrogen	0.17	0.12	0.13	0.13
Phosphorus	0.05	0.03	0.03	0.02
Potassium	0.22	0.17	0.16	0.18
Carbon	0.27	0.27	0.23	0.24
Sodium	0.72	0.44	0.58	0.64

P_1 : Chenopodium martima, P_2 : Heliotropium curassavicum, P_3 : Arundo nax.

were marked in the TALCO campus and enlistment of vegetation. Three quadrats were marked at different places varying in soil pH such as 7.5, 8.0 and 8.5 for the analysis of variation in species diversity in relation to soil pH. Three species - *Heliotropium curassavicum, Chenopodium martima* and *Arundo donax* were taken for the decontamination studies. These plants were grown separately in pots filled with tannery polluted soil collected from the vicinity of the sedimentation tank in common effluent treatment plant for a period

of 60 days. Physico-chemical characteristics such as pH, Chloride, Calcium, Nitrogen, Phosphorus, Potassium, Carbon and Sodium were estimated before the introduction of plants in the pots and after 60 days to find out the comparative efficiency of plants to decontaminate the soil.

RESULTS AND DISCUSSION

Physico-chemical characteristics of tannery affected soils and garden soil are presented in Table 1. Physico-chemical characteristics of tannery affected soil showed that it is varied from garden soil. High pH is said to be caused by the different ions including chlorides present in it. Chemicals such as sodium carbonate, sodium bicarbonate, sodium chloride, calcium carbonate etc used in the tanning causes the alkalization of the soil results in the increase of pH. Since sodium chloride and calcium chloride are the two chemicals used in excessive quantity during tanning, with the discharged effluent it come in contact with soil and accumulate as respective ions. It increases the osmotic concentration of the soil and facilitates exosmosis from plant parts, which is growing in it. In addition to this, less quantity of nutrients such as N,P,K and less amount of organic matter etc, together caused the soil less adoptable for the growth of vegetation. It is found out that addition of treated effluent to the soil affects the physical properties of the soil by increasing the bulk density and decreasing the hydraulic conductivity and porosity (Singaram, 1994 and Raniperumal and Singaram, 1996). The salt accumulations affect the soil quality by altering its chemical composition and degradation of minerals and leads to the crop failure, since less availability of nutrients.

The flora present in tannery polluted soil is presented in Table 2. Fourteen plant species had been enlisted from TALCO Tannery Environmental control system Ltd. campus as natural vegetation. Among the 14 species one was a shrub and 13 were coming under herbs. Out of these 3 plant species (*Chenopodium Sp, Heliotropium Sp and Cynodon dactylon)* were comparatively higher in density, where the soil pH is more than 8. Among the plants *Chenopodium martima* shows two ecotypes. One is normal in appearance; the leaves are linear and green in colour with clustered spike inflorescence. The other one grows in highly saline affected areas with succulent leaves. The leaves are like seedless grapes and pale green in colour with stunted in appearance. This succulent nature of this species indicates the salt tolerance. The species of *Heliotropium* is ash green in appearance. This species is more in number but next to *Chenopodium*. These species are generally found only in coastal and saltish backwater areas. The occurrence of these species in Dindigul District, Tamilnadu, India grabs special attention. So the plant species may be considered as a bio-indicator for saline condition and during the course of time these plants growing well in effluent discharged soil due to high salinity.

Introduced tree species in the study site is presented in Table 3. Out of the twenty-three species of trees introduced, 6 species (*Acacia leucopholea, Acacia suma, Melia azadirachta, Causuaria equisetifolia, Eucalyptus Sp. and Bambusa arudinacea)* showed a flash growth in comparison to others.

Chloride, nitrogen, phosphorous and potassium content of selected species

was presented in Table 4. Growth performance of selected species in garden soil and tannery-affected soil was presented in Table 5. It has observed from the comparative growth performance of selected species in tannery soil as well as garden soil, in tannery soil *Chenopodium martima* exhibited maximum growth in all parameters. It are followed by *Heliotropium curassavicum*, *Arundo donax* and *Physalis minima*. But in garden soil *Chenopodium* martima and *Arundo donax* observed a higher growth and *Heliotropium curassavicum* and *Physalis minima* showed a lower growth.

Variation in species diversity in relation to soil pH is presented in Table 6. Variation in species diversity in relation to season is presented in Table 7. Comparative decontamination capacity of selected species on tannery soil were presented in Table 8. The species *Chenopodium* grown in tannery soil showed a gradual decrease of chloride level in the soil after a period of 60 days. Decontamination capacity of *Heliotropium Sp* comes next. From the present observation it is clear that plants such as *Chenopodium martima* and heliotropium *curassavicum* decontaminate the soil by absorbing the excess amount of chloride present in the soil and accumulating it in the body parts. Phytoremediation is a very effective and economic method for the decontamination of tannery effluent affected soil.

ACKNOWLEDGEMENT

Authors are thankful to the Director, TALCO, Dindigul (Pvt.) Ltd. for allotting land for field level studies and Gandhigram Rural Institute, Gandhigram for offering facilities to carryout this work.

REFERENCES

APHA. 1990. *Standard Methods for the Examination of Water and Waste Water*, 18th edition, American Public Health Association, Washington,DC.

Apparao, B.V. and Karthikeyan, G. 1990. Pollution due to tannery of Dindigul. *GRI*, Gandhigram, Tamilnadu, PP. 19-24.

Bhosale, L.J. 1985. Effect of water pollution on plants. In: *Current Pollution Researches in India*. (Eds. R.K.Trivedy & P.K. Goel) Environmental Publications, Karad, India.

Bonneae, M., Garbage, J. and Le Tacon, F. 1997. Analysis of heavy metal content in certain plant species. *Proceedings of the International conferences on biogeochemistry of trace elements Paris*, (France) May 15-19.pp. 121-135.

Raniperumal and Singaram, P. 1996. Chemical pollution of soil and Irrigation water by tannery effluent-Tamilnadu experience. *Indian.J.agric. Chem.*XXIX (1&2): 1-8.

Singaram, P. 1994 Removal of Chromium from tannery effluent by using waste weeds. *Indian.J. of Environ. Hlth.* 36 (3) : 1997-1999.