Phytoremediation Potential of *Tecomastance* plant for Municipal Solid Waste Management

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Abstract:

Municipal solid waste management, like most of other infrastructural services has come under great stress. Therefore, the present study was undertaken to find out the problems and prospects of Municipal solid waste and to study various physicochemical parameters and heavy metals of soil which is collect from Sukali compost and landfill depot, Amravati. Present paper aim to investigate the capacity of *Tecomastans* to remove contaminant in waste soil polluted by various heavy metals. Quality of waste soil have been investigated with respect to important physicochemical parameters pH, soil colure, texture, temperature, conductivity, chlorides, Na, K, etc. Significantly increase the concentration of chlorophyll a than chlorophyll b in waste soil sample as compared to control. All recorded differences in morphological and chlorophyll content of plants were caused by differences of cumulative environmental conditions with dominant effects of the contamination degree of locations of soil. Heavy metal analysis of initial waste soil, it contained Cu 8.83 mg/g its 88-89 %, Zn 14.490 mg/g its 74-75 %, Cr 4.97 mg/g its 96-97%, Ni 1.20 mg/g its 90-91% and Mn 14.464 mg/g its 72-73% higher than control soil. Concentration of Fe was 10-15% higher in control soil over the waste soil. *Tecomastans* can extract, stabilize, volatilize and accumulate Cu 40-45 %, Zn 70-72 %, Ni 85-86 %, Cr 85-86 % and Mn 65-66 %. After 2 months of phytoremediation study, using *Tecomastans* its act as an accumulator, it hyperaccumulate Cr, Ni and Zn

Keywords:
Tecomastans, phytoremediation, landfill depot, Toxicity, Pollutants, Heavy metals.

Introduction:

The quality of life on earth is linked inextricably to the overall quality of the environment. The Municipal Solid Waste Management is worldwide problem. Global population is expected to reach 7 billion by the year 2013 (Guerinot and Salt, 2001) which warrants escalating pollution load in the environment through human activities. In Indian cities, solid waste generation rate is goes on the increase.

In Amravati total waste generated per day 319 Million Tons (MT) (AIILSG, 2003), per capita waste generated 271 gram/person/ day, total quantity of solid waste collected per day 276.5 MT and percentage of waste collected everyday 86.7 MT. Amravati city has a population of 6, 78,192 in 2008 including 1, 28,682 rural and 5, 59,510 urban persons. Amravati is a city in the state of Maharashtra, India and seventh most populous metropolitan city. According to Health Department, Amravati Municipal

Corporation, Amravati report of 2009-2010, around 692.11 TPD solid wastes has generated every day (Personal Communication with Dr. Jadhav). The total area of Sukali composed depot of about 9.5 hectors, it totally polluted due to solid waste.

Phytoremediation involves the use of plants to remove, transfer, stabilize and or degrade contaminants in soil, sediment and water (Huang *et al.*, 1997). *Tecomastans* is an erect shrub commonly found in India this plant have capacity of phytoremediation(Photo Plate 2).

Material and methods:

Selection of site and sample collection: Soil samples were collected in summer season 2009-2011 from Sukali compost and landfill depot **(Plate 1).**
Collection and germination of Seed: *Tecomastans* seeds were collect from different sites of Amravati.
Physicochemical analysis: Moisture content (Dhyansingh*et al.*, 1999) and soil texture (Arora and Pathak, 1989) was analyze. pH, Electrical conductivity and temperature of the soil was measured by pH meter, conductivity meter and thermometer. Colour notations indicated by using Munsell`s soil colour chart.
Mineral and salt analysis: Na, K and Ca ions were analyzed by flame photometer (Hanway and Heidel, 1952). The organic carbon (Walkely and Black, 1934).Calcium carbonate by titrimetric method(Piper, 1966).The chloride content (Santra*et al.*, 2006).
Metal analysis: Detection and analysis of metal ions such as Cu, Zn, Cr, Ni, Fe, Mn and Co from soil and sediments, wet oxidation of sample were carried out. Wet oxidation employs oxidizing acids like HNO_3 – $HCLO_4$ di-acid mixture (Jackson, 1958). Calculate Pollution index (Klorke, 1979) and metal enrichment factor (EF) (Kim and Kim, 1999).
Chlorophyll contents of plants: Chlorophyll was extracted in 80% acetone and absorbance at 663 nm and 645 nm had read using UV-Visible spectrophotometer (Elico SL 164). Leaves samples with control and treatments had estimated following the procedure of (Whatley and Arnon, 1963).
Statistical analysis: The difference between control and waste soil compared using *t* tests and significant differences were found at ($p < 0.01$), ($p < 0.05$), ($p < 0.2$).

Result and discussion:

Growth Performance of *Tecoma stance*

The results showed that marked difference between the plants grown in control and those grown in waste soil. Seeds were germinate in pots (Photo plate 2; Table 1) within a week; maximum germination was found in waste soil (64 %) whereas, in control (56 %). The length and breadth of leaves, number of leaves and height of plant was studied; significant increase was noticed in number of plants which grown in waste soil in comparison to control. The maximum biomass production was observed in waste soil 25.82 gm (after 30 days) and 27.64 gm (after 60 days) these values 65-88 % higher than control 3.34 gm (after 30 days) and 9.47 gm (after 60 days), it was totally due to various nutrients in greater quantity in waste soil, it show stimulating effect on the growth and biomass production (Photo Plate 2; Table 1). According to Anikwe and Nwobodo (2001), municipal wastes increase the nitrogen, pH, cation exchange capacity, percentage base saturation and organic matter.

Chlorophyll contents

The higher chlorophyll contents (Chl. a, Chl. b and total Chl.) in the waste soil after 60 days as compared to the **control (Table 1). However**, relation between chl. a and chl. b content, in waste soil chl. a and chl. b content were significantly increase as compared to control. The plants grown in control were higher concentration of chl. b after 30 days but pigment concentration decreases gradually after 60 days. In waste soil growing plants chl. b increase 91-92 % after 60 days. Total chlorophyll content in *T. stans*grown in waste and control soil a gradual increase in chl. content in waste soil as compared to control. Potassium has also been reported to be involved in maximum increase in nutrient uptake by virtue of more photosynthesis resulting in more chlorophyll formation with an increased leaf area (Belorkar*et al.*, 1992).

Physicochemical analysis of soil

(*Tecomastans* grown plant in experimental field trial)

Evaluation of physicochemical parameters the results were tabulated in Table 2.Theinitial temperature of CS (30°C) was slightly higher than WS (29°C). pH of WS (8.57) it reduces during the two months. Moisture content of WS (4.32 %) this value was 50 % lower than control (8.54 %). Determination of organic carbon (43.33 %) and chloride content (42.6 mg/kg) in initial WS these values 50 % higher than control (Table 2); during the 2-months experimental period organic carbon was totally lower down or zero through plants. Conductivity of initial WS was ($0.192X10^6$) i.e. 30-50 % higher than the CS ($0.128X10^6$). Concentration of some minerals and metals in WS was Na (21 mg/kg), K (93 mg/kg) and $CaCO_3$ (75.24 mg/kg) the values 60-80 % higher over the control (Table 2) except Ca ions. During the 2 months of experimental period, plants absorbed Na (57-58 %) and K (20-25 %). Highamount of organic carbon influences the soil physical andchemical properties and it also plays a vital role in soilproductivity it enhances intensive root growth which leadsto accumulation of organic residues in the soil (Chopraand Kanwar, 2002).

Comparative study of metal phytoremediation through *Tecomastans:*

Results of heavy metals concentration in initial waste and control soil are given in **Table 3**.In WS Cu (88-89 %), Zn (74-75 %), Cr (96-97 %), Ni (90-91 %) and Mn (72-73 %) recorded highest amount as compared to CS. Concentration of Fe was 10-15% higher in CS over the WS. Present data showed that the waste soil contain higher amount of Cu, Zn, Cr, Ni and Mn.

Absorptive study of metals from soil through *Tecomastans:*

*Tecomastans*was found to be a more effective plant regarding as heavy metal accumulator for study, which accumulate most of the heavy metals effectively (Table 3). Data showed that *Tecomastans* can extract, stabilize, volatilize and accumulate Cu (40-45 %), Zn (70-72 %), Ni (85-86 %), Cr (85-86 %) and Mn (65-66 %) from WS. After 2 months of phytoremediation study, using *Tecomastans* its act as an accumulator, it hyperaccumulate Cr, Ni and

Zn. Zn present in higher concentrations in municipal waste soil, it showed stimulating effect on growth and Biomass production in *Cassia tora*(Shirbhate and Malode, 2012 a). *A. manihot* plant can tolerate Cu, Zn, Ni and Mn ions in waste soil this plant was hyperaccumulate Ni and Zn (Shirbhate and Malode, 2012 b). It has well known that elements such as Cu, Mo, Ni, Cr, and Zn among others are essential for plant growth in low concentrations (Taiz and Zeiger, 1998).

Table. 1-Growth Performance of *Tecoma stance* in field trial.

Parameters	After 30 Days		After 60 Days	
	CS	WS	CS	WS
Seed germination (%) (After 7 days)	56	64****		
Plant height (cm)	6.8±0.59	14.86±1.08*	9.88±0.68	20.3±1.18*
No of Branches/plant	3±0.40	4±0.49*****	3±0.28	5±0.44**
Number of leaflet	1.0±0	3±0.40*****	2±0.34	9±1.09**
Number of leaves	10±0.66	21±2.65**	16±1.16	34±1.38*****
Length of leaves in (cm)	3.6±0.27	6.1±0.29*	4.82±0.31	7.14±0.42*
Breadth of leaves in (cm)	1.0±0.07	2.18±0.22**	1.44±0.10	2.42±0.15**
**Biomass (gram)	3.34	25.82*****	9.47	27.64*
*Chl. a (mg chl./gm tissue)	0.39	0.47*****	0.59	0.67**
*Chl. b (mg chl./gm tissue)	0.16	0.06	0.04	1.4**
*Total chl.(mg chl./gm tissue)	0.55	0.54	0.63	0.82**

NS- Non significant,* ****p < 0.2, ****p < 0.1, ***p < 0.02, **p< 0.05, *P< 0.01
***Leaves, ** plant sample**

Table. 2-Physicochemical analysis of soil (*Tecomastans* grown in experimental field trial).

Parameters	Initial Analysis		After two month soil	
	CS	WS	CS	WS
Temperature (^{o}C)	30	29	24.5	25.5
pH	8.26	8.57	8.41	8.49
Colour	Dark reddish	Grayish	Dark	Grayish
Moisture content (%)	8.54	4.32	8.075	4.48
Moisture correction	1.08	0.11	1.08	1.04
Soil texture	Sandy loam	Sandy	Sandy loam	Sandy
Organic Carbon (%)	27.82	43.33	35.1	Nil
Chlorides (mg/Kg)	28.4	42.6	28.4	56.8
Conductivity µmho/m	0.128 X10^6	0.192X10^6	0.128 X10^6	0.576
Na (mg/Kg)	3.5	21	5	9
K (mg/Kg)	12	93	14	75
Ca (mg/Kg)	710	260	500	290
$CaCO_3$ (%)	19.44	75.24	21.6	81.12

Table. 3-Comparative study of metal phytoremediation through *Tecomastans.*

Sr. No.	Type of Soil	Metals Ions mg/g					
		Cu^{2+}	Zn^{2+}	Cr^{4+}	Ni^{2+}	Fe^{2+}	Mn^{4+}
1.	Initial control soil (I-	1.006	3.648	0.182	0.118	21.72	4.019
2.	Plant absorbs metals	0.300	2.284	0.086	0.355	13.24	0.278
3.	Total metals remains	0.708	4.271	0.529	0.130	23.87	4.582
4.	Initial waste soil (I-WS)	8.83	14.49	4.97	1.120	21.07	14.46
5.	Plant absorbs metals	0.285	1.977	0.091	0.315	11.93	0.136
6.	Total metals remains	4.950	4.271	0.725	0.173	22.11	4.970

Plate. 1-Experimental site of Sukali compost and landfill depot, Amravati (M.S.)

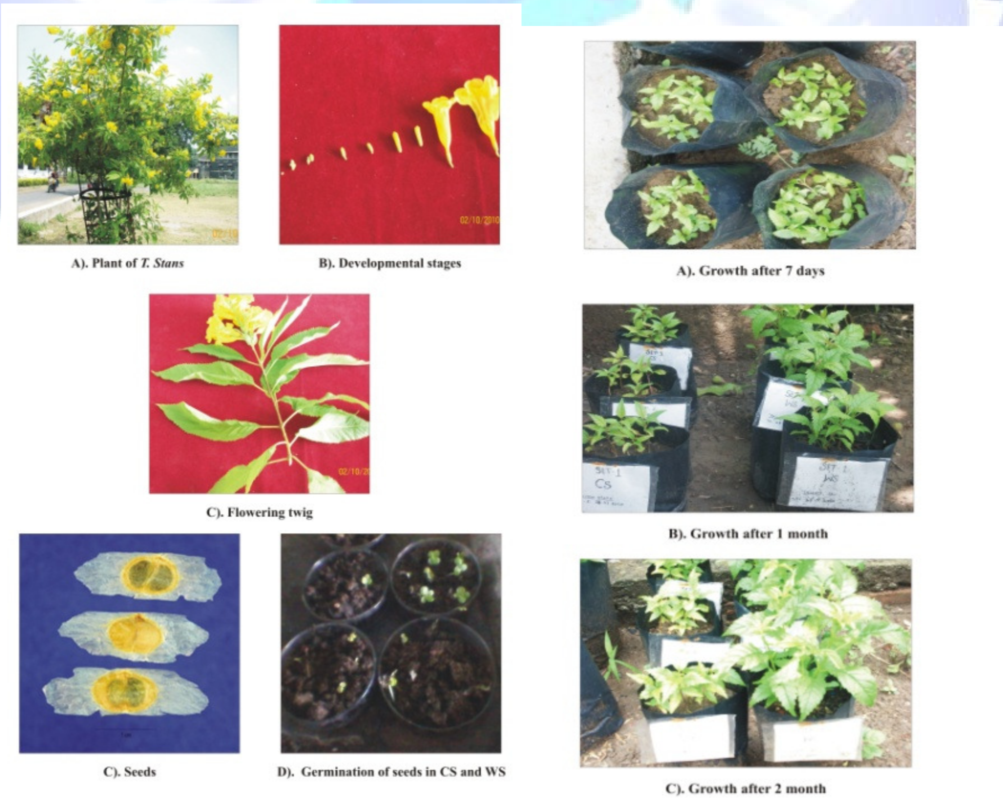

Plate.2- *Tecomastans*grown in experimental field trial

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