

THE FIFTH INTERNATIONAL CONFERENCE ON VETIVER

**A HYDROPONIC VETIVER SYSTEM TO
REMOVE CADMIUM AND CHROMIUM
FROM CONTAMINATED WATER**



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Introduction

River water contamination - industrial effluents, sewage water, municipal wastes, fertilizers and pesticides.

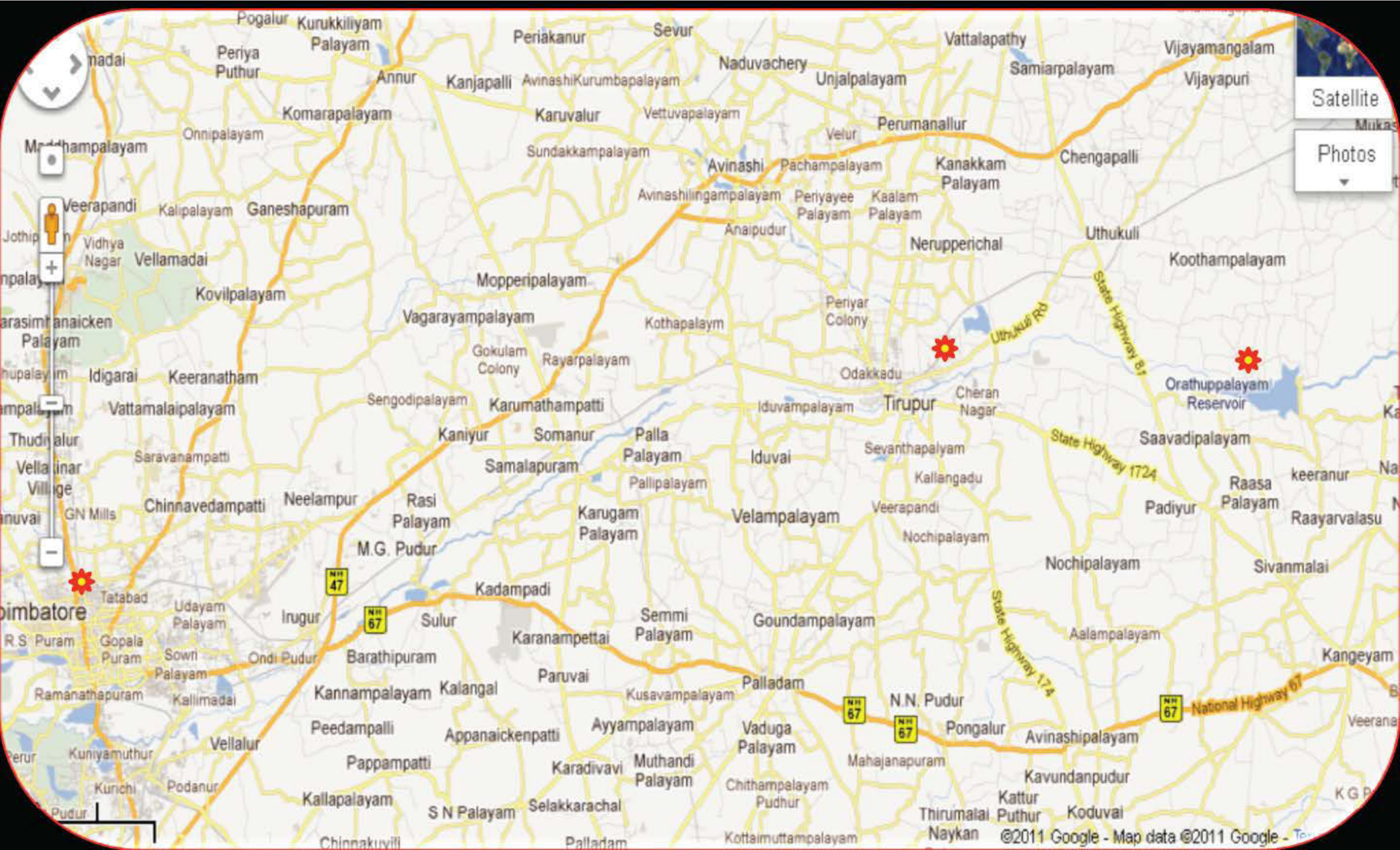
Orathupalayam Reservoir - built in 1992 to store flood water from Noyyal river in Erode district of Tamilnadu

Polluted by 75-100 million litres/day of effluent water from more than 700 dyeing and bleaching industries situated in the town of Tiruppur,

Effluents contain soluble solids, suspended solids, organic matter, heavy metals and toxic constituents.

Toxic metal contamination of the river water poses a major environmental and human health problem, which is still in need of an effective and affordable technological solution.

Orathupalayam Location



Vetiver (*Chrysopogon zizanooides*)

High tolerance to heavy metal and grows well in heavy metal contaminated soil.

Heavy metals accumulate both in the roots and shoots .

Tolerant to herbicides.

Used to treat industrial effluents - by land irrigation method.

Methodology

Characterization of
contaminated water

Vetiver slips from
Agricultural Research
Station, TNAU,
Aruppukottai, India

Plant harvest &
sample analysis

Plant growth &
treatment
Synthetic media as well as
reservoir water

Characterization of Orathupalayam Reservoir Water

Parameters	Results	Permissible limit (BIS Guideline value)
pH	8.5	6.5-8.5
TSS (mg/L)	371	100
TDS (mg/L)	2910	2000
Cadmium (ppm)	0.00052	0.01
Chromium (ppm)	0.0577	0.05

Vetiver Hydroponics



Vetiver was grown under differing concentrations of Cd and Cr. The table gives the various combinations of Cd and Cr used. The medium was Hoagland's. O_s is the Orathupalayam reservoir water sample

Treatments	Treatment condition	
	Cd as Cd(NO ₃) (ppm)	Cr as K ₂ Cr ₂ O ₇ (ppm)
T1	0	0
T2	5	0
T3	10	0
T4	20	0
T5	0	10
T6	5	10
T7	10	10
T8	20	10
T9	0	50
T10	5	50
T11	10	50
T12	20	50
T13	0	75
T14	5	75
T15	10	75
T16	20	75
T17	O_s	O_s
T18	$O_s + 5$	O_s
T19	O_s	$O_s + 10$
T20	$O_s + 5$	$O_s + 10$

Vetiver Hydroponics



Vetiver Hydroponics

T1
CONTROL

DAY 14

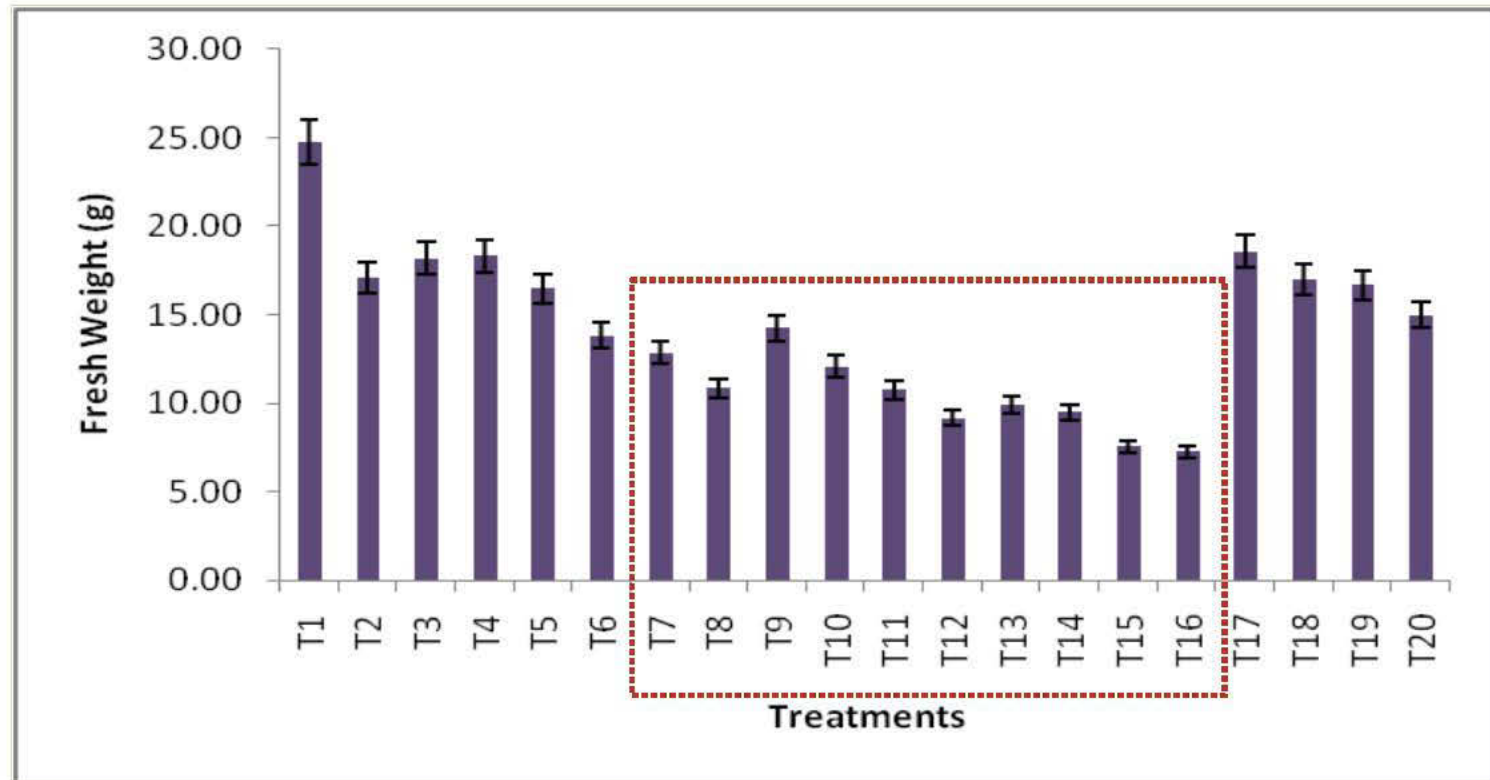
Cd → '0' ppm

Cr → '0' ppm

T17
ORATHUPALAYAM
SAMPLE
DAY 14



Biomass Analysis



T1 (Cd -0, Cr -0)

T4 (Cd -20, Cr -0)

T7 (Cd -10, Cr -10)

(Cd -5, Cr -50)

T13 (Cd -0, Cr -75)

T16 (Cd -20, Cr -75)

T19 (Cd -0.00052, Cr -10.0577)

T2 (Cd -5, Cr -0)

T5 (Cd -0, Cr -10)

T8 (Cd -20, Cr -10)

T11 (Cd -10, Cr -50)

T14 (Cd -5, Cr -75)

T17 (Cd -0.00052, Cr -0.0577)

T20 (Cd -5.00052, Cr -10.0577)

T3 (Cd -10, Cr -0)

T6 (Cd -5, Cr -10)

T9 (Cd -0, Cr -50)

T12 (Cd -20, Cr -50)

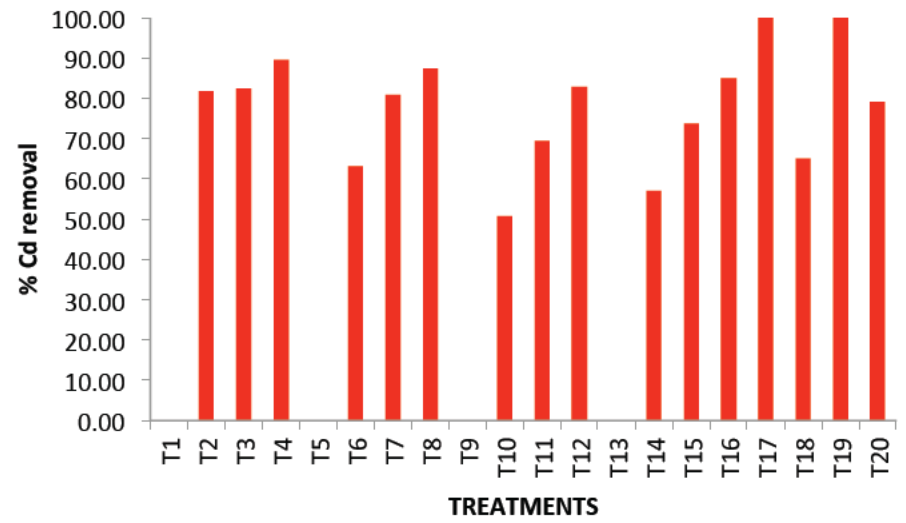
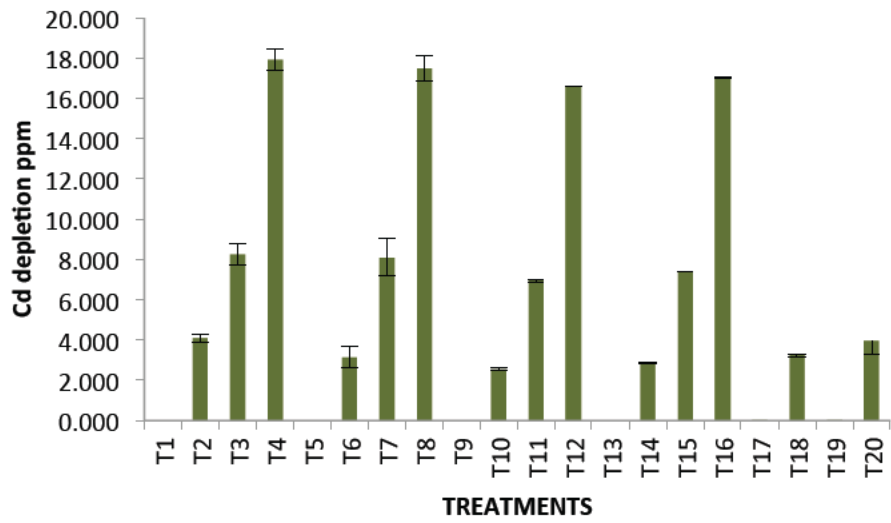
T15 (Cd -10, Cr -75)

T18 (Cd -5.00052, Cr -0.0577)

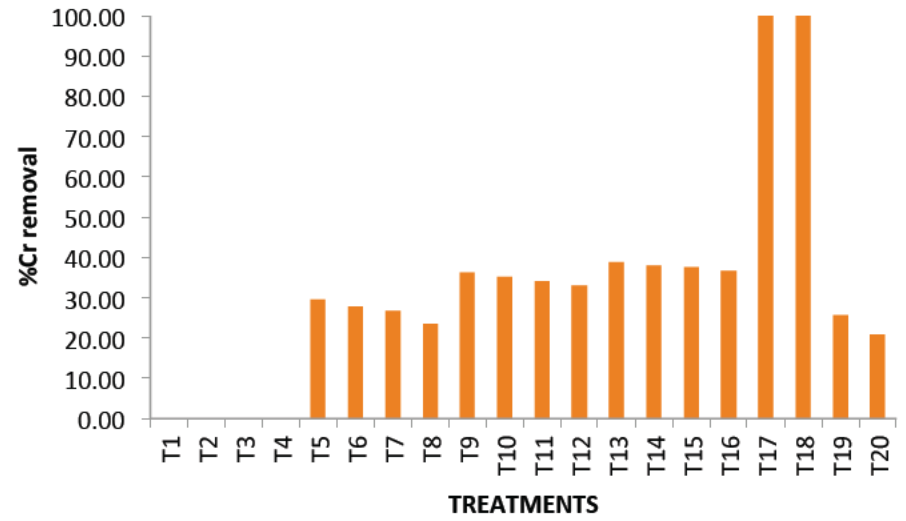
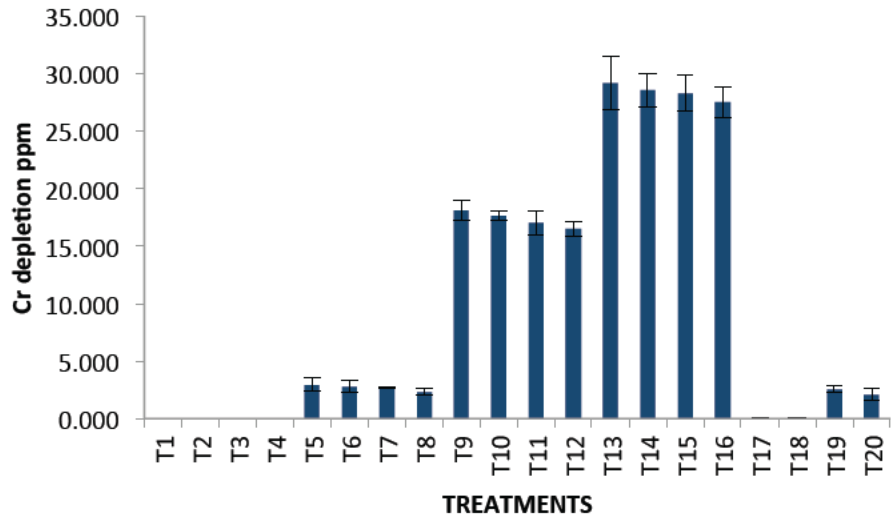
T10

Depletion of Cd and Cr in the water sample after 14 days of vetiver growth

Depletion of heavy metal in water sample						
Treatment	Initial conc. ppm		Depletion ppm		Depletion %	
	Cd	Cr	Cd	Cr	Cd	Cr
T1	0	0	-	-	-	-
T2	5	0	4.09 ± 0.196*	0.00	81.72	-
T3	10	0	8.24±0.539*	0.00	82.35	-
T4	20	0	17.92±0.540*	0.00	89.60	-
T5	0	10	0.00	2.95±0.557*	-	29.52
T6	5	10	3.15±0.531*	2.78±0.491*	63.07	27.77
T7	10	10	8.10±0.917*	2.69±0.085*	80.98	26.86
T8	20	10	17.48±0.649*	2.35±0.237*	87.40	23.54
T9	0	50	0.00	18.11±0.888*	-	36.22
T10	5	50	2.54±0.065*	17.64±0.428*	50.83	35.29
T11	10	50	6.94±0.049*	17.04±1.057*	69.36	34.08
T12	20	50	16.58±0.014*	16.52±0.670*	82.89	33.04
T13	0	75	0.00	29.11±2.332*	-	38.82
T14	5	75	2.85±0.041*	28.55±1.454*	57.08	38.07
T15	10	75	7.37±0.007*	28.25±1.555*	73.71	37.67
T16	20	75	17.02±0.013*	27.48±1.306*	85.09	36.64
T17	0.00052	0.0577	0.00	0.06±0.000	100.00	100.00
T18	5.00052	0.0577	3.25±0.084*	0.06±0.000	65.05	100.00
T19	0.00052	10.0577	0.00	2.58±0.357*	100.00	25.64
T20	5.00052	10.0577	3.96±0.707*	2.11±0.528*	79.16	20.98



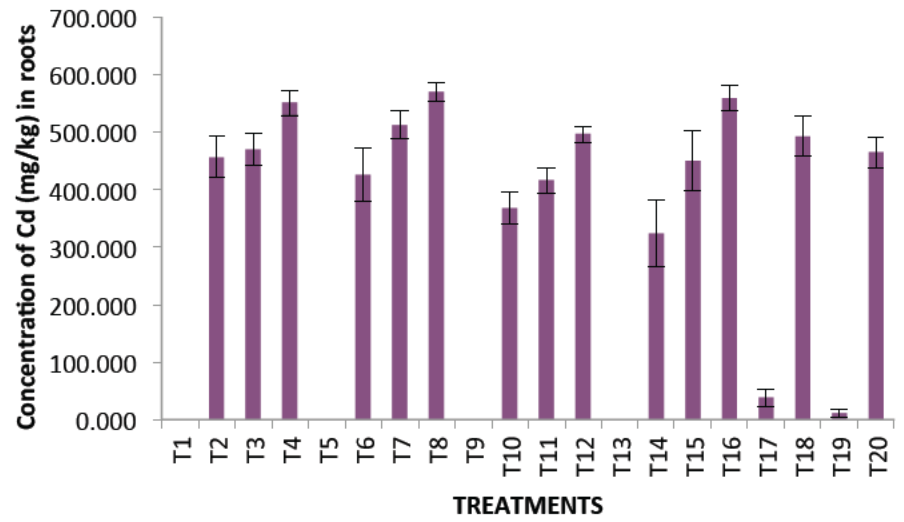
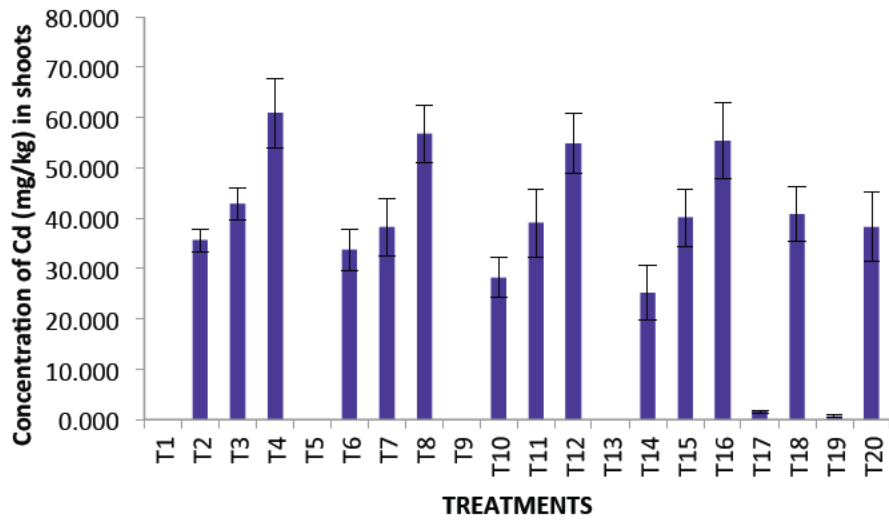
Depletion of Cd and Cr from the Water and Removal % of Cd and Cr



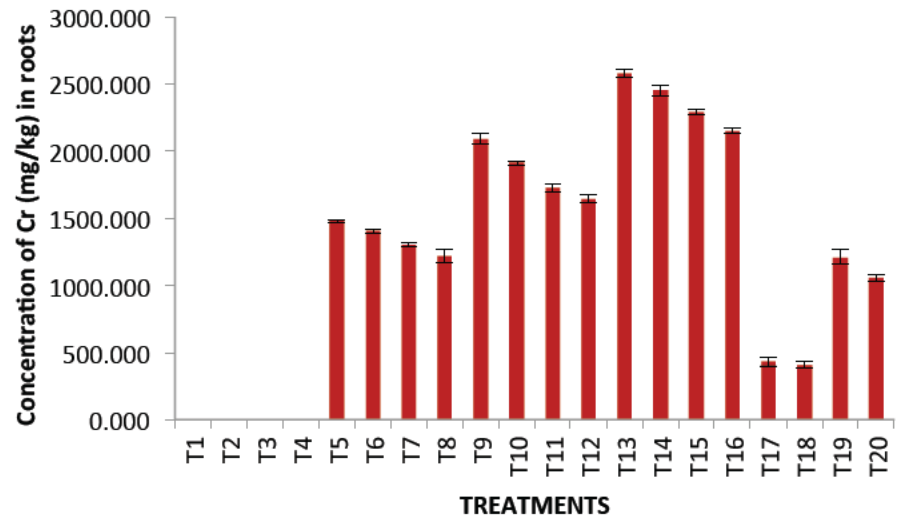
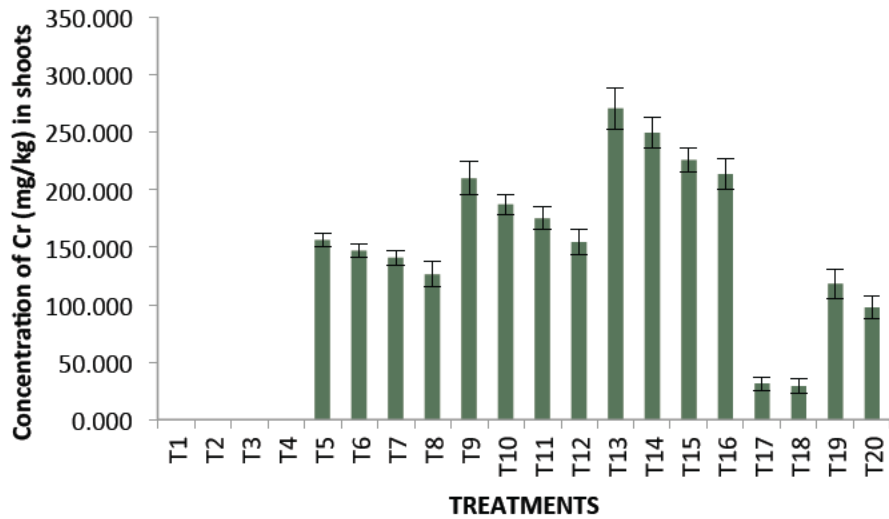
T1 (Cd -0, Cr -0); T2 (Cd -5, Cr -0); T3 (Cd -10, Cr -0); T4 (Cd -20, Cr -0); T5 (Cd -0, Cr -10); T6 (Cd -5, Cr -10); T7 (Cd -10, Cr -10); T8 (Cd -20, Cr -10); T9 (Cd -0, Cr -50); T10 (Cd -5, Cr -50); T11 (Cd -10, Cr -50); T12 (Cd -20, Cr -50); T13 (Cd -0, Cr -75); T14 (Cd -5, Cr -75); T15 (Cd -10, Cr -75); T16 (Cd -20, Cr -75); T17 (Cd -0.00052, Cr -0.0577); T18 (Cd -5.00052, Cr -0.0577); T19 (Cd -0.00052, Cr -10.0577); T20 (Cd -5.00052, Cr -10.0577);

Metal accumulation by vetiver grown for 14 days under various treatment conditions

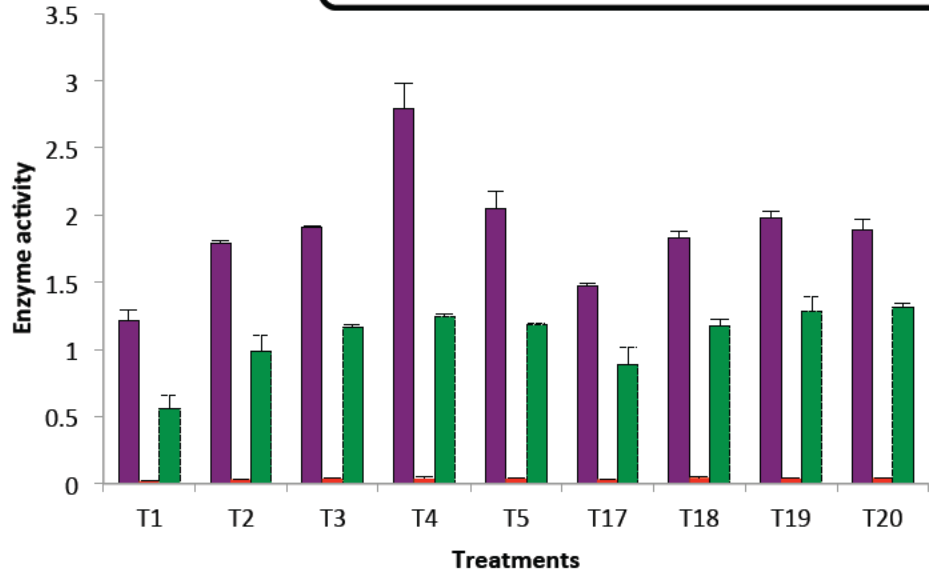
Treatment	Initial Conc in solution ppm		Metal accumulation in plant parts			
			Conc of Cd mg/kg		Conc of Cr mg/kg	
	Cd	Cr	Shoot	Root	Shoot	Root
T1	0	0	0.000	0.000	0.000	0.000
T2	5	0	35.650±2.275	455.700±35.705	0.000	0.000
T3	10	0	42.800±3.251	468.950±26.940	0.000	0.000
T4	20	0	60.825±6.803	550.300±21.648	0.000	0.000
T5	0	10	0.000	0.000	155.830±6.284	1481.850±11.895
T6	5	10	33.775±4.152	425.350±46.573	146.840±5.836	1405.700±15.757
T7	10	10	38.175±5.698	512.200±24.297	140.485±6.083	1302.850±21.747
T8	20	10	56.725±5.786	568.900±16.325	126.448±10.953	1219.500±52.342
T9	0	50	0.000	0.000	209.918±14.851	2088.050±39.886
T10	5	50	28.150±3.943	367.150±27.169	186.675±8.494	1910.475±17.904
T11	10	50	39.025±6.664	415.700±21.966	175.008±10.066	1724.250±28.234
T12	20	50	54.775±5.890	495.900±13.841	154.575±10.736	1642.325±27.963
T13	0	75	0.000	0.000	270.063±18.197	2577.225±28.103
T14	5	75	25.225±5.496	323.850±57.323	249.188±13.496	2451.800±40.636
T15	10	75	40.100±5.735	449.380±52.060	225.583±10.619	2290.875±20.775
T16	20	75	55.350±7.378	558.970±22.150	213.633±13.190	2150.475±23.470
T17	0.00052	0.0577	1.600±0.271	39.150±15.470	31.215±5.643	431.100±31.579
T18	5.00052	0.0577	40.800±5.350	492.130±34.855	29.358±6.777	408.975±21.219
T19	0.00052	10.0577	0.700±0.245	12.050±7.576	118.155±12.854	1207.975±53.141
T20	5.00052	10.0577	38.275±6.830	464.305±26.420	97.620±9.715	1057.280±25.065



Cd and Cr Accumulation in Shoots and Roots



Antioxidant Enzyme Activities

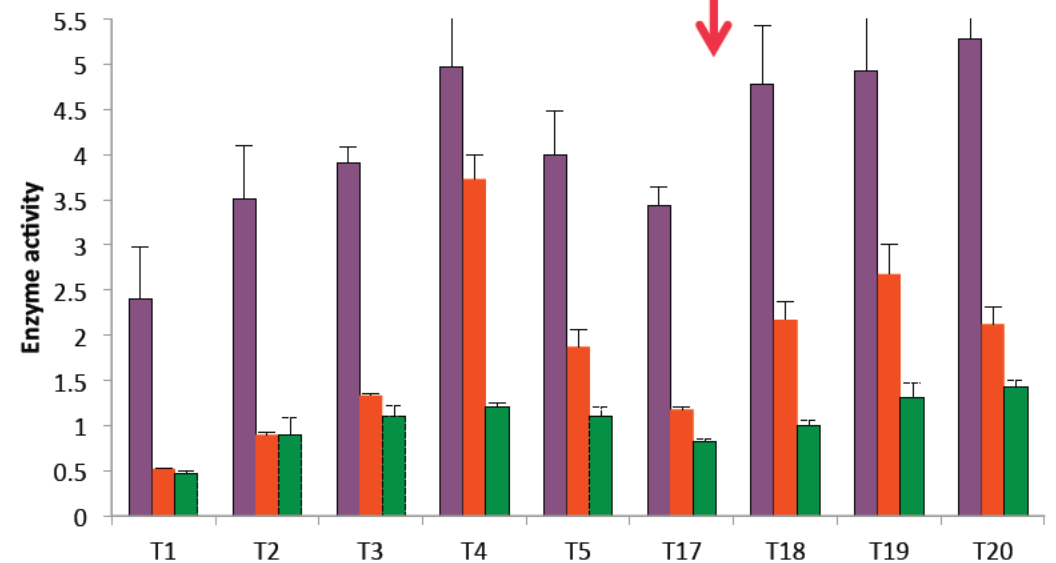


← Antioxidant activity in Shoots

↓ Antioxidant activity in Roots

■ POD ■ CAT ■ SOD

POD - peroxidase, $\mu\text{M min}^{-1} \text{mg}^{-1}$ protein, SOD - superoxide dismutase, $\text{U min}^{-1} \text{mg}^{-1}$ protein, CAT - catalase, $\mu\text{M min}^{-1} \text{mg}^{-1}$ protein



T1 (Cd -0, Cr -0); T2 (Cd -5, Cr -0); T3 (Cd -10, Cr -0); T4 (Cd -20, Cr -0); T5 (Cd -0, Cr -10); T17 (Cd -0.00052, Cr -0.0577); T18 (Cd -5.00052, Cr -0.0577); T19 (Cd -0.00052, Cr -10.0577); T20 (Cd -5.00052, Cr -10.0577)

Conclusion

The vetiver accumulates maximum of about 625.63 mgkg^{-1} of Cadmium and $2847.28 \text{ mgkg}^{-1}$ Chromium under the given treatment conditions.

Vetiver could accumulate more than 100 mgkg^{-1} cadmium and $>1000 \text{ mgkg}^{-1}$ chromium, it can be considered a good accumulator for cadmium and chromium – a good candidate for use in their remediation.

It could completely remove the Cd and Cr present in the Orathupalayam water, as well as the spiked water – so could be used in *in situ* treatment of effluents prior to disposal??

Acknowledgement

We thank PSG College of Technology, Coimbatore for the support of the M.Tech. (Biotechnology) student project.

Thank you for your kind attention!

Questions?