Phyto-remediation: A Green Technology to clean environment

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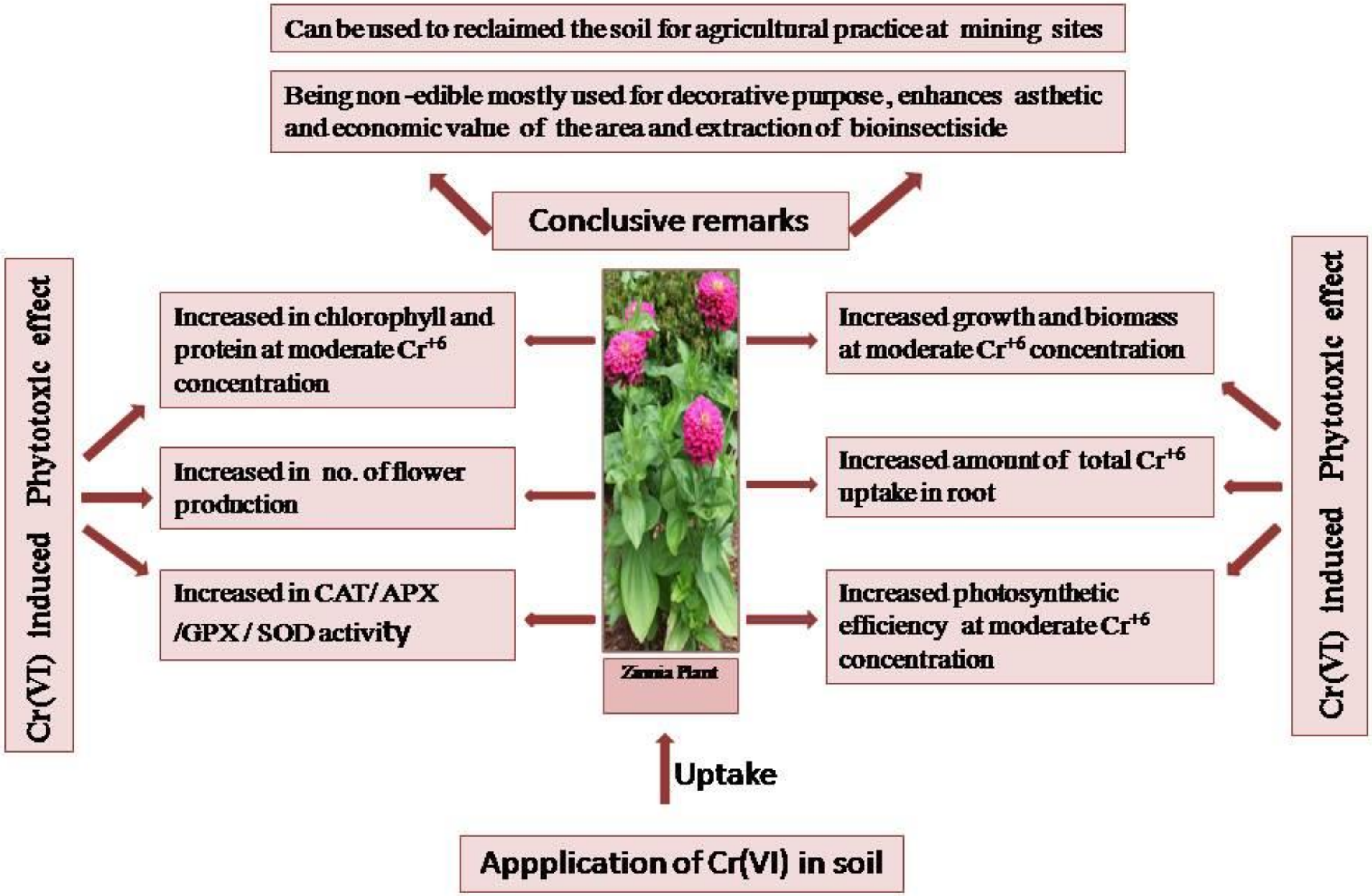
Map of India showing chromite mine area in the state of Odisha

Significance

- Plants are used to absorb and filter the minerals which have a deleterious effect on the environment.
- More cost-effective
- Use little energy
- Functions well at low concentration of metals
- Do not usually produce harmful emissions
- Reduce the pollution of metal-contaminant areas
- Successful commercial heavymetal-filtration processes include the extraction of chromium in our Department.



Can be used to reclaimed the soil for agricultural practice at mining sites
Being non -edible mostly used for decorative purpose, enhances asthetic and economic value of the area and extraction of bioinsectiside
Conclusive remarks
Cr(VI) Induced Phytotoxic effect
Increased in chlorophyll and protein at moderate Cr^{+6} concentration
Increased in no. of flower production
Increased in CAT/ APX /GPX / SOD activity
Zinnia Plant
Increased growth and biomass at moderate Cr^{+6} concentration
Increased amount of total Cr^{+6} uptake in root
Increased photosynthetic efficiency at moderate Cr^{+6} concentration
Cr(VI) Induced Phytotoxic effect
Uptake
Appplication of Cr(VI) in soil

What is Phytoremediation?

- Phytoremediation is a remediation process by the use of plants to remove, transfer, stabilize, and/or destroy contaminants in the soil.
- Phytoremediation is used for the remediation of metals,pesticides,explosives,fuels, volatile organ ic compounds(VOCs) & semi-volatile organic compounds (SVOCs)
- Research is underway to understand the role of phytoremediation to remediate perchlorate, a contaminant that has been shown to be persistent in surface and groundwater systems.

Types of Plant Selected for Phytoremediation

- While there are many ways to structure plant classification, one way is to group them into vascular and non-vascular plants, seed bearing and spore bearing, and **angiosperms and gymnosperms**. Plants can also be classified as grasses, herbaceous plants, woody shrubs, and trees.

The Concept of Phytoremediation

- Phytoremediation is a cost-effective, plant-based approach to remediation that takes advantage of the ability of plants to concentrate elements and compoundsfrom the environment & metabolize various molecules in their tissues.
- It refers to the natural ability of certain plants called hyperaccumulators to bioaccumulate, degrade, or render harmless contaminants in soil, water, or air. Toxic heavy metals and organic pollutants are the major targets for phytoremediation.

Phytosequestration

- Also referred to as phytostabilization, there are many different processes that fall under this category. They can involve absorption by roots, adsorption to the surface of roots, or the production of biochemicals by a plant that is released into the soil or groundwater in the immediate vicinity of the roots and can sequester, precipitate, or otherwise, immobilize nearby contaminants.

Rhizodegradation

- This process takes place in the soil or groundwater immediately surrounding the plant roots. Exudates (excretions) from plants stimulate rhizosphere bacteria to enhance biodegradation of soil contaminants.
- Plant-assisted bioremediation, sometimes referred to as a type of phytoremediation, involves the interaction of plant roots and the microorganisms associated with these root systems to remediate soils containing elevated concentrations of organic compounds.

Phytohydraulics

- Use of deep-rooted plants—usually trees—to contain, sequester, or degrade groundwater contaminants that come into contact with their roots. For example, poplar trees were used to contain a groundwater plume of methyl-tert-butyl-ether (MTBE).

Phytoextraction

- This term is also known as phytoaccumulation. Plants take up or hyper-accumulate contaminants through their roots and store them in the tissues of stems or leaves. The contaminants are not necessarily degraded but are removed from the environment when the plants are harvested.
- This is particularly useful for removing metals from soil. In some cases, the metals can be recovered for reuse by incinerating the plants in a process called phytomining.

Phytovolatilization

- Plants take up volatile compounds through their roots, and transpire the same compounds, or their metabolites, through the leaves, thereby releasing them into the atmosphere.

Phytodegradation

- Contaminants are taken up into the plant tissues where they are metabolized, or biotransformed. Where the transformation takes place depends on the type of plant and can occur in roots, stems, or leaves.

Heavy Metal Pollution

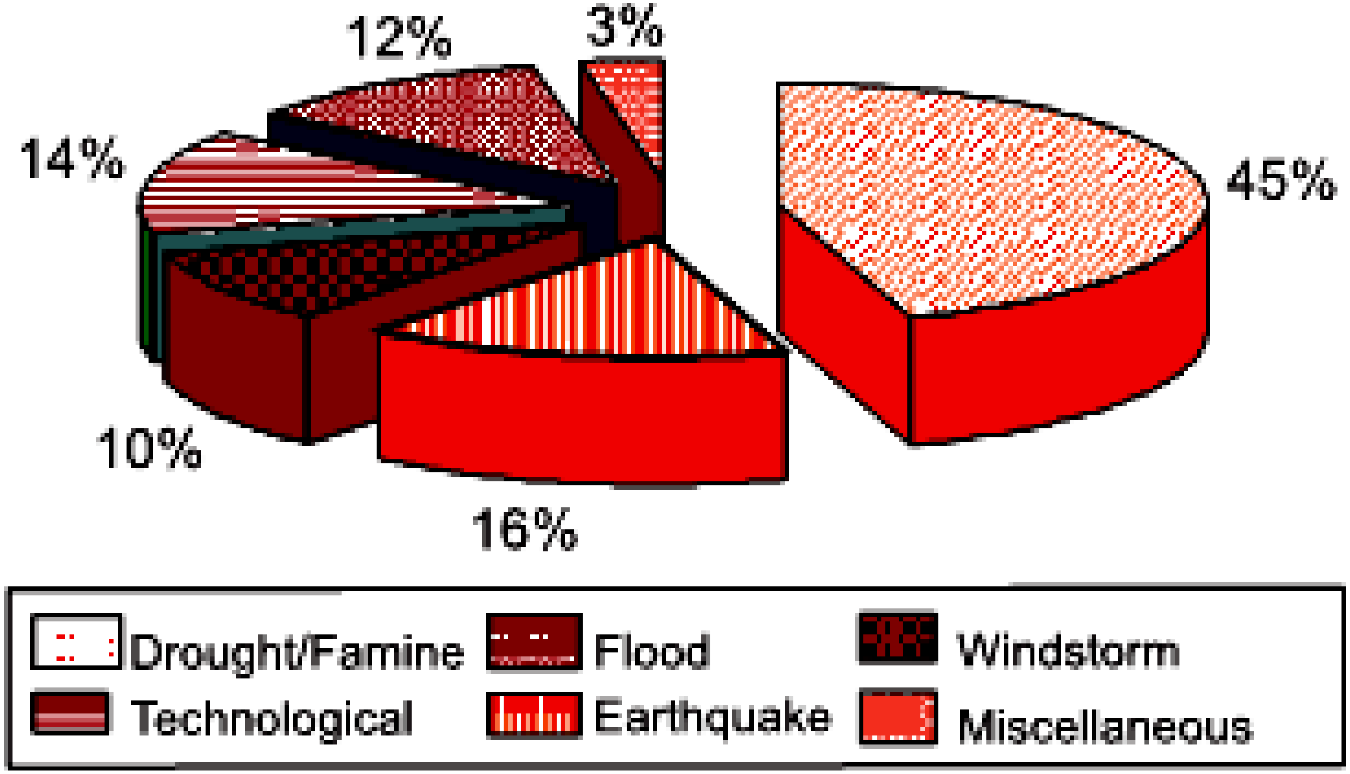
In the World Health Organisation's list of ten chemicals of major public concern. include manganese, chromium, cobalt, nickel, copper, zinc, selenium, silver, antimony and thallium.

Heavy metals can bind to vital cellular components such as structural proteins, enzymes, and nucleic acids, and interfere with their functioning".

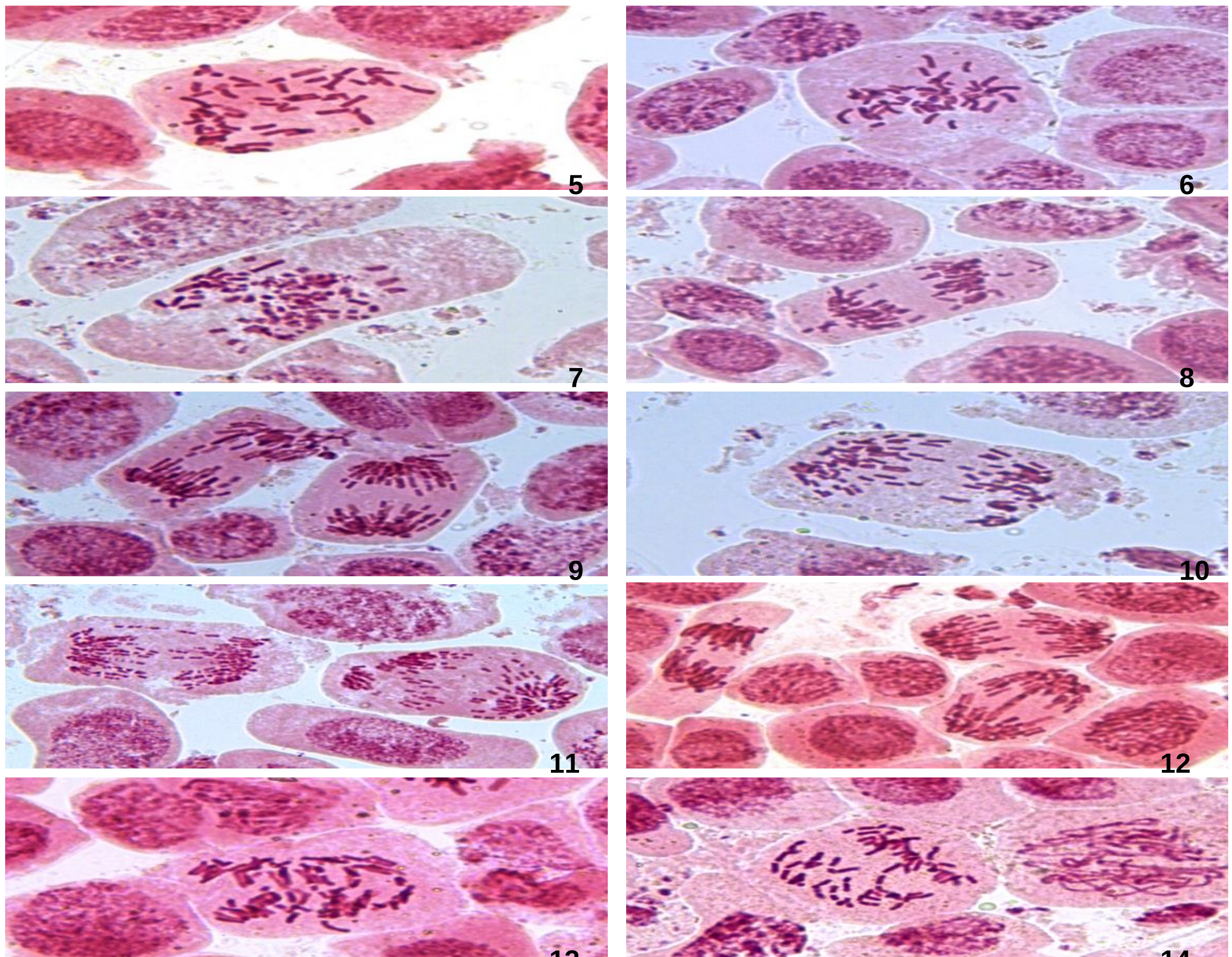
Environmental emergencies

- Technological accidents
- Industrial accidents,
- Usually involving leakage hazardous material and occur where these materials are produced, used or transported.
- Mining activities are generally included in this definition because they tend to be caused by humans

World Scenario: Reported Deaths from all Disasters



Effect of metal toxicity on cell



CONTROL OF TECHNOLOGICAL DISASTER

- Selection of plants depending on their accumulation efficiency in rhizospheric region.

- Selection of aquatic weeds and their phyto-accumulation potential.

Frontiers in Life Science, 2015
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Antimicrobial effect of silver zinc oxide (Ag-ZnO) nanocomposite particles

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Environ Monit Assess (2013) 185:4347–4359
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Physico-chemical assessment of paper mill effluent and its heavy metal remediation using aquatic macrophytes—a case study at JK Paper mill, Rayagada, India

Swayamprabha Mishra · Monalisa Mohanty · Chinmay Pradhan · Hemanta Kumar Patra · Ritarani Das · Santilata Sahoo

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BIOLIFE ORIGINAL ARTICLE

TOXICOLOGICAL CHANGES IN RICE UNDER NICKEL STRESS

Jyotirmay Mathan[1], Monalisa Mohanty[2], Chinmay Pradhan[3]*and Hemanta Kumar Patra[4]

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International Research Journal of Environment Sciences ISSN 2319–1414
Vol. **3(11)**, 20-28, November **(2014)** *Int. Res. J. Environment Sci.*

An *in vitro* hydroponic study on Physiological and Biochemical responses of Indian wild Rice to varying doses of Hexavalent Chromium

Nayak J., Mathan J., Mohanty M. and Pradhan C.*
Laboratory of Plant Biochemistry and Environmental Biotechnology, Post Graduate Department of Botany. Utkal University, Bhubaneswar-751004, Odisha, INDIA

Acta Biologica Hungarica 66(1), pp. 80–92 (2015)
DOI: 10.1556/ABiol.66.2015.1.7

CHROMIUM TRANSLOCATION, CONCENTRATION AND ITS PHYTOTOXIC IMPACTS IN *IN VIVO* GROWN SEEDLINGS OF *SESBANIA SESBAN* L. MERRILL.

MONALISA MOHANTY,[1]* CHINMAY PRADHAN[2] and HEMANTA KUMAR PATRA[1]

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 Cytologia **82**(2): 183–191

Silver Nitrate Mediated Oxidative Stress Induced Genotoxicity of *Allium cepa* L.

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ORIGINAL ARTICLE

Contribution of native phosphorous-solubilizing bacteria of acid soils on phosphorous acquisition in peanut (*Arachis hypogaea* L.)

Madhusmita Pradhan[1] · Ranjan Kumar Sahoo[2] · Chinmay Pradhan[3] · Narendra Tuteja[4] · Santanu Mohanty[5]

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Study on P solubilizing efficiencies of native PSB isolates from acid soils of Odisha

Madhusmita Pradhan, Shilpee Dhali, Priti Binita Lakra, Chinmay Pradhan and Santanu Mohanty

Cytologia **83**(2): 1–6

Ionic Stress Induced Cytotoxic Effect of Cadmium and Nickel Ions on Roots of *Allium cepa* L.

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Proteomic and genomic responses of plants to nutritional stress

Rout George Kerry, Gyana Prakash Mahapatra, Sushmita Patra, Santi Lata Sahoo, Chinmay Pradhan, Bijaya Kumar Padhi & Jyoti Ranjan Rout

BioMetals
An International Journal on the Role of Metal Ions in Biology, Biochemistry and Medicine

ISSN 0966-0844

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Springer

Journal of Applied Biology & Biotechnology Vol. 4 (05) pp. 014-025, Sep-Oct, 2016
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DOI: 10.7324/JABB.2016.40503

Physiological and biochemical characterization of *Sesamum* germplasms tolerant to NaCl

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American Journal of Plant Sciences, 2016, 7, 2399-2411
http://www.scirp.org/journal/ajps
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Agromorphological and Molecular Characterization of *Sesamum indicum* L.—An Oil Seed Crop

Tapaswini Hota[1], Chinmaya Pradhan[2], Gyana Ranjan Rout[2*]

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Original Research

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Assessment of air pollution tolerance index of some selected roadside plants of Bhubaneswar city of Odisha State in India

Authors Info

S. Acharya, R.C. Jena, S.J. Das, C. Pradhan and P.K. Chand*

Abstract

Aim : A periodic evaluation of air pollution tolerance index (APTI) of thirteen different plant species (including nine trees and four shrubs), distributed alongside the national highway (NH 5) passing through Bhubaneswar, Odisha, India was carried out aiming at proper selection of tolerant plants to be used as bio filters against harmful vehicular air pollutants.

International Journal of Science and Research (IJSR)
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Impact Factor (2018): 7.426

Biochemical and Toxicological Effects of Cadmium on *Phaseolus vulgaris* L.

Running title: Cadmium stress in *Phaseolus vulgaris* L.

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CHAPTER-2

Chromium Induced Toxicity on Physiological and Biochemical Parameters of Horse Gram [*Macrotyloma uniflorum* (L.) Verdc.] var. Madhu

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Environmental Science and Pollution Research
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RESEARCH ARTICLE

Biochemical, molecular, and elemental profiling of *Withania somnifera* L. with response to zinc stress

Jyoti Ranjan Rout[1,4] · Rout George Kerry[2] · Debasna Panigrahi[3] · Santi Lata Sahoo[4] · Chinmay Pradhan[4] · Shidharth Sankar Ram[5] · Anindita Chakraborty[5] · Mathummal Sudarshan[5]

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ORIGINAL RESEARCH ARTICLE

Cr^{+6}- induced growth, biochemical alterations and Chromium bioaccumulation in *Cassia tora* (L.) Roxb.

Priyanka Jena, Chinmay Pradhan and Hemanta Kumar Patra*
Laboratory of Environmental Biotechnology, Post-Graduate Department of Botany, Utkal University, Bhubaneswar-751004, Odisha, India

Jena et al., J Plant Physiol Pathol 2016, 4:3
DOI: 10.4172/2329-955X.1000153

Journal of Plant Physiology & Pathology

Research Article

a SciTechnol journal

Effects of Chelate-Assisted Chromium (Cr^{+6}) on Growth, and Chromium Bioaccumulation in Paragrass (*Brachiaria mutica* Forssk. Stapf)

Priyanka Jena, Chinmay Pradhan and Hemanta Kumar Patra*

sites as the conventional processes are complex, costly and sometimes damaging to soil organization [3].

Our previous investigations using Paragrass in the field condition at mining site of Odisha (India) was limited to bioconcentration of ionic chromium only (i.e., Cr^{+6}) which even does not provide detail information on growth physiology, associated toxicological parameters and chromium bioavailability in graminaceous plants in relation to application of ionic and chelate assisted Cr [6,7]. In this context, pot culture study with chromium amended soils was designed to analyze the phytotoxic effects of ionic Cr and chelate-assisted Cr on bioavailability in a graminaceous fodder plant i.e., paragrass

Chemosphere 193 (2018) 793–799

Contents lists available at ScienceDirect

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journal homepage: www.elsevier.com/locate/chemosphere

An in *situ* study of growth of Lemongrass *Cymbopogon flexuosus* (Nees ex Steud.) W. Watson on varying concentration of Chromium (Cr^{+6}) on soil and its bioaccumulation: Perspectives on phytoremediation potential and phytostabilisation of chromium toxicity

Deepak Kumar Patra, Chinmay Pradhan, Hemanta Kumar Patra*

Post Graduate Department of Botany, Utkal University, Bhubaneswar 751004, India

International Journal of Phytoremediation

ISSN: 1522-6514 (Print) 1549-7879 (Online) Journal homepage: https://www.tandfonline.com/loi/bijp20

Chelate based phytoremediation study for attenuation of chromium toxicity stress using lemongrass: *Cymbopogon flexuosus* (nees ex steud.) W. Watson

Deepak Kumar Patra, Chinmay Pradhan & Hemanta Kumar Patra

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Chemosphere

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Chromium bioaccumulation, oxidative stress metabolism and oil content in lemon grass *Cymbopogon flexuosus* (Nees ex Steud.) W. Watson grown in chromium rich over burden soil of Sukinda chromite mine, India

Deepak Kumar Patra, Chinmay Pradhan*, Hemanta Kumar Patra

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Assessment of chromium phytotoxicity, phytoremediation and tolerance potential of *Sesbania sesban* and *Brachiaria mutica* grown on chromite mine overburden dumps and garden soil

Deepak Kumar Patra [a], Chinmay Pradhan [a, *], Jagdish Kumar [b], Hemanta Kumar Patra [a]

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Environmental Science and Pollution Research
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RESEARCH ARTICLE

Alleviating Cr(VI) stress in horse gram (*Macrotyloma uniflorum* Var. Madhu) by native Cr-tolerant nodule endophytes isolated from contaminated site of Sukinda

Shilpee Dhali[1] · Madhusmita Pradhan[2] · Ranjan Kumar Sahoo[3] · Santanu Mohanty[4] · Chinmay Pradhan[1]

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AM fungi mediated bioaccumulation of hexavalent chromium in *Brachiaria mutica*-a mycorrhizal phytoremediation approach

Bandana Kullu [a, 1], Deepak Kumar Patra [b, 1], Srinivas Acharya [a], Chinmay Pradhan [a, *], Hemanta Kumar Patra [a]

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THANK
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