Chromium

Title	**Chromium(VI) Toxicity in Legume Plants: Modulation Effects of Rhizobial Symbiosis**
Author Name	Uliana Ya Stambulska, Maria M. Bayliak, and Volodymyr I. Lushchak
Journal Name	BioMed Research International
Year	2018
Volume and Issue	Volume 2018, Article ID 8031213
Pages	13 pages
Abstracts	Most legume species have the ability to establish a symbiotic relationship with soil nitrogen-fixing rhizobacteria that promote plant growth and productivity. There is an increasing evidence of reactive oxygen species (ROS) important role in formation of legume-rhizobium symbiosis and nodule functioning. Environmental pollutants such as chromium compounds can cause damage to rhizobia, legumes, and their symbiosis. In plants, toxic effects of chromium(VI) compounds are associated with the increased production of ROS and oxidative stress development as well as with inhibition of pigment synthesis and modification of virtually all cellular components. These metabolic changes result in inhibition of seed germination and seedling development as well as reduction of plant biomass and crop yield. However, if plants establish symbiosis with rhizobia, heavy metals are accumulated preferentially in nodules decreasing the toxicity of metals to the host plant. This review summarizes data on toxic effects of chromium on legume plants and legume-rhizobium symbiosis. In addition, we discussed the role of oxidative stress in both chromium toxicity and formation of rhizobial symbiosis and use of nodule bacteria for minimizing toxic effects of chromium on plants.
Keywords	chromium, environmental pollutants, legume, rhizobia, heavy metals

Title	**Chromium tolerance, bioaccumulation and localization in plants: An overview**
Author Name	Vibha Sinha, Kannan Pakshirajan, Rakhi Chaturvedi
Journal Name	Journal of Environmental Management
Year	2018
Volume and Issue	Volume 206
Pages	715-730
Abstracts	In the current industrial scenario, chromium (Cr) as a metal is of great importance, but poses a major threat to the environment. Phytoremediation provides an environmentally sustainable, ecofriendly, cost effective approach for environmental cleanup of Cr. This review presents the current status of phytoremediation research with particular emphasis on cleanup of Cr contaminated soil and water systems. It gives a detailed account of the work done by different authors on the Cr bioavailability, uptake pathway, toxicity and storage in plants following the phytoextraction mechanism. This paper also describes recent findings related to Cr localization in hyperaccumulator plants. It gives an insight into the processes and mechanisms that allow plants to remove Cr from contaminated sites under varying conditions. These detailed knowledge of changes in plant metabolic pool in response to Cr stress would immensely help understand and improve the phytoextraction process. Further, this review provides a detailed understanding of Cr uptake and detoxification mechanism by plants that can be applied in developing a suitable approach for a better applicability of the process.
Keywords	Cr, Phytoremediation, Hyperaccumulator, Metal stress, Uptake mechanism

Title	**Biomonitoring chromium III or VI soluble pollution by moss chlorophyll fluorescence**
Author Name	Yang-ErChena, Hao-Tian Mao, Jie Ma, Nan Wu, Chao-Ming Zhang, Yan-Qiu Su, Zhong-Wei Zhang, Ming Yuan, Huai-Yu Zhang, Xian-Yin Zeng, ShuYuan
Journal Name	Chemosphere
Year	2018
Volume and Issue	Volume 194
Pages	220-228
Abstracts	We systematically compared the impacts of four Cr salts (chromic chloride, chromic nitrate, potassium chromate and potassium bichromate) on physiological parameters and chlorophyll fluorescence in indigenous moss Taxiphyllum taxirameum. Among the four Cr salts, K2Cr2O7 treatment resulted in the most significant decrease in photosynthetic efficiency and antioxidant enzymes, increase in reactive oxygen species (ROS), and obvious cell death. Different form the higher plants, although hexavalent Cr(VI) salt treatments resulted in higher accumulation levels of Cr and were more toxic than Cr(III) salts, Cr(III) also induced significant changes in moss physiological parameters and chlorophyll fluorescence. Our results showed that Cr(III) and Cr(VI) could be monitored distinguishably according to the non-photochemical quenching (NPQ) fluorescence of sporadic purple and sporadic lavender images respectively. Then, the valence states and concentrations of Cr contaminations could be evaluated according to the image of maximum efficiency of PSII photochemistry (Fv/Fm) and the quantum yield of PSII electron transport (ΦPSII). Therefore, this study provides new ideas of moss's sensibility to Cr(III) and a new method to monitor Chromium contaminations rapidly and non-invasively in water.
Keywords	Chromium, Antioxidants, Chlorophyll fluorescence, Moss, Oxidative stress

Title	**Removal of Chromium from Soils Cultivated with Maize (*Zea Mays*) After the Addition of Natural Minerals as Soil Amendments**
Author Name	**A**. Molla, Z. Ioannou, S. Mollas, E. Skoufogianni & A. Dimirkou
Journal Name	Bulletin of Environmental Contamination and Toxicology
Year	2017
Volume and Issue	98, Issue 3
Pages	347-352
Abstracts	The efficiency of natural minerals, i.e. zeolite, bentonite and goethite, regarding the retention of chromium, from maize was examined. Specifically, 1.0 kg of soil, 1.0 g of soil amendment and either 50 mg L^{-1} Cr(III) or 1 mg L^{-1} Cr(VI) were added in plant pots. Then, seeds of maize were cultivated. Each treatment was repeated three times. The statistical results of the experiments were analyzed by LSD test. Cr(III) addition in soil has shown that zeolite was the only amendment that increased the dry weight. Zeolite and bentonite reduced significantly the total chromium in plants after the addition of 50 mg L^{-1} Cr(III). The addition of Cr(VI) in soil has shown that bentonite was the only amendment that increased the dry weight of biomass and the plants' height. All soil amendments reduced to zero the total chromium concentration measured to plants after the addition of 1 mg L^{-1} Cr(VI).
Keywords	Zeolite, Bentonite, Goethite, Maize, Soil amendments

Title	**Isolation of indigenous *Staphylococcus sciuri* from chromium-contaminated paddy field and its application for reduction of Cr(VI) in rice plants cultivated in pots**
Author Name	Avishek Dutta, Sayanti Ghosh, Jayanta D. Choudhury, Riddhi Mahansaria, Malancha Roy, Asish Kumar Ghosh, Tarit Roychowdhury & Joydeep Mukherjee
Journal Name	Bioremediation Journal
Year	2017
Volume and Issue	21, Issue1
Pages	30-37
Abstracts	Accumulation of Cr(VI) in rice seeds cultivated in Cr-contaminated soil of the Sundarbans (India) is an environmental problem. Cr(VI) concentration in this soil was 6.2 ± 0.3 mg/kg, whereas total chromium was 32.04 ± 1.60 mg/kg. A Cr(VI)-removing bacterium isolated from Cr-contaminated paddy field soil of Sundarbans was identified as*Staphylococcus sciuri*. Enrichment culture of *S. sciuri* was applied to pot cultivation of rice in Cr-contaminated soil. After 8 weeks, 71 ± 3% Cr(VI) (final concentration 2.15 ± 0.01 mg/kg) and 65 ± 2% total Cr removal (end concentration 11.3 ± 0.5 mg/kg) were attained in bacterium-treated soils. Growth parameters indicated healthy development of plants cultivated in bacterium-treated soils that was not observed in control plants. Total Cr removal attained in rice seeds of plants cultivated in bacterium-treated soils compared with control rice seeds was 78 ± 4%. Total Cr concentration in test seeds was 0.72 ± 0.05 mg/kg (World Health Organization [WHO] permissible limit: 1.30 mg/kg), whereas the same in control seeds was 3.27 ± 0.16 mg/kg. Cr(VI) reduction achieved in rice seeds cultivated in bacterium-treated soil compared with control rice seeds was 95 ± 5%. Cr(VI) concentration in rice seeds cultivated in treated soil was 0.050 ± 0.003 mg/kg, whereas the same in untreated control was 0.93 ± 0.05 mg/kg. Successful paddy field soil bioremediation by any *Staphylococcus* species was demonstrated for the first time.
Keywords	Agriculture, biotransformation, 16SrRNA, Sundarbans, tannery

Title	**Synergistic effect of chickpea plants and Mesorhizobium as a natural system for chromium phytoremediation**
Author Name	Pilar A. Velez, Melina A. Talano,Cintia E. Paisio, Elizabeth Agostini & Paola S. González
Journal Name	Environmental Technology
Year	2017
Volume and Issue	38, Issue17
Pages	2164-2172
Abstracts	The presence of chromium in soils not only affects the physiological processes of plants but also the microbial rhizosphere composition and metabolic activities of microorganisms. Hence, the inoculation of plants with Cr(VI)-tolerant rhizospheric microorganisms as an alternative to reduce Cr phytotoxicity was studied. In this work, chickpea germination was reduced by Cr(VI) concentrations of 150 and 250 mg/L (6 and 33%, respectively); however lower Cr(VI) concentrations negatively affected the biomass. On the other hand, its symbiont, *Mesorhizobium ciceri*, was able to grow and remove different Cr(VI) concentrations (5–20 mg/L). The inoculation of chickpea plants with this strain exposed to Cr(VI) showed a significantly enhanced plant growth. In addition, inoculated plants accumulated higher Cr concentration in roots than those noninoculated. It is important to note that Cr was not translocated to shoots independently of inoculation. These results suggest that *Mesorhizobium*'s capability to remove Cr(VI) could be exploited for bioremediation. Moreover, chickpea plants would represent a natural system for phytoremediation or phytostabilization of Cr *in situ* that could be improved with *M. ciceri* inoculation. This strategy would be considered as a phytoremediation tool with great economic and ecological relevance.
Keywords	Chromium, chickpea, phytoremediation, microsieve, Mesorhizobium, interaction

Title	**Chromium Accumulation in Medicinal Plants Growing Naturally on Tannery Contaminated and Non-contaminated Soils**
Author Name	S. Jaison,T. Muthukumar
Journal Name	Biological Trace Element Research
Year	2017
Volume and Issue	175, Issue1
Pages	223-235
Abstracts	Herbal preparations used to treat human ailments globally can be contaminated with various heavy metals (HMs) originating from the raw materials or from the manufacturing processes. Therefore, we assessed 22 medicinal plants growing naturally on tannery pollutant contaminated (Site-C) and non-contaminated (Site-NC) sites for their ability to accumulate chromium (Cr). The Cr contents in soil and various plant parts were estimated using an atomic absorption spectrophotometer. Translocation and bioconcentration factors were calculated. The soil at Site-C had 27-fold higher concentration of total Cr than at Site-NC. Chromium accumulation is reported for the first time in 50 % of the medicinal plants examined and varied significantly among the sites. Shoots of Ricinus communis andAmaranthus viridis had maximum concentrations of Cr at Site-C, whereas in Site-NC, none of the plants had Cr accumulation >30 ppm. Ricinus communis, Amaranthus viridis, andAmaranthus spinosus had translocation factor (TF) greater than the one in the Site-C andLantana camara had TF >1 in Site-NC. The bioconcentration factor (BCF) was >1 only forRicinus communis at both the sites. The majority of the medicinal plants at Site-NC had Cr content exceeding the permissible limit of 2 ppm suggested for herbal raw material. The results of the study clearly emphasize the need for screening plants of therapeutic value for the presence of HMs even when collected from non-contaminated soils. Moreover, proportional allocation of Cr in different plant parts provided an insight on the safety of these parts when specifically used in herbal preparations.
Keywords	Bioconcentration factor, Heavy metal, Herbal raw material, Potential risk, Traditional medicine, Translocation factor

Title	**Phyto-Toxicity of Chromium in Maize: Oxidative Damage, Osmolyte Accumulation, Anti-Oxidative Defense and Chromium Uptake**
Author Name	Shakeel Ahmad Anjum, Umair Ashraf, Imran Khan,Mohsin Tanveer, Muhammad Shahid, Abdul Shakoor, Longchang Wang
Journal Name	Pedosphere
Year	2017
Volume and Issue	27, Issue2
Pages	262-273
Abstracts	Agricultural production systems are immensely exposed to different environmental stresses in which heavy metal stress receives serious concerns. This study was conducted to explore the deleterious effects of different chromium (Cr) stress levels,i.e., 0, 30, 60, 90, 120, and 150 μmol L−1, on two maize genotypes, Wandan 13 and Runnong 35. Both genotypes were evaluated by measuring their growth and yield characteristics, Cr accumulation in different plant tissues, alterations in osmolyte accumulation, generation of reactive oxygen species (ROS), and anti-oxidative enzyme activity to scavenge ROS. The results showed that Cr stress decreased the leaf area, cob formation, 100-grain weight, shoot fresh biomass, and yield formation, while Cr accumulation in different maize tissues was found in the order of roots > leaves > stem > seeds in both genotypes. The increased Cr toxicity resulted in higher free proline, soluble sugars and total phenolic contents, and lower soluble protein contents. However, enhanced lipid peroxidation was noticed in the forms of malondialdehyde, hydrogen peroxide (H2O2) and thiobarbituric acid reactive substance accumulation, and electrolyte leakage. The hyperactivity of superoxide dismutase, peroxidase, catalase, ascorbate peroxidase, especially glutathione peroxidase and glutathione reductase indicated that these anti-oxidative enzymes had a central role in protecting maize from Cr toxicity, especially for Wandan 13. Moreover, higher uptake and less translocation of Cr contents into the grains of Wandan 13 implied its importance as a potential candidate against soil Cr pollution.
Keywords	agronomic characteristics, anti-oxidative enzyme activity,Cr accumulation,Cr translocation, heavy metal stress, reactive oxygen species