Nickel

Title	**Nitric oxide induces rice tolerance to excessive nickel by regulating nickel uptake, reactive oxygen species detoxification and defence-related gene expression**
Author Name	Muhammad Rizwan, Mohammad Golam Mostofa , Muhammad Zulfiqar Ahmad, Muhammad Imtiaz, Sajid Mehmood, Muhammad Adeel, Zhihua Dai, Zheyong Li, Omar Aziz, Yihui Zhang, Shuxin Tu
Journal Name	Chemosphere
Year	2018
Volume and Issue	Volume 191, January 2018
Pages	23-35
Abstracts	Soil contamination with nickel (Ni) is a persistent threat to crop production worldwide. The present study examined the putative roles of nitric oxide (NO) in improving Ni-tolerance in rice. Our findings showed that application of exogenous sodium nitroprusside (SNP), a NO donor, significantly improved the growth performance of rice seedlings when grown under excessive Ni. The enhanced Ni-tolerance of rice prompted by SNP could be ascribed to its ability to regulate Ni uptake, decrease Ni-induced oxidative stress as evidenced by reduced levels of hydrogen peroxide, malondialdehyde, and electrolyte leakage in Ni-stressed plants. The positive roles of NO against Ni-toxicity also reflected through its protective effects on photosynthetic pigments, soluble proteins and proline. SNP also boosted antioxidant capacity in Ni-stressed plants by maintaining increased levels of ascorbate, enhanced activities of ROS-detoxifying enzymes, particularly peroxidase (POD) and catalase (CAT) in both roots and shoots compared with Ni-stressed alone plants. Moreover, SNP treatment also upregulated the transcript levels of CAT, POD, ascorbate peroxidase, glutathione reductase and superoxide dismutase genes in shoots under Ni-stress. Using different sulfide compounds and NO scavenger cPTIO, we also provided evidence that NO, rather than other byproducts of SNP, contributed to the improved performance of rice seedlings under Ni-stress. Collectively, our results conclude that exogenous SNP-mediated modulation of endogenous NO enhanced rice tolerance to Ni–stress by restricting Ni accumulation, maintaining photosynthetic performance and reducing oxidative damage through improved antioxidant system, thereby suggesting NO as an effective stress regulator in mitigating Ni-toxicity in economically important rice, and perhaps in other crop plants.
Keywords	Antioxidant system, Gene expression, Nickel stress, Nitric oxide Oxidative stress, Rice

Title	**Nickel biopathways in tropical nickel hyperaccumulating trees from Sabah**
Author Name	Antony Van Der Ent, Damien L.Callahan, Barry N. Noller, Jolanta Mesjasz-Przybylowicz, Wojciech J. Przybylowicz, Alban Barnabas & Hugh H. Harris
Journal Name	Scientific Reports
Year	2017
Volume and Issue	7:41861
Pages	1-21
Abstracts	The extraordinary level of accumulation of nickel (Ni) in hyperaccumulator plants is a consequence of specific metal sequestering and transport mechanisms, and knowledge of these processes is critical for advancing an understanding of transition element metabolic regulation in these plants. The Ni biopathways were elucidated in three plant species, *Phyllanthus balgooyi*, *Phyllanthus securinegioides* (Phyllanthaceae) and *Rinorea bengalensis* (Violaceae), that occur in Sabah (Malaysia) on the Island of Borneo. This study showed that Ni is mainly concentrated in the phloem in roots and stems (up to 16.9% Ni in phloem sap in *Phyllanthus balgooyi*) in all three species. However, the species differ in their leaves – in *P. balgooyi* the highest Ni concentration is in the phloem, but in *P. securinegioides* and *R. bengalensis* in the epidermis and in the spongy mesophyll (*R. bengalensis*). The chemical speciation of Ni2+ does not substantially differ between the species or between the plant tissues and transport fluids, and is unambiguously associated with citrate. This study combines ion microbeam (PIXE and RBS) and metabolomics techniques (GC-MS, LC-MS) with synchrotron methods (XAS) to overcome the drawbacks of the individual techniques to quantitatively determine Ni distribution and Ni2+ chemical speciation in hyperaccumulator plants.
Keywords	Hyperaccumulator , Biopathways, metabolomics techniques

Title	**Nickel bioaccumulation by the chosen plant species**
Author Name	Jacek Antonkiewicz, Czesława Jasiewicz, Małgorzata Koncewicz-Baran & Renata Sendor
Journal Name	Acta Physiol Plant
Year	2016
Volume and Issue	
Pages	38:40
Abstracts	Concentrations of ground-level ozone ([O3]) over much of the Earth's The investigations aimed at the evaluation of nickel bioaccumulation ability of plants from various families (Poaceae—maize, Fabaceae—field bean and Asteraceae—lettuce). The research was conducted under hydroponic conditions. The experimental design comprised ten objects differing with nickel concentrations in the solution (ranging from 0.0 to 10.0 mg Ni dm−3 of the nutrient solution). The parameters, assumed as the basis on which nickel bioretention by selected plant species was determined were: the yield, nickel content in various plant parts, uptake and utilization of this element by the plant, tolerance index (TI) and translocation factor (TF), the metal concentrations in the aboveground parts index (CI) and bioacummulation factor (BAF). On the basis of the obtained results it was found that, due to low tolerance of nickel, maize could be used as the indicator plant for the environment quality assessment.
Keywords	Bioaccumulation, Hydroponic, Heavy metals

Title	**Evaluation of nickel tolerance in *Amaranthus paniculatus* L. plants by measuring photosynthesis, oxidative status, antioxidative response and metal - binding molecule content**
Author Name	Fabrizio Pietrini, Valentina Iori, Alexandra Cheremisina, Nina I. Shevyakova, Nataliya Radyukina, Vladimir V. Kuznetsov, Massimo Zacchini
Journal Name	Environmental Science and Pollution Research
Year	2015
Volume and Issue	22, Issue 1
Pages	482-494
Abstracts	Among metals, Ni has been indicated as one of the most dangerous for the environment, and plants exposed to this metal are frequently reported to undergo a severe stress condition. In this work, the tolerance responses to different Ni concentrations at physiological and biochemical levels were evaluated in *Amaranthus paniculatus* L., a plant species previously characterised for their ability to phytoremove Ni from metal-spiked water. Results indicated a good metal tolerance of this plant species at environmentally relevant Ni concentrations, while clear symptoms of oxidative damages were detected at higher Ni concentrations, both in roots and leaves, by measuring lipid peroxide content. At the photosynthetic level, pigment content determination, chlorophyll fluorescence image analysis and gas-exchange parameter measurements revealed a progressive impairment of the photosynthetic machinery at increasing Ni concentrations in the solution. Regarding biochemical mechanisms involved in antioxidative defence and metal binding, antioxidative enzyme (ascorbate peroxidase, APX; catalase, CAT; guaiacol peroxidase, GPX; superoxide dismutase, SOD) activity, polyamine (PA) content, polyamine oxidase (PAO) activity and organic acid (OA) content were differently affected by Ni concentration in the growth solution. A role for GPX, SOD, PAs, and oxalic and citric acid in Ni detoxification is suggested. These results can contribute to elucidate the tolerance mechanisms carried out by plants when facing environmentally relevant Ni concentrations and to identify some traits characterising the physiological and biochemical responses of Amaranthus plants to the presence and bioaccumulation of Ni.
Keywords	Photosynthetic, Amaranthus, bioaccumulation , chlorophyll fluorescence

Title	**Photosynthetic response and proline bioaccumulation in black gram induced by Nickel stress**
Author Name	Das S, Samantaray S, Mohanty RC, Mohanty M, Pradhan C
Journal Name	The International Daily journal
Year	2015
Volume and Issue	27 : 97
Pages	36-42
Abstracts	The present study assesses the impact of varying treatment concentrations of nickel (Ni) on photosynthetic responses and stress induced praline accumulation in a leguminous plant i.e. black gram [*Vigna mungo* (L.) Hepper] cultivars (PU31C and Shekhar1C). After exposure to different concentrations of toxic Ni2+, the two cultivars of *V. mungo* i.e. PU31C and Shekhar1C showed significant changes in their photosynthetic response. Sekhar1C variety showed high chlorophyll content in seedlings treated with toxic Ni (200μM) when compared to Control and other variety. PU31C variety showed four times more Chlorophyll content than seedlings of control treatment. The present hydroponic study exhibited stimulatory effects of nickel on total chlorophyll content, carotenoid and increased proline level after two weeks exposure period. Present preliminary study indicates the tolerance nature of two green gram cultivars to toxic doses of Ni+2.
Keywords	Nickel, Chlorophyll, Proline, Hydroponics

Title	**Estimation of plant growth promoting potential of a nickel accumulating isolate obtained from Dhapa industrial wasteland (Kolkata, India) soil on Indian yellow mustard (*Brassica hirta*)**
Author Name	Santanu Maitra and Pranab Kumar Banerjee
Journal Name	Int.J.Curr.Microbiol.App.Sci
Year	2015
Volume and Issue	4 : 1
Pages	765-772
Abstracts	Plant growth promoting bacteria (PGPB) are known to influence plant growth by various direct or indirect mechanisms. Present study was conducted with an aim to estimate the PGP potential of one nickel tolerant bacterial isolate from Dhapa industrial wasteland, Kolkata, India. Isolate I (Gram negative *coccobacilli*) was observed to tolerate and accumulate significant amounts of nickel and also have multiple Plant Growth Promoting (PGP) activities like IAA production and phosphate solubilization. Present study also shows that seeds of yellow mustard (*Brassica hirta*) inoculated with the test isolate individually, significantly enhanced root and shoot growth and also protected the plant from the various phytotoxic effects of nickel.
Keywords	Nickel, Accumulation, IAA Production, Phosphate Solubilization, Brassica hirta Bioremediation