Nanoparticles

Title	**Zinc oxide nanoparticles alter the wheat physiological response and reduce the cadmium uptake by plants**
Author Name	Afzal Hussain, Shafaqat Ali, Muhammad Rizwan, Muhammad Zia ur Rehman, Muhammad Rizwan Javed, Muhammad Imran, Shahzad Ali Shahid Chatha& Rashid Nazir
Journal Name	Environmental Pollution
Year	2018
Volume and Issue	242, Part B
Pages	1518-1526
Abstracts	An experiment was performed to explore the interactive impacts of zinc oxide nanoparticles (ZnO NPs) and cadmium (Cd) on growth, yield, antioxidant enzymes, Cd and zinc (Zn) concentrations in wheat (Triticumaestivum). The ZnO NPs were applied both in Cd-contaminated soil and foliar spray (in separate studies) on wheat at different intervals and plants were harvested after physiological maturity. Results depicted that ZnO NPs enhanced the growth, photosynthesis, and grain yield, whereas Cd and Zn concentrations decreased and increased respectively in wheat shoots, roots and grains. The Cd concentrations in the grains were decreased by 30–77%, and 16–78% with foliar and soil application of NPs as compared to the control, respectively. The ZnO NPs reduced the electrolyte leakage while increased SOD and POD activities in leaves of wheat. It can be concluded that ZnO NPs (levels used in the study) could effectively reduce the toxicity and concentration of Cd in wheat whereas increase the Zn concentration in wheat. Thus, ZnO NPs might be helpful in decreasing Cd and increasing Zn biofortification in cereals which might be effective to reduce the hidden hunger in humans owing the deficiency of Zn in cereals.
Keywords	Zinc biofortification; Cadmium; Antioxidants; Wheat; Grain yield

Title	**Iron Oxide Nanoparticles as Nano-adsorbents: A Possible Way to Reduce Arsenic Phytotoxicity in Indian Mustard Plant (Brassica juncea L.)**
Author Name	Afsana Praveen, Ehasanullah Khan, Serena Ngiimei D, Mohammad Perwez, Meryam Sardar & Meetu Gupta
Journal Name	Journal of Plant Growth Regulation
Year	2018
Volume and Issue	37, 2
Pages	612–624
Abstracts	Application of nanoparticles (NPs) is very effective in reducing metal toxicity. The present study was designed to determine the effectiveness of iron oxide nanoparticles (Fe_3O_4 NP) in reducing the toxicity of arsenic in Indian mustard (Brassica juncea var. PusaJagannath) plant. Fourteen-day-old mustard plants were subjected to 150 µM As(III), Fe_3O_4 NPs (500 mg L^{-1} Fe_3O_4), 500 mg L^{-1} $FeSO_4$ or As(Ш) + Fe_3O_4 NPs (150 µM + 500 mg L^{-1}) stress for a period of 96 h. Significant toxicity was observed in seed germination indicators, and root–shoot length under arsenic (As) stress, but application of Fe_3O_4 NPs along with As improved the overall growth of plant. Results demonstrated increased photosynthetic pigment and protein content under Fe_3O_4 NP augmentation as compared to As-alone treatment. Antioxidative enzymes such as SOD, CAT, APX and stress-related parameters (cysteine and proline) showed varied results under different treatments. However, decreased stress-related parameters might be due to restricted entry of As inside the plant in the presence of Fe_3O_4 NP, and hence detoxification machinery is not required. The ameliorating effect of Fe_3O_4 NPs in combination with As was confirmed by reduced MDA and H_2O_2 content. Further, the addition of Fe_3O_4 NPs along with As altered sulphur-related gene transcripts. Overall, this study suggests the possible involvement of Fe_3O_4 NPs as nano-adsorbents in reducing As toxicity in the plant through its size variation and increase/decrease of various study parameters.
Keywords	Arsenic; Iron oxide nanoparticles; Toxicity; Oxidative stress; Brassica juncea

Title	**Magnetic (Fe_3O_4) Nanoparticles Reduce Heavy Metals Uptake and Mitigate Their Toxicity in Wheat Seedling**
Author Name	AlexandreKonate, Xiao He, Zhiyong Zhang, Yuhui Ma, Peng Zhang, Gibson Maswayi Alugongo & Yukui Rui
Journal Name	Sustainability
Year	2017
Volume and Issue	9, 5
Abstracts	Heavy metal pollution is not only a hazard to living organisms but also an important worldwide environmental concern. Experiments were performed to investigate the physiological mechanisms of magnetic (Fe_3O_4) nanoparticles (nano-Fe_3O_4) mitigation of the toxicity of heavy metals (Pb, Zn, Cd and Cu) in wheat seedlings. All the Petri dishes with germinating seedlings (1d) were covered, sealed with parafilm, and placed in a dark growth chamber. All parameters (seedling growth inhibition, heavy metal accumulation, enzymatic activities, and reducing effects of nano-Fe_3O_4 on heavy metal toxicity) were analyzed only after five days. The results showed that the tested heavy metals significantly affected the growth of wheat seedling by decreasing root length, shoot length and even death at 10 mM concentration in the case of Cd and Cu. Heavy metals exposure also showed that superoxide dismutase (SOD) and peroxidases (POD) activities decreased significantly when the malondialdehyde (MDA) content was significantly higher in wheat seedlings. Addition of magnetic (Fe_3O_4) nanoparticles (2000 mg/L) in each heavy metal solution (1 mM) significantly decreased the growth inhibition and activated protective mechanisms to reduce oxidative stress induced by heavy metals in the wheat seedlings. The reducing effects of nano-Fe_3O_4 against heavy metals stress could be dependent on the increase in the enzyme activity (SOD and POD). Their protective role was confirmed by the decrease in MDA content. The alleviating effect of nano-Fe_3O_4 is associated with their adsorption capacity of heavy metals.
Keywords	alleviation; heavy metals; magnetic (Fe_3O_4) nanoparticles; inhibition; oxidative stress; wheat

Title	**Effect of metal and metal oxide nanoparticles on growth and physiology of globally important food crops: A critical review**
Author Name	Muhammad Rizwan, Shafaqat Ali, Muhammad Farooq Qayyum, Yong Sik Ok, Muhammad Adrees, Muhammad Ibrahim, Muhammad Zia-ur-Rehman, Mujahid Farid, Farhat Abbasa
Journal Name	Journal of Hazardous Materials
Year	2017
Pages	2-16
Volume and Issue	322
Abstracts	The concentrations of engineered metal and metal oxide nanoparticles (NPs) have increased in the environment due to increasing demand of NPs based products. This is causing a major concern for sustainable agriculture. This review presents the effects of NPs on agricultural crops at biochemical, physiological and molecular levels. Numerous studies showed that metal and metal oxide NPs affected the growth, yield and quality of important agricultural crops. The NPs altered mineral nutrition, photosynthesis and caused oxidative stress and induced genotoxicity in crops. The activities of antioxidant enzymes increased at low NPs toxicity while decreased at higher NPs toxicity in crops. Due to exposure of crop plants to NPs, the concentration of NPs increased in different plant parts including fruits and grains which could transfer to the food chain and pose a threat to human health. In conclusion, most of the NPs have both positive and negative effects on crops at physiological, morphological, biochemical and molecular levels. The effects of NPs on crop plants vary greatly with plant species, growth stages, growth conditions, method, dose, and duration of NPs exposure along with other factors. Further research orientation is also discussed in this review article.
Keywords	Crop plants; Genotoxicity; Metals toxicity; Plant biochemistry

Title	**Effect of copper oxide nanoparticles on growth, morphology, photosynthesis, and antioxidant response in Oryzasativa**
Author Name	M. V. J. Da Costa & P. K. Sharma
Journal Name	Photosynthetica
Year	2016
Volume and Issue	54, 1
Pages	110–119
Abstracts	The physiological and biochemical behaviour of rice (Oryzasativa, var. Jyoti) treated with copper (II) oxide nanoparticles (CuO NPs) was studied. Germination rate, root and shoot length, and biomass decreased, while uptake of Cu in the roots and shoots increased at high concentrations of CuO NPs. The accumulation of CuO NPs was observed in the cells, especially, in the chloroplasts, and was accompanied by a lower number of thylakoids per granum. Photosynthetic rate, transpiration rate, stomatal conductance, maximal quantum yield of PSII photochemistry, and photosynthetic pigment contents declined, with a complete loss of PSII photochemical quenching at 1,000 mg(CuO NP) L^{-1}. Oxidative and osmotic stress was evidenced by increased malondialdehyde and proline contents. Elevated expression of ascorbate peroxidase and superoxide dismutase was also observed. Our work clearly demonstrated the toxic effect of Cu accumulation in roots and shoots that resulted in loss of photosynthesis.
Keywords	ascorbate; nanoparticle; proline; superoxide dismutase; thylakoid