Zinc

Title	**Effects of zinc fertilizer amendments on yield and grain zinc concentration under controlled environment conditions**
Author Name	Sarah Anderson, Jeff Schoenau & Albert Vandenberg
Journal Name	Journal of Plant Nutrition
Year	2018
Volume and Issue	Volume 41, Issue 14
Pages	1842-1850
Abstracts	The application of zinc (Zn) fertilizer to lentil is an agronomic strategy that has the potential to improve yield and enhance grain Zn concentration. A pot study was conducted to determine if Zn fertilizer applied to three popular Saskatchewan lentil cultivars could increase yield and concentration of Zn in the grain. The effects of soil and foliar applied Zn forms, including ZnSO4, Zn chelated with EDTA, Zn *lignosulphonate*, and a control were evaluated. Forms of Zn were not found to significantly increase yield (P D 0.828) or grain Zn concentration (P D 0.708) in any of the lentil cultivars tested. Fertilization with soil applied ZnSO4 resulted in significantly (P < 0.0001) higher amounts of residual available Zn in the soil relative to other Zn treatments. Soil fertilized with ZnSO4 had 1.13 mg kgi1 *diethylenetriaminepentaacetic* acid (DTPA)-extractable Zn compared to 0.84 mg Zn kgi1 and 0.77 mg Zn kgi1 in the soil and foliar applied chelated Zn, respectively.
Keywords	cultivar, fertilizer, lentil, uptake, zinc

Title	**Zinc in soils, water and food crops**
Author Name	Noulas Christos, Tziouvalekas Miltiadis & Karyotis Theodore
Journal Name	Journal of Trace Elements in Medicine and Biology
Year	2018
Volume and Issue	49
Page	252-260
Abstracts	A basic knowledge of the dynamics of zinc (Zn) in soils, water and plants are important steps in achieving sustainable solutions to the problem of Zn deficiency in crops and humans. This paper aims at reviewing and discussing the relevant aspects of the role of Zn in the soil–water–plant agro biological system: from the origins of Zn in soils and water to soil Zn deficiency distribution and the factors affecting soil Zn availability to plants, therefore to elucidate the strategies potentially help combating Zn deficiency problems in soil-planthuman continuum. This necessitates identifying the main areas of Zn-deficient soils and food crops and treating them with Zn amendments, mainly fertilizers in order to increase Zn uptake and Zn use efficiency to crops. In surface and groundwater, Zn enters the environment from various sources but predominately from the erosion of soil particles containing Zn. In plants is involved in several key physiological functions (membrane structure, photosynthesis, protein synthesis, and drought and disease tolerance) and is required in small but nevertheless critical contents. Several high revenue food crops such as beans, citrus, corn, rice etc are highly susceptible to Zn deficiency and *biofortification* is considered as a promising method to accumulate high content of Zn especially in grains. With the world population continuing to rise and the problems of producing extra food rich in Zn to provide an adequate standard of nutrition to increase, it is very important that any losses in production easily corrected so as Zn deficiencies are prevented.
Keywords	Zn content; Soil; Water; Food crops; Zn deficiency; Biofortification

Title	**Zinc oxide nanoparticles alter the wheat physiological response and reduce the cadmium uptake by plants**
Author Name	AfzalHussain, ShafaqatAli, MuhammadRizwan, MuhammadZia urRehman, Muhammad RizwanJaved, Muhammad Imran, Shahzad Ali ShahidChatha & RashidNazirf
Journal Name	Environmental Pollution
Year	2018
Pages	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	**Zinc effect on growth rate, chlorophyll, protein and mineral contents of hydroponically grown mungbeans plant (Vignaradiata)**
Author Name	Tayyeba Samreen, Humaira, Hamid Ullah Shah, Saleem Ullah and Muhammad Javid
Journal Name	Arabian Journal of Chemistry
Year	2017
Volume and Issue	Volume 10
Pages	S1802-S1807
Abstracts	Four varieties of *mungbeans (Ramazan, Swat mungI, NM92 and KMI)* from different research stations of KPK (*Khyber Pukhtunkhwa*) in Pakistan were grown hydroponically in pots containing sand giving nutrient solutions with and without Zn. Each variety was applied with Zn solutions at three levels i.e. 0, 1 and 2 µM concentrations. Plant samples were taken 2 months after transplant and the effect of Zn supply was observed on plant growth rate, protein, minerals and chlorophyll contents of *mungbean leaves*. Plant growth, chlorophyll contents, crude proteins and Zn contents were noted to be higher when greater supply of zinc doses was applied. Plant phosphorous contents declined with supply of Zn from 1 µM to 2 µM compared to the control signifying a Zn/P complex foundation possibly in roots of plant, preventing the movement of P to plant. Plant copper and Mg contents increased whereas Fe showed competitive behavior with Zinc while K, Na and Mn plant contents were non-significantly depressive with Zn increase from control to 2 µM. Zinc application at 2 µM concentrations in solution culture turned out to be the best treatment for improving the growth and quality parameters of mungbean.
Keywords	Mungbean; Hydrophonic; Protein; Chlorophyll; Zn; Micronutrients

Title	**Zinc biofortification of wheat through preceding crop residue**

	incorporation into the soil
Author Name	Amir Hossein Khoshgoftarmanesh, Mojtaba Norouzi, Majid Afyuni and Rainer Schulin
Journal Name	European Journal of Agronomy
Year	2017
Volume and Issue	Volume-89
Pages	131 - 139
Abstracts	We conducted a two-year field experiment to investigate the potential benefit of preceding crop residue incorporation into the soil as a strategy to enhance the density of *bioavailable* grain zinc (Zn) in a subsequent wheat *(Triticumaestivum L.)* crop. Sunflower *(Heilianthusannuus L. cv. Allstar),* sorghum *(Sorghum bicolor L. cv. Speed Feed)*, clover *(Trifoliumpratense L.)* and safflower *(Carthamustinctorius L. cv. Koseh-e-Isfahan)* were grown as preceding crop (precrop) on a Zn-deficient calcareous soil in central Iran, followed by a culture of two wheat cultivars i.e., Kavir and Back Cross Rushan. The harvested aboveground plant matter was air-dried, crushed into pieces of 0.5–2 cm size, mixed, and after taking a sample for analysis, incorporated manually into the upper 15 cm of the soil of one half of the same plot from which it had been harvested, while the other half received no residues. The aboveground residues of precrops were incorporated into soil or removed. A treatment with no preceding crop (fallow) and no residue incorporation, but with the same management otherwise, was implemented as control treatment. For both wheat cultivars studied, higher grain yield was obtained after clover (between 14 and 25.6%) and sunflower (between 11.3 and 19.5%) than that after safflower, sorghum and the fallow. All precrop treatments significantly increased the accumulation of grain Zn and N and decreased the phytic-acid-to-Zn (PA:Zn) molar ratio (by 5–41% in Kavir and by 11–48% in Back Cross), most effectively the clover treatment. The treatment effects on grain Zn were closely correlated with soil pH and dissolved soil organic carbon (DOC). The results show that the cultivation of appropriate *precrops*, especially legumes, can be an effective strategy to *biofortify* wheat grains with Zn without compromising yields.
Keywords	Biofortification;Crop residue; Green manure; Precrop culture; Wheat; Zinc

Title	**Silicon addition to soybean (Glycine max L.) plants alleviate zinc**
Author Name	Pascual MB, Echevarria V, Gonzalo MJ & Hernández-Apaolaza L.
Journal Name	Plant Physiology and Biochemistry
Year	2016
Volume and Issue	108
Pages	132-138
Abstracts	It is well established the beneficial role of silicon (Si) in alleviating *abiotic* stress. However, it remains poorly understood the mechanisms of the Si-mediated protection against metal deficiency, especially the zinc (Zn) one. Recently, it has been proposed that Si may act by an interaction with this *biometal* in the root *apoplast* contributing to its movement through the plant, as in the case of Fe deficiency. In the present work, the effect of initial or continuous Si doses in soybean Zn deficient plants has been studied. For that purpose, plants grown in hydroponic culture were treated with different Si doses (0.0, 0.5 and 1.0 mM) under Zn limiting conditions. SPAD index in leaves, several growth parameters, mineral content in the whole plant and the formation of Zn pools in roots were determined. An initial addition of 0.5 mM of Si to the nutrient solution led to an enhancement of plants growth, Zn and Si content in leaves, and a higher storage of Zn in the root apoplast. The results suggest that this treatment enhanced Zn accumulation on roots and its movement to shoots when needed, mitigating Zn deficiency symptoms.
Keywords	Apoplast; Silicon; Soybean; Zinc deficiency; Zn; Si interaction

Title	**Effect of crop residue and residual zinc on zinc fractions and their contribution to zinc uptake under rice-wheat cropping system in calciorthents.**
Author Name	Kumari, kamini; prasad, j.; kumar, vipin; solanki, i. S.
Journal Name	Research on Crops
Year	2015
Volume and Issue	Volume 16, Issue 2
Pages	205-212
Abstracts	The long term effect of crop residue and residual zinc on Zn fractions in soil and their contribution to Zn uptake in rice-wheat system was studied in *calciorthents* of the *Rajendra Agricultural University, Pusa, Samastipur (Bihar)* during 2010-11 and 2011-12. Application of zinc and crop residue increased the water soluble+exchangeable, complexed, organically bound, carbonate and amorphous oxide, crystalline oxide, residual and total Zn in the soil. The order of dominance of different fractions in soil was total Zn (164.35 mg/kg) "*residual-Zn (156.41 mg/kg)"* Zn bound to *crystalline oxide (3.06 mg/kg) "complexed Zn (2.27 mg/kg)"* organically bound "Zn (1.14 mg/kg)" water soluble plus exchangeable Zn (0.84 mg/kg) and Zn bound carbonate and amorphous oxide (0.73 mg/kg). All the soil Zn fractions were significantly correlated among themselves indicating existence of a dynamic equilibrium with each other. Zinc uptake by rice-wheat was improved with zinc along with crop residue plus compost. Among different Zn fractions, Zn bound to crystalline oxide, followed by Zn bound to carbonate and amorphous oxide played a key role in explaining the variation in yield and nutrient uptake by rice and wheat. The highest zinc uptake by rice and wheat was reported with the conjoint use of 100% crop residue and 10 kg Zn/ha.
Keywords	Zn fractions; zinc; calciorthents; carbonate

Title	**Understanding the Role of Iron and Zinc in Animals and Crop Plants from Genomics Perspective**
Author Name	Zargar SajadMajeed*, Mahajan Reetika, Farhat Sufia, Nazir Muslima, Mir Rakeeb Ahmad, Nazir Momina, Salgotra R K, Mallick S A
Journal Name	Indian Journals
Year	2015
Pages	182-196
Abstracts	The micronutrients iron (Fe) and zinc (Zn) play an important role in the metabolism of both animals and plants. The deficiency of these micronutrients, therefore, has a direct effect on their growth and metabolism. In order to enhance the level of micronutrients in crop plants, it is necessary to understand the genetic makeup and regulation of their transporter genes. The genetic improvement of crop plants is an option to attain nutritional security along with food security. In this review, we have described the impact of Fe and Zn on animal and crop plants, the need to improve the mineral contents (Fe and Zn) in crops with a special focus on common bean as a model for understanding the mineral uptake and the approaches towards deciphering the micronutrient contributing genes.
Keywords	Iron; Zinc; Common bean; Transporters; Genomics.

Title	**Inhibitory Effect of Pre-harvest Foliar Application of Zinc Sulphate on Sucrose Inversion in the Harvested Sugarcane**
Author Name	R. Banerji, S. Solomon, Rajesh Kumar, Ram Kishor, P. Singh, A. Chandra
Journal Name	Sugar Research & Promotion
Year	2015
Volume and Issue	Volume-17, Issue-3
Pages	322–324
Abstracts	Sugar recovery in sub-tropical India is low during late milling season despite improved cane varieties and management practices. For maximizing sugar recovery, post-harvest sucrose loss could be minimized by either reducing the time lag between harvest and milling or minimizing sucrose inversion by using some invertase inhibitors. Keeping above facts in view, field experiments were conducted during the year 2007 and 2008 for studying the effect of pre-harvest foliar application of divalent cation zinc as zinc sulphate (an invertase inhibitor) on post-harvest sucrose loss and internodal acid invertase activity during staling of cane. Results showed the deterioration of zinc sulphate treated cane was less in comparison todeterioration of untreated cane as revealed by significant higher commercial cane sugar (CCS %) in zinc sulphate treated trash covered cane after 1 week of staling in comparison to CCS % of control trash covered cane. Higher CCS % in zinc sulphate treated cane was due to lower enzymic inversion of sucrose because of inhibition of internodal acid invertase by zinc sulphate.
Keywords	Pre-harvest; Foliar application; Zinc sulphate; Sucrose inversion Harvested sugarcane.