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Mineral biofortification and metal/metalloid accumulation in food crops: recent research and trends (Part II)

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Introduction

This is the second part of the special issue on *Mineral Biofortification and Metal/Metalloid Accumulation in Food Crops* (Hussain 2022). The agricultural sector is under major challenge to produce high yields and nutritious foods from soils that are suffering fertility decline and metal(loid) contamination (Qin *et al.* 2021; Silver *et al.* 2021). A short description of the research articles included in this part of the special issue is given below.

Biofortification using fertilisers

A key solution to mineral deficiencies in animals and humans is the use of mineral fertilisers for the biofortification of food/fodder crops. In a field study, $ZnSO_4$ application increased yield, quality and profitability of grass forages (oat, barley, annual ryegrass and triticale) cultivated in calcareous soil (Sher *et al.* 2022). Other methods of nutrient application, such as seed priming and foliar application, have also been recommended by researchers for the biofortification of food crops. Su *et al.* (2022) suggested foliar Zn application for increasing grain Zn and decreasing grain phytic acid concentrations in 19 rice cultivars. In another study on rice, seed priming with Zn and K increased seedling growth, whereas foliar Zn application increased grain yield and grain Zn concentration (Yamuangmorn *et al.* 2022). Ram *et al.* (2022) reported that integrating foliar Zn with thiamethoxam and propiconazole did not reduce their efficacy for enriching Zn in grains and controlling insect and disease attacks on field-grown wheat. In another study on wheat grown on low-Zn calcareous soils, seed priming with 0.5 M $ZnSO_4$ improved grain yield (by 63%) and grain Zn concentration (by 43%) compared with non-primed seeds (Rehman *et al.* 2022).

Biofortification using microorganisms

Microorganisms govern nutrient dynamics in soils and their uptake by plant roots. Therefore, microorganisms can contribute to agronomic mineral biofortification. In field-grown maize, seed inoculation with Zn-solubilising *Bacillus* biofertilisers (*Bacillus* sp. ZM20, *B. aryabhattai* ZM31, *B. aryabhattai* S10 and *B. subtilis* ZM63) was effective in increasing grain Zn and Fe concentrations (Mumtaz *et al.* 2022). Inoculation of B-primed chickpea seeds with *Bacillus sp*. MN54 increased grain yield and grain B concentration over control seeds (Mehboob *et al.* 2022). In glasshouse and field experiments, seed inoculation with *Streptomyces albus* (CAI-24 and KAI-27) significantly increased the concentration of Fe, Zn and Ca in grains of pearl millet hybrids (Srinivas *et al.* 2022).

Genotypes, salinity and biofortification

Genotypic variations in grain mineral densities are important for biofortification programs. Field experiments were conducted at six locations in Kazakhstan and Russia to study genotype × environment interactions for grain mineral densities in 18 spring wheat cultivars of the region (Morgounov *et al.* 2022). Prominent cultivars were identified for high grain yield, and high grain concentrations of P, S, Mn, Cu, Zn and proteins. From a 3-year field experiment on low-Zn calcareous soils of southern Loess Plateau, China, 19 high-yielding cultivars were identified that had similar yield potentials but had grain Zn concentrations ranging from 9 to 27 mg kg^{-1} (Wang *et al.* 2022).

Genotypic variation in soil salinity tolerance may also be linked with the accumulation of minerals in grains. Significant genotypic differences in grain accumulation of Zn (26–54 mg kg^{-1}), Fe (32–62 mg kg^{-1}) and Se (2–62 μg kg^{-1}) were detected in 20 wheat genotypes grown in saline soil (Zhao *et al.* 2022). In another study, resistance to NaCl salinity correlated positively with the accumulation of Fe and Zn in wheat genotypes (Abbas *et al.* 2022*b*). Considering plant growth and mineral uptake, wheat cultivar SARC-1 was recommended for the environments low in Zn and Fe and affected by salts. Taqdees *et al.* (2022) reported negative effects of NaCl stress on plant growth and mineral uptake that were mitigated by the use of Si/Zn-nanoparticle-enriched miscanthus biochar.

Metal/metalloid accumulation

Toxic levels of metals, such as Cd, damage the antioxidative defence system and nutrient accumulation in plants (Abbas *et al.* 2022*a*). Suitable nutrient management can alleviate such negative effects by limiting the uptake and translocation of metal(loid)s in food crops. Rather *et al.* (2022) reviewed the beneficial role of S and its assimilatory products in tolerance, detoxification and partitioning of heavy metal(loid)s in plants. Shi *et al.* (2022) recommended applying $CaCl_2$ to immobilise As, Sb and Cd in soils and to decrease their accumulation in grains of rice grown in flooded soil co-contaminated by Sb and Cd. By contrast, under these conditions, the application of P (as NaH_2PO_4) increased the soil mobility and grain accumulation of Sb and As.

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Conflicts of interest. The author declares no conflicts of interest.

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