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Silicon Extends Beneficial Effects Towards the Accumulation of Micronutrients and Rare Earth Elements

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Background: Silicon (Si) is one of the elements whose role in plant nutrition and development is not fully defined and has become of great interest as of recent. The presence of Si, is, however, known to extend several benefits to plants, which include increased biomass production and tolerance against both biotic and abiotic stressors, furthermore, it improves plant rigidity.**Aim:** This study represents a greenhouse experiment that was designed to explore the effects of Si accumulation and its relationship with the uptake of essential and nonessential elements while alleviating toxicity in plants with different nutrition strategies.**Methods:** Four plant species, *Brassica napus* (*B. napus*, a hyperaccumulator), *Lupinus albus* (*L. albus*, an excluder), *Cucumis sativus*, and *Zea mays* (*C. sativus and Z. mays*, both Si accumulators), were cultivated on a semi hydroponic substrate under greenhouse conditions. The plants were treated with a variation between a solution made of a trace element mix (Al, Cd, Mn and REE) without Si (further denoted *TE-mix*) and a similar mix with Si- fertilizer as silicic acid (further denoted *Si+*). The solution concentrations were varied between 10 and 100 µM, to investigate the effect of Si. After harvest, the concentration of Ca, Mn, Fe, P, Al, Cd and REE were determined using IC-PMS. **Results**: Treatment with 10 µM *TE-mix* and Si+ showed a decrease in biomass on the biomass of B. napus and L. albus. The effect of Si on the biomass of Si accumulators (*C. sativus* and *Z. mays*) decreased with the increasing concentration of the TE application. Treating the plants with Si+ at both low and high concentrations resulted in low Ca concentration in B. napus and C. sativus when compared to the concentrations from TE-mix treatment which are up to fivefold higher. The influence of Si+ on the concentration of Mn, and Fe increased (≥150 % and ≥10% respectively) with increased Si+ concentration. The results further indicated that treating the plants with Si+ increased the concentration of Al and Cd accumulated in B. napus, C. sativus and Z. mays. Higher concentrations of LREE were accumulated when compared to LREE in all species when treated either with TE-mix or Si+ (at both 10 and 100 µM). The highest REE concentration was accumulated in B. napus (21.4 µg /g LREE and 17.4 µg /g HREE) when the plants were treated with 100µM Si+. **Conclusion**: The results from this study provide further insight into the benefits of supplementing Si as fertilizer, toward plant development and nutrition. Even when utilized on plants with different nutrition strategies, Si may assist the plants in biomass production and to acquire nutrients such as Fe and Mn. Furthermore, the use of Si can assist plants in resisting high concentrations of toxic trace elements such as Al and Cd while also accumulating nonessential but

valuable elements such as rare earth elements when implementing phytoremediation.