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Uptake of Germanium and Rare Earth Elements (La, Gd, Er, Nd) by white mustard (Brassica alba L.) and common millet (Panicum milliaceum L.) as affected by Phosphorus Nutrition

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The effect of phosphate nutrition is important due to the future usage of fertilizer treatment in phytomining experiments e.g. in accumulation of the economically important rare earth elements (REE). It is expected that the trivalent charge of REE will result in complexation with phosphate and REEs could be immobilized and not further bioavailable for plants which would cause losses of REE concentration in biomass. To investigate this influence on lanthanum, neodymium, gadolinium and erbium two plant species Brassica alba (white mustard) and Panicum miliaceum (common millet) were cultured in a greenhouse study. The plants were cultivated onto two different substrates and were poured with modified REE and phosphate solutions within an eight-week period. The concentrations of REE in soil, soil solution and plant samples were determined by inductively coupled plasma-mass spectrometry (ICP-MS). The results show an increase of concentration of REE with increasing levels of element solution applied for both species. REE accumulations are elevated in roots and decrease in the order of roots> leaves> stem> fruit/blossom. Brassica accumulated more REE in root whereas Panicum showed higher REE concentrations in leaves. Exposure to increased phosphate addition did not significantly change the concentrations of REE in both plant species yet the REE concentrations in leaves slightly decreased with increasing phosphate addition. For root and stem no precise trend could be determined. It is most likely that REEs precipitate with phosphate on root surfaces and in the roots. The bioavailability of REE to plants is affected by complexation processes of REEs with phosphate in the rhizosphere. The results indicate that phosphate application plays an important role on REE uptake by roots and accumulation in different parts of a plant and it might have an influence on translocation of REE within the plant.