Liming effects on trace element bioavailability in acid soils

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Liming has been demonstrated to be effective in managing the bioavailability of potentially toxic trace elements in acid soils. However, an undesirable side-effect of liming can be an associated reduction in the plant-available fraction of elements that are essential micronutrients (e.g. Fe, Mn and Zn). We undertook a dual approach to investigating the effects of liming on trace element bioavailability: (i) at a whole-plant scale and (ii) at the root-soil interface.
We amended two different, well-characterized, acidic (pH 5.45 and 6.5) and nutrient-rich New Zealand horticultural soils with different amounts of lime ($CaCO_3$, 0.31 - 10 wt%). The amended soils were then used in a greenhouse trial, where we grew replicate White Lupin (Lupinus albus L.) plants in the different treatments for six weeks. After the growth period, we harvested the plants and measured the shoot biomass and elemental (Fe, Mn, Ni, Cu, Zn, Cd and P) concentrations. We also carried out a rhizobox experiment to enable the investigation of trace elements mobilization near key root structures in one of the soils using high resolution diffusive gradients in thin-films (HR-DGT) and laser ablation-ICP-MS (LA-ICP-MS).
The increasing lime rates effected significant changes to the pH of the two soils. While the lupin uptake of all of the trace elements decreased by over 50% in both soils between the control and the highest rate of lime application, there were distinct differences in the elements' responses to liming in the two soils. A significant effect on the biomass production was not observed. The HR-DGT measurements showed distinct hotspots of trace element mobilization near the location of an observed cluster root in the control treatment, providing further evidence that these root structures can employ special mechanisms for nutrient acquisition from discrete areas of soil.