Trace element transfer into the plant: What can we learn from element ratios?

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Not many studies deal with the uptake of non-nutrient elements by plants. Hence, the processes controlling the uptake of these elements and their sequestration in different plant organs are not well understood. Research about soil-to-plant transfer-factors (TF) of nutrients combined with non-nutrients could provide a powerful tool to gain a much broader understanding of elemental uptake. Non-nutrient trace elements are usually transferred into plants, although they are not required for plant growth and only taken up by membrane proteins that evolved for chemically similar ions of nutrient elements [1]. The ratios at which non-nutrients and nutrients are passing through the soil-root barrier could provide valuable information for agriculture.

We will present a multivariate statistical approach on a data set of over 800 physiological TFs of different plants grown on different soils with different pollutant levels [2]. In order to avoid spurious correlations among main and trace elements and their TFs, the statistical methods discussed are based on the analysis of log-ratios [3]. Linear discriminant analysis is used to study the differences between groups of samples [4]. The challenge is to choose in a data set of 45 elements, which ratios of concentrations or TFs provide information about e.g. uptake/synergism, competition/antagonism, sequestration within the plant, etc.

Two examples of how a statistical approach can be used are discussed. 1) The log ratios of TFs of some trace elements show a correlation with the TFs of other elements, like Ca and Sr, Rb and Cs, La with all other REE and Nb, etc. Deviations from the general correlation within element pairs of TFs give hints at differences in soil parameters or in the cultivars or ecotypes of a certain plant species. 2) Log ratios of TFs of elements which are not correlated to any nutrient element may provide information e.g. about the underlying lithofacies/soil conditions.

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