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Exudation of organic acids by Lupinus albus and Lupinus angustifolius as affected by phosphorus supply

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In phytomining and phytoremediation research mixed cultures of bioenergy crops with legumes hold promise to enhance availability of trace metals and metalloids in the soil plant system. This is due to the ability of certain legumes to mobilize trace elements during acquisition of nutrients making these elements available for co-cultured species. The legumes achieve this element mobilization by exudating carboxylates and enzymes as well as by lowering the pH value in the rhizosphere.

The aim of our research was to determine characteristics and differences in the exudation of *Lupinus albus* and *Lupinus angustifolius* regarding to quantitative as to qualitative aspects. Especially the affection by phosphorus (P) supply was a point of interest. Thus we conducted laboratory batch experiments, wherein the plants were grown over four weeks under controlled light, moisture and nutritional conditions on sand as substrate. Half of the plants were supplied with 12 mg P per kg substrate, the other half were cultivated under a total lack of P.

After cultivation the plants were transferred from the cultivation substrate into a 0,05 mmol·L^{-1} $CaCl_2$ solution. After two hours the plants were removed, moist and dry mass off shoots and roots were measured together with the root length (Tennants' method). Concentrations of exudated carboxylates in the $CaCl_2$ solution were determined via IC (column: Metrosept OrganicAcids, eluent 0.5 mol·L^{-1} H_2SO_4 + 15% acetone, pH=3; 0.5 mL·min^{-1}).

As a result four different organic acids were identified (citric acid, fumaric acid, tartaric acid, malic acid) in concentration ranges of 0.15 mg·L^{-1} (fumaric acid) to 9.21 mg·L^{-1} (citric acid).

Lupinus angustifolius showed a higher exudation rate (in nmol per cm root length per hour) than *Lupinus albus* in the presence of phosphorus (e.g. regarding citric acid: 1.99 vs 0.64 nmol·$(g·h)^{-1}$). However, as the root complexity and length of *L. albus* were far higher than of *L. angustifolius,* the total amount of exudated organic acids per plant of *L. albus* was higher than of *L.angustifolius*. Thus *L.albus* should be addressed as the more exudation effective plant in comparison to *L.angustifolius* (could be addressed as the more efficient one). Since organic acids in the rhizosphere of intermingling root systems of intercropped species play a key role during mobilization of trace metals our result clearly show that *L.albus* is most suitable for intercropping in a sense of phytoremediation and phytomining.

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