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Regulation of *Medicago truncatula* N_2 Fixation under Phosphorus Deficiency

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Abstract

Phosphorus is one of the most important elements that significantly affect plant growth and metabolism. The crop production on more than 30 % of the world's arable land is limited by P availability, with the acid, weathered soils of the tropics and subtropics particularly prone to P deficiency. For legume growth and symbiotic N_2 fixation, P is critically the major limiting factor. In extreme cases P deficiency prevents nodulation and symbiotic N_2 fixation. The legume *Medicago truncatula* and its microsymbiont *Sinorhizobium meliloti* serve as models to study the mechanisms of the regulation and inhibitory effect of low P supply on symbiosis. The aim of this study was to evaluate the hypothesis that control of nodulation and N_2 fixation under P deficiency involves sensing of change in tissue N composition and attempted to identify the potential biochemical signal(s) involved.

Medicago truncatula plants were grown in a growth chamber in a hydroponic system and inoculated with Sino*rhizobium meliloti*. Phosphorus was investigated in two different experiments: low (0.2 to 5.0 μM P) and high (1.0 to 12.0 μM P) P range levels. At day 52 phloem sap extracts were collected, plants were harvested and frozen in liquid N_2. Free amino acids were analysed as well as sugars and organic acid concentrations in nodule tissues. P and N concentrations were analysed for various plant organs.

Low P concentrations strongly reduced the growth of *Medicago truncatula* plants. A very low P concentrations ($<$ 1.0 μM P) totally prevented nodulation. Reducing P concentration impaired N assimilation and as a result the concentration of N and N/P ratios were much increased while C/N ratios were decreased. Free amino acid profile showed higher accumulation of free amino acids in the phloem and nodules and asparagine was the amino acid with the most dramatic increase in concentration under P deficiency. Accordingly, we propose that P shortage reduces the growth rate of the plants and protein synthesis. This will leads to higher N concentrations in the plants and gives rise to free amino acid accumulation. Therefore, we suggest a feedback mechanism for regulating nodulation and N_2 fixation under P deficiency.

Keywords: Asparagine, model legume, N_2 fixation, phosphorus, regulation

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