Effects of impaired soil P and N stoichiometries on plant symbioses with microorganisms

Abstract

Phosphorus (P) often limits the primary productivity of natural and agroecosystems because of its low availability and mobility in most soils. In response to low P environments, vascular plants have evolved a range of phosphorus acquisition strategies, such as forming root hairs or increasing the root surface by branching. Support to plant P acquisition is obtained from phosphate solubilizing microorganisms that solubilize mineral and organic P, and arbuscular mycorrhizal fungal (AMF) mycelium that provide the mycorrhiza pathway for phosphate uptake that reaches outside the P limitation zone around the roots. The microorganisms may thus account for up to 90% of the total P requirement of the plant. Microorganisms also have a central role in soil nitrogen (N) cycling and plant N uptake. For instance, AMF can acquire N from both mineral and organic N sources and transfer some of this N to their host plants, suggesting a central role in N acquisition in N poor soils. The specific strategies for plant phosphorus acquisition under nutrient addition-induced soil stoichiometric N:P imbalance remain unclear. Based on this, we investigate the following:

Under conditions of different soil N:P stoichiometries, induced by controlled nitrogen and phosphorus fertilizations:

(1) How do the AMF and root architecture respond?

(2) How do the responses of AMF and phosphate solubilizing microorganisms interact?

(3) How are root pathways, mycorrhizal pathways, and leaf reabsorption pathways balanced?

(4) What are the mechanisms underlying the response and interaction between AMF and mycelial bacteria?

(5) How is this related to the bacteria involved in nitrogen cycling?