

# Heterologous expression of secreted bacterial BPP and HAP phytases in plants stimulates *Arabidopsis thaliana* growth on Phytate

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## Abstract

© 2018 Valeeva, Nyamsuren, Sharipova and Shakirov. Phytases are specialized phosphatases capable of releasing inorganic phosphate from myo-inositol hexakisphosphate (phytate), which is highly abundant in many soils. As inorganic phosphorus reserves decrease over time in many agricultural soils, genetic manipulation of plants to enable secretion of potent phytases into the rhizosphere has been proposed as a promising approach to improve plant phosphorus nutrition. Several families of biotechnologically important phytases have been discovered and characterized, but little data are available on which phytase families can offer the most benefits toward improving plant phosphorus intake. We have developed transgenic *Arabidopsis thaliana* plants expressing bacterial phytases PaPhyC (HAP family of phytases) and 168phyA (BPP family) under the control of root-specific inducible promoter Pht1;2. The effects of each phytase expression on growth, morphology and inorganic phosphorus accumulation in plants grown on phytate hydroponically or in perlite as the only source of phosphorus were investigated. The most enzymatic activity for both phytases was detected in cell wall-bound fractions of roots, indicating that these enzymes were efficiently secreted. Expression of both bacterial phytases in roots improved plant growth on phytate and resulted in larger rosette leaf area and diameter, higher phosphorus content and increased shoot dry weight, implying that these plants were indeed capable of utilizing phytate as the source of phosphorus for growth and development. When grown on phytate the HAP-type phytase outperformed its BPP-type counterpart for plant biomass production, though this effect was only observed in hydroponic conditions and not in perlite. Furthermore, we found no evidence of adverse side effects of microbial phytase expression in *A. thaliana* on plant physiology and seed germination. Our data highlight important functional differences between these members of bacterial phytase families and indicate that future crop biotechnologies involving such enzymes will require a very careful evaluation of phytase source and activity. Overall, our data suggest feasibility of using bacterial phytases to improve plant growth in conditions of phosphorus deficiency and demonstrate that inducible expression of recombinant enzymes should be investigated further as a viable approach to plant biotechnology.

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## Keywords

*Arabidopsis*, Phosphorus, Phytase, Phytate, Soil bacteria, Transgenic plant

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