

Tolerance of high phosphorus concentrations in *Ptilotus exaltatus* depends on the accumulation of phosphorus and calcium in different leaf cells

Daihua Ye¹, Peta Clode², Timothy Hammer², Jiayin Pang², Hans Lambers², and Megan Ryan²

¹Sichuan Agricultural University - Chengdu Campus

²The University of Western Australia

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Abstract

Under very high phosphorus (P) supply, *Ptilotus* hyperaccumulates P without toxicity while *Kennedia* is intolerant. What physiological mechanisms underlie this difference? *P. exaltatus* and *K. prostrata* were grown in sandy soil with low- and high-P treatments. Under high P, both species hyperaccumulated P (>20 mg g⁻¹) in leaves, and shoot dry weight was unchanged for *P. exaltatus* but decreased by >50% for *K. prostrata*. Under high P, both species preferentially accumulated leaf P as inorganic P but *P. exaltatus* preferentially allocated P to mesophyll cells and stored Ca as occasional crystals in specific lower mesophyll cells separate from P, while *K. prostrata* preferentially allocated P to epidermal and spongy mesophyll cells and co-located P and Ca in palisade mesophyll cells. Mesophyll cellular [P] correlated positively with potassium for both species and negatively with sulfur for *P. exaltatus*. High P tolerance arose from P and Ca allocation to different leaf cell types, formation of Ca crystals, and enhanced K and decreased S accumulation to balance high cellular [P]. Intolerance to high P arose from the co-location of Ca and P in palisade mesophyll cells. This study advances the understanding of leaf physiological mechanisms for high P tolerance in plants.

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