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Phosphorus in Aeolian desert dust deposits can be captured, dissolved, and absorbed by plant leaves

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Phosphorus (P) limitation is prevalent around the world, primarily because most soil P have low bioavailability. In P poor ecosystems, deposition of P-rich desert dust is recognized as a major component of the P cycle. The acknowledged paradigm is that plants acquire P deposited in soil primarily via their roots. We tested whether, and to what extent, plants acquire P directly from dust deposited on their leaves and what are the underlining uptake mechanisms of insoluble P. P-rich dust was applied to P sufficient and P deficient chickpea, maize and wheat plants and was compared to plants which received inert silica powder. Foliar application of dust doubled the growth of P stressed chickpea and wheat, two crops originating near the Syrian Desert. P deficiency enhanced the acquisition of insoluble P through series of leaf modifications that increased foliar dust capture, acidified the leaf surface and, in chickpea, enhanced exudation of P-solubilizing organic acids. In in-situ trials, we demonstrated that the modifications of leaf pH and exudation of oxalic and malic acids substantially promoted P solubilisation from dust. Foliar responses did not occur in maize and in P sufficient plants which displayed only a marginal response to dust. Our results demonstrate that foliar uptake of P from dust can be an alternative P acquisition pathway in P-deficient plants. Interestingly, the abovementioned foliar responses are comparable to known P uptake root responses. Given that P limitation is almost universal, foliar P uptake pathway will have significant ecological and agricultural implications.