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The *Arabidopsis* SUMO E3 ligase SIZ1 controls phosphate deficiency responses

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Plants sense phosphate (Pi) deficiency and initiate signaling that controls adaptive responses necessary for Pi acquisition. Herein evidence establishes that AtSIZ1 is a plant small ubiquitin-like modifier (SUMO) E3 ligase and is a focal controller of Pi starvation-dependent responses. T-DNA insertional alleles of *AtSIZ1* (At5g60410) cause *Arabidopsis* to exhibit exaggerated prototypical Pi starvation responses; including cessation of primary root growth, extensive lateral root and root hair development, increase in root/shoot mass ratio, and greater anthocyanin accumulation, even though intracellular Pi levels (Pi_{int}) in *siz1* plants were similar to wild type. AtSIZ1 has SUMO E3 ligase activity *in vitro* and immunoblot analysis revealed that the protein sumoylation profile is impaired in *siz1* plants. AtSIZ1-GFP was localized to nuclear foci. Steady-state transcript abundance of Pi starvation-responsive genes *AtPT2*, *AtPS2*, and *AtPS3* was moderately, but clearly, greater in *siz1* seedlings than in wild type when Pi is sufficient. Pi starvation induced the expression of these genes to the same extent in *siz1* and wild-type seedlings. However, induction of transcript abundance of two other Pi starvation-responsive genes *AtIPS1* and *RNS1*, which is similar in *siz1* and wild type when Pi is sufficient, occurred more slowly in *siz1* seedlings. PHR1, a MYB transcriptional activator of *AtIPS1* and *RNS1*, is an AtSIZ1 sumoylation target. These results indicate that AtSIZ1 is a SUMO E3 ligase and that sumoylation is a focal negative and positive control process of several Pi deficiency responses.