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What root traits determine resistance of grasses to phosphorus deficiency in managed grasslands?

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Phosphorus (P) inputs into agricultural soils are declining as a result of restricted P application and diminishing global P resources. To maintain high productivity of managed grasslands, it is therefore imperative to identify key root traits that determine P acquisition of grasses in soils with low P status. In a 9-month greenhouse experiment we grew eight common grass species and cultivars on a soil with a low P status, and related root morphological traits to their performance under P-limiting conditions. We applied (P1) or withheld (P0) P fertilisation while providing adequate amounts of all other nutrients. Biomass production differed significantly ($p<0.001$) amongst species and fertilisation treatments, varying from 17.1 to 72.1 g pot-1 in the P0 treatment and from 33.4 to 85.8 g pot-1 in the P1 treatment. We observed a trade-off between root biomass and specific root length. Structural equation modelling identified total root length as key factor with respect to resistance to P deficiency, especially when roots explored the subsoil. Optimising root length and subsoil exploration could be the key to maintaining high productivity of grasslands with decreasing P availability. This is relevant for both plant breeding programmes and in composing seed mixtures for reseeding grassland.