Genotypic variability of lettuce root system in response to P availability

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Context

P is an important macronutrient whose resources are limited. Adaptation to low P commonly leads to reduced primary root growth and increased lateral root initiation and elongation, but inter and intra-specific variations are reported. We explored root system adaptations to low P and their consequences on P use efficiency (PUE) in the *Lactuca* genus.

Mat & Methods

14 genotypes including wild lettuce and old or modern cultivars were grown for 4 weeks in PVC tubes filled with sand and vermiculite and irrigated with nutrient solutions at two levels of P availability : 0.1 mM (LP) and 1 mM (HP). Roots were then separated from the substrate, shoot and root mass and their P contents were measured, while root traits were measured in samples of thick and fine roots: rooting depth (Depth), root elongation potential (length/diameter, Elong), maximal apical diameter (Dmax), minimum diameter (Dmin), inter-branching distance (IBD), the slope of the regression of the lateral root diameters by the mother root diameter (Dldm) and lateral root lengths. PUE was decomposed into the product of the uptake efficiency (P absorbed / P applied) by the utilization efficiency (Shoot mass / P absorbed).

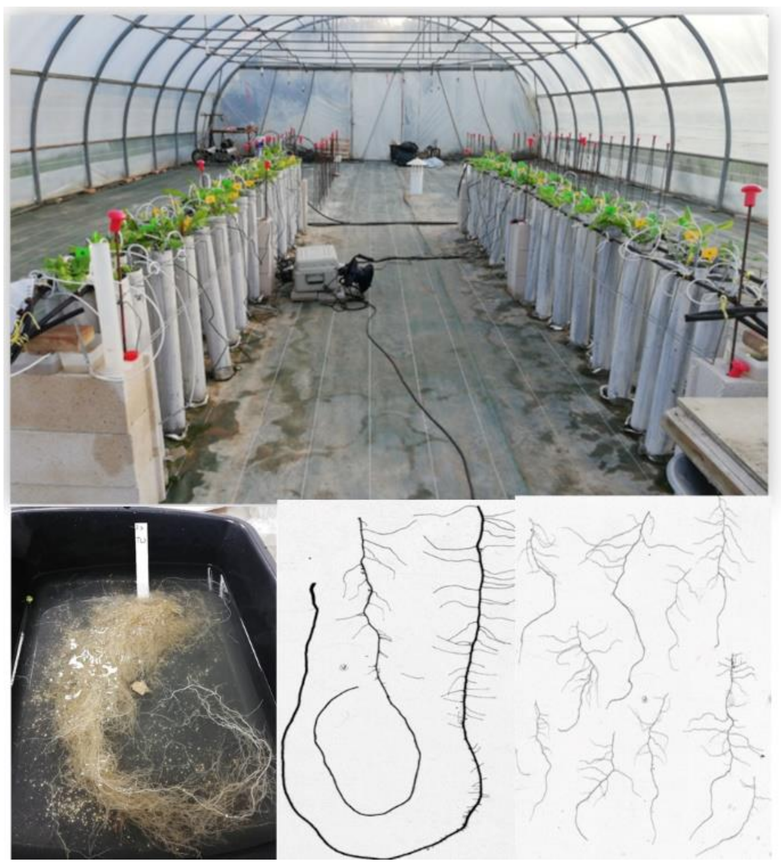

Fig. 1 Experimental design and root sampling

Higher taproot dominance and lower lateral roots at low P

All genotypes reduced their shoot mass at low P (on average -57%), but root mass was only reduced in some genotypes. Genotypic variability was observed for all root traits examined. Total root biomass was associated with taproot traits Dmax and Depth.

Low P availability:
- reduced taproot Depth, Dmax and Dldm
- increased IBD and elongation potential of taproot and lateral roots
- had no effect on Dmin

There was limited GxE interactions in these responses.

The relative response of Dmax and Dldm were negatively correlated, indicating a tradeoff between the maintening of taproot diameter and lateral root diameters.

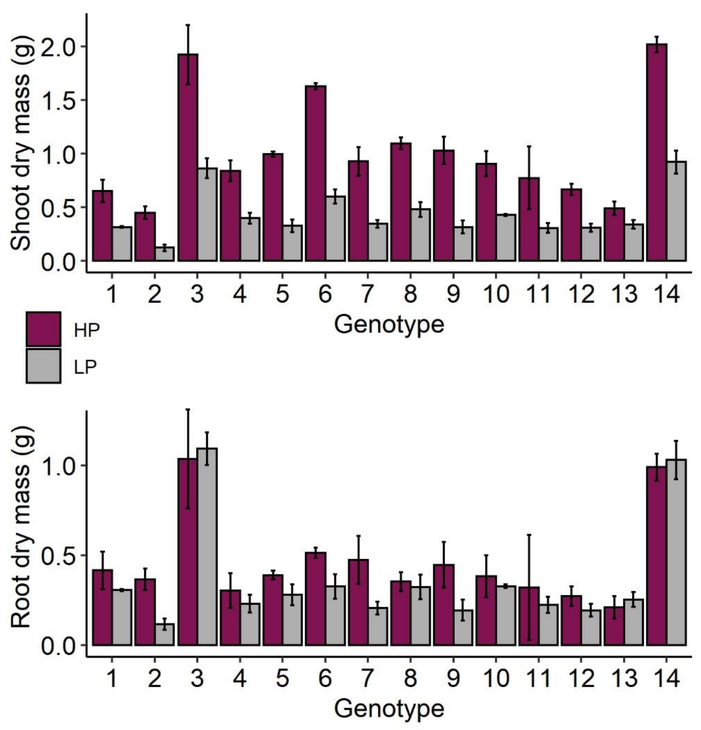

Fig. 2 Shoot and root masses in the P treatments

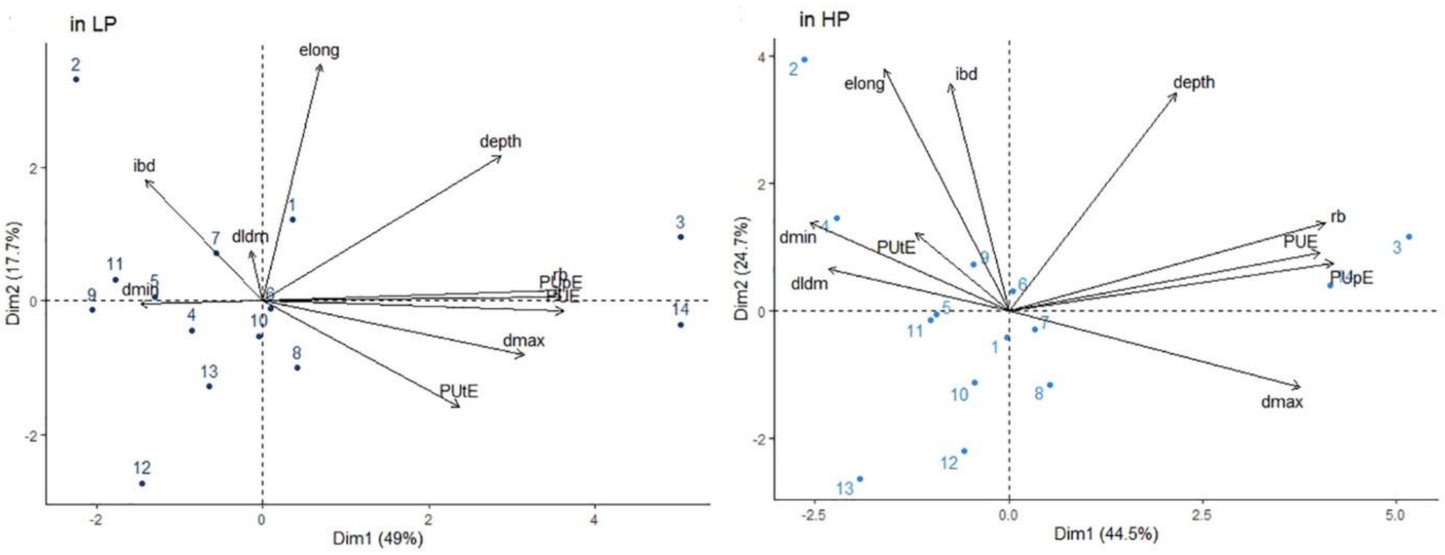

Fig. 3 PCA on root traits, root biomass, and PUE components

High PUE is associated to taproot characteristics

PUE ranged between 15 and 70 $g.g^{-1}$ in HP and 70 and 430 $g.g^{-1}$ in LP.

PUE was mostly determined by P uptake efficiency and associated with utilization efficiency in LP only. PUE was correlated with root biomass and taproot diameter and length.

The sharpest increase of PUE at low P availability was recorded on genotypes that either had a high Dmax or whose Dmax has not been reduced too much by P stress.

Conclusions and perspectives

Root system architecture response to low P in *Lactuca* is specific, with less ramification and thinner lateral roots, though showing greatest elongation potential for a given diameter. Wild species showed the highest root biomass and PUE, associated with taproot characteristics. These results provide information about relevant traits to be conserved when selecting P-efficient varieties.

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ackowledgements

See more in
Beroueg *et al*., *Frontiers in Plant Sciences*, 2021
Pagès *et al*., Ecological Modelling, 2014