Analyses of root traits and their role in phosphorus acquisition efficiency in maize

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Phosphorus (P) is an essential nutrient to the plants and is acquired from the rhizosphere solution as inorganic phosphate (Pi), primarily in the form of $H_2PO^-_4$. In tropical soils, the Pi concentration in the soil solution is often low and its diffusion strongly limited by fixation to aluminum and iron oxides in the clay fraction. Hence, P is one of the least available mineral elements particularly in highly weathered, tropical soils, with P deficiency strongly limiting plant growth. One interesting approach to help circumvent P deficiency in tropical areas is to explore the genetic diversity available in plants to breed cultivars that are efficient in P acquisition. In this study we used two maize genotypes which were previously defined as being efficient and inefficient in P absorption and utilization in field trials to perform a detailed characterization of root morphological traits in nutrient solution with low (0 and 2.5uM) and high (150 and 250uM) P. We also assessed the expression of genes that had been previously described by other groups as being involved with changes in root morphology. After standardizing the experimental conditions to distinguish genotypes for P acquisition efficiency, we analyzed 60 different maize genotypes (30 inbreed lines and 30 hybrids) under low P condition. We showed that a low P condition for 12 days is adequate to distinguish maize contrasting genotypes considering root traits. We expect P efficient genotypes to show more fine roots, have a larger volume, a higher root to shoot ratio and higher shoot P content than the P inefficient ones. 12 days under low P (2.5 uM) produced results that showed this contrast between genotypes. Genes (*rtcs*, *bk2* and *rth3*), which had been previously implicated in root formation, showed higher expression levels in the P efficient genotype under low P, which is consistent with a possible role in P efficiency. Root characteristics showed a strong dominance effect and a high heritability. Moreover, we showed that root characteristics have a high correlation among themselves and that there is no correlation between inbreeds and hybrids. These results are essential to start an early selection process and to support advanced studies in molecular biology and physiology, culminating on the production of more efficient maize cultivars that use less fertilizers.

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