

Phosphate Use Efficiency in Plants: A GWAS Approach to Identify the Pathways Involved

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Abstract : Phosphate (Pi) is one of the essential macronutrients in plant growth and development, and it plays a central role in metabolic processes in plants, particularly photosynthesis and respiration. Limitation of crop productivity by Pi is widespread and is likely to increase in the future. Applications of Pi fertilizers have improved soil Pi fertility and crop production; however, they have also caused environmental damage. Therefore, in order to reduce dependence on unsustainable Pi fertilizers, a better understanding of phosphate use efficiency (PUE) is required for engineering nutrient-efficient crop plants. Enhanced Pi efficiency can be achieved by improved productivity per unit Pi taken up. We aim to identify, by using association mapping, general features of the most important loci that contribute to increased PUE to allow us to delineate the physiological pathways involved in defining this trait in the model plant Arabidopsis. As PUE is in part determined by the efficiency of uptake, we designed a hydroponic system to avoid confounding effects due to differences in root system architecture leading to differences in Pi uptake. In this system, 18 parental lines and 217 lines of the MAGIC population (a Multiparent Advanced Generation Inter-Cross) grown in high and low Pi availability conditions. The results showed revealed a large variation of PUE in the parental lines, indicating that the MAGIC population was well suited to identify PUE loci and pathways. 2 of 18 parental lines had the highest PUE in low Pi while some lines responded strongly and increased PUE with increased Pi. Having examined the 217 MAGIC population, considerable variance in PUE was found. A general feature was the trend of most lines to exhibit higher PUE when grown in low Pi conditions. Association mapping is currently in progress, but initial observations indicate that a wide variety of physiological processes are involved in influencing PUE in Arabidopsis. The combination of hydroponic growth methods and genome-wide association mapping is a powerful tool to identify the physiological pathways underpinning complex quantitative traits in plants.

Keywords : hydroponic system growth, phosphate use efficiency (PUE), Genome-wide association mapping, MAGIC population

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