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Do performing upland rice varieties and CRISPR edited lines with less aerenchyma in roots also show less aerenchyma in the leaves? A 2023-2024 CIRAD AGROPOLIS project.

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In 2022, our team conducted experiments on the relative volume of aerenchyma (%AA) in rice roots. We showed that (i) %AA in roots of rice plants grown in aerobic environments was significantly lower in upland varieties than in lowland varieties, (ii) transpiration per leaf area was negatively correlated with %AA and (iii) CRISPR-edited lines for three regulatory genes of aerenchyma formation had lower %AA in roots than the parental line, similar to the %AA of the drought-resistant varieties. These results suggest that reduced %AA in roots is a key factor contributing to the adaptation of rice varieties to upland environments. Improving this trait could further enhance the performance of upland rice crops. However, the limitation of routine root sampling hinders the practical use of this trait in breeding. Nevertheless, since the aerenchyma forms a complete network in rice plants, we expect that variations in %AA in roots will also be observed in shoots. Therefore, establishing a significant correlation between %AA in roots and shoots will allow quantification of %AA through easier observations in shoot organs than in roots. In Work Package (WP) 1, scheduled from June to December 2023, our project aims to standardize a method for measuring %AA in leaves. We will explore different combinations of leaf cross-section and imaging techniques, and additionally perform whole-plant morphological X-ray CT analysis to determine morphometric characteristics of the aerenchyma network. The selected leaf cross-sectional method will be employed in WP2 (January-June 2024) to quantify the correlation between %AA in leaves and roots. We will investigate ten contrasting varieties and eight CRISPR-edited lines in two sets, all grown under three soil moisture levels, to validate the results under different environmental conditions. This project marks the initial phase of a collaborative international initiative aimed at exploring novel approaches in upland rice breeding, and offering alternatives to enhance the resilience of smallholder farmers to climate change. The outcomes of this project will provide a tool for modifying plant anatomy to accelerate the rate of genetic yield progress in upland rice.