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"Filling gaps and removing traps
for sustainable resource management"

Effects of P Nutrition and VPD on Rice Leaf Morphology and Photosynthesis

Oliver Knopf, Sabine Stürz, Marc Schmierer, Folkard Asch

University of Hohenheim, Inst. of Agric. Sci. in the Tropics (Hans-Ruthenberg-Institute), Germany

Abstract

The first time in a decade, global hunger is on the rise again driven by conflicts and climate change. The rice cultivation system as such is a significant contributor to greenhouse gas emissions and a major consumer of phosphate (PO_4^{3-}) a non- renewable resource and the most limiting nutrient for plant growth after nitrogen. In order to meet the sustainable development goals, rice production has to be increased by 50–110 % and at the same time, the impact on environment and water usage has to be reduced. To address this issue, a greenhouse experiment was conducted comprising 32 rice plants of two varieties (IR64, Chomrong). Plants were grown in a hydroponic system and manipulated using a nutrient solution with two different phosphate levels (low and optimal P) and two levels of vapour pressure deficit (low and high VPD). Destructive samplings, leaf phosphate analysis, stomatal imprints were performed during the vegetative phase of the plants. Additionally, gas exchange measurements were conducted on young and on older leaves.

Plants subjected to the low phosphate treatment had a significantly smaller leaf area, a lower leaf phosphate concentration, higher root to shoot ratio and generally a higher stomatal density.

While in young leaves P nutrition did not significantly affect assimilation rates, in old leaves reduced P nutrition led to higher assimilation rates in IR64 at high VPD due to higher stomatal conductance. Since under P deficiency, inorganic phosphate (Pi) is translocated from old to young leaves, stomatal control is probably lost in highly P deficient old leaves of IR64. In contrast, Chomrong was able to maintain its stomatal control even in its old leaves, which could be an interesting trait for plant breeding for P limited environments.

Keywords: Climate change, phosphate, phosphor, photosynthesis, resource management, rice, stomata, sustainability, vapor pressure deficit

Contact Address: Oliver Knopf, University of Hohenheim, Inst. of Agric. Sci. in the Tropics (Hans-Ruthenberg-Institute), Stuttgart, Germany, e-mail: oliver.knopf@uni-hohenheim.de