UNIVERSITY OF HOHENHEIM

Institute of Agricultural Sciences in the Tropics (Hans-Ruthenberg-Institute) (490)

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

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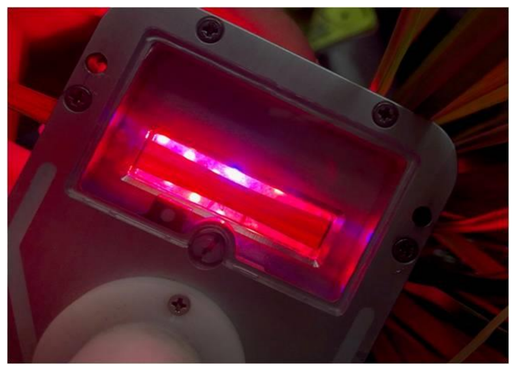
Introduction

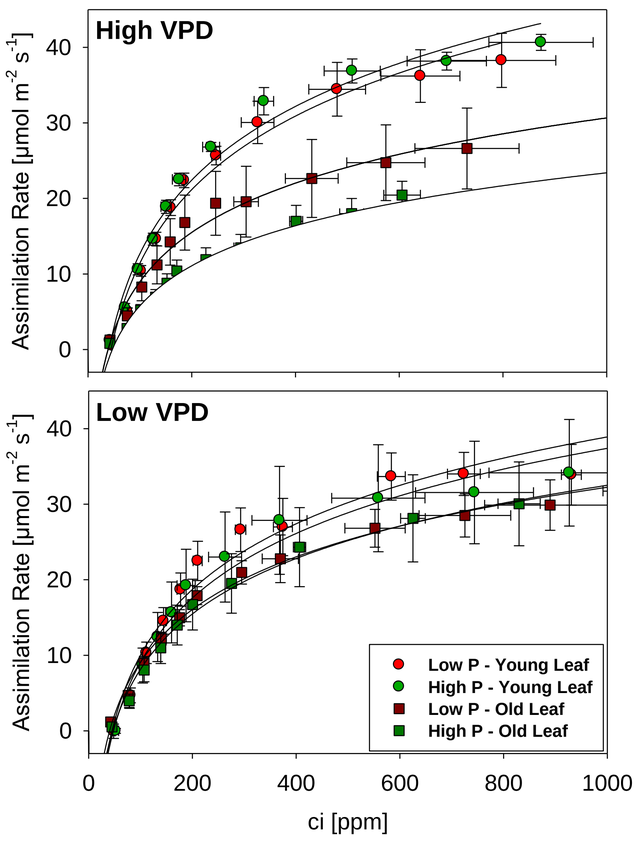
Rice cultivation is a major consumer of phosphate (PO_4^{3-}), a non-renewable resource and the most limiting nutrient for plant growth after nitrogen. Under phosphorus (P) deficiency, plants usually show a smaller leaf area and a higher root-shoot-ratio, but maintain high photosynthetic activity, apart from very severe deficiencies. For photosynthesis, P is required in the form of ATP and it has been argued that plants can maintain their ATP pool even under P deficiency due to the high turnover rates of ATP. However, low P concentrations in the chloroplasts can lead to limited export of photosynthates and increased starch accumulation.

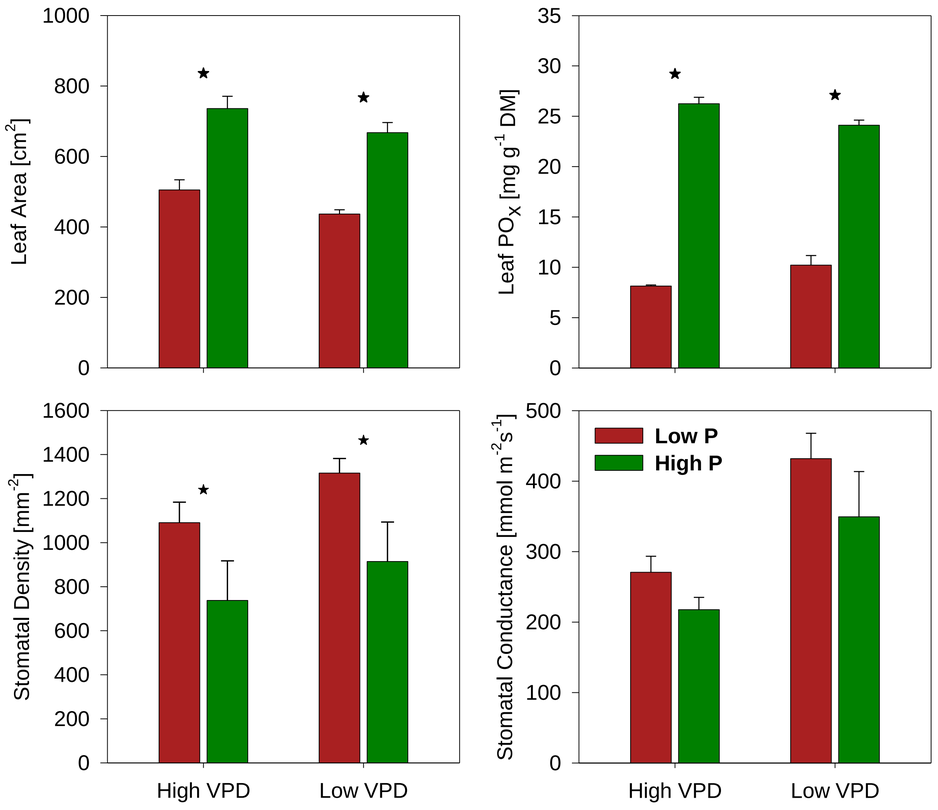


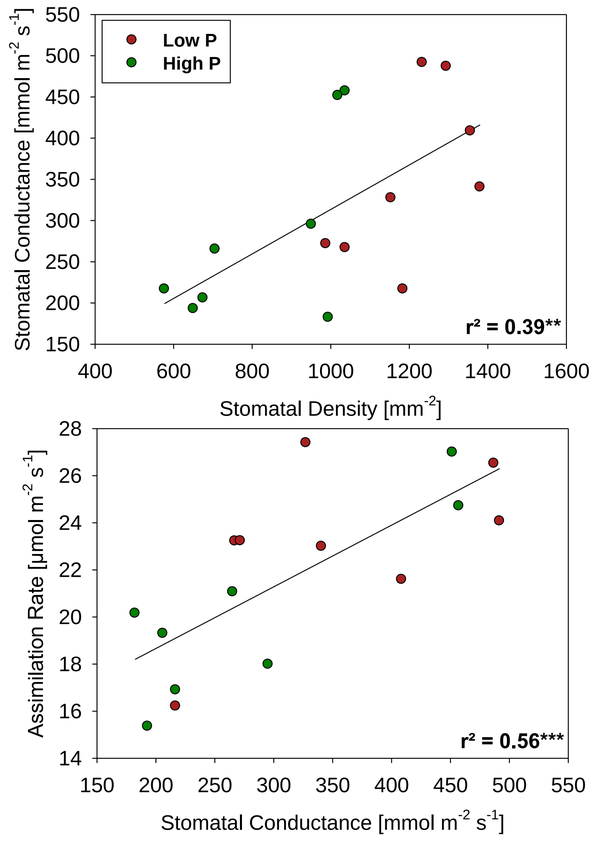
Conclusions

- Reduced leaf expansion in phosphorus-deficient rice plants leads to higher stomatal density in the leaves.
- Increased stomatal density is associated with increased stomatal conductance.
- Results indicate, that P-deficient plants maintain high photosynthetic rates because of a higher stomatal density.

Results and Discussion







- Assimilation rates under P-deficiency were not reduced compared to control
- At high VPD in older leaves, P-deficient leaves showed higher assimilation rates than control leaves
- ▶ Photosynthates are not translocated, but stored in chloroplasts as starch
- ▶ Results suggest that growth of P-deficient plants is sink-limited

- Leaf area is lower in P-deficient plants
- Number of stomata per leaf area is increased, as well as stomatal conductance
- ▶ Absolute number of stomata per leaf is unchanged
- ▶ Stomatal density is increased as a result of reduced leaf expansion

- Higher stomatal density is associated with higher stomatal conductance
- Assimilation rates are closely correlated with stomatal conductance
- ▶ Leaf gas-exchange is facilitated by increased number of stomata
- ▶ P-deficient plants can maintain high assimilation rates because of their high stomatal density

Materials and Methods

In a greenhouse experiment, plants of one rice variety (IR64) were grown hydroponically in „Yoshida“ nutrient solution. Two PO_4^{3-} levels were established, i.e. 0.32 mmol L^{-1} (100%) and 0.04 mmol L^{-1} (12.5%) starting at 24 days after germination. At the same time, plants were transferred into two self-constructed growth chambers, where two different levels of vapour pressure deficit (VPD) were maintained until the end of the experiment. Mean air temperature, relative air humidity and VPD were 26.3°C / 52% / 1.65 kPa and 27.4°C / 84% / 0.60 kPa at high and low VPD, respectively. Assimilation rates at varying CO2 concentratioon were measured with a WALZ GFS-3000 on the same leaves 3 and 5 weeks after onset of treatment. After termination of the gas-exchange measurements, stomatal imprints were produced on the same leaves on both sides, and stomata were counted under a microscope. Leaf area and phosphate concentration in the leaves were determined after destructive sampling.