UNIVERSITY OF HOHENHEIM

1818 2018 200 YEARS

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

Diffusive and Biochemical Contributions to Shade-Induced Alterations of Photosynthesis of Rice During the Reproductive Phase

Marc Schmierer, Oliver Knopf, Folkard Asch

University of Hohenheim, Garbenstraße 13, 70599 Stuttgart, Germany

Background

Tree intercropping is a promising approach to replenish poor soils, mitigate drought events and prevent erosion. However, cereals like rice show large reductions in yield when intercropped within trees. This fact is often attributed to tree-crop competition for nutrients, soil moisture and light.

We therefore combined a yield component analysis of rice plants grown in a climate chamber experiment under 2 different levels of shade (50 and 75 percent compared to a control treatment) and 2 levels of nitrogen-supply with an analysis of limiting components of flag leaves.

Objectives

- How shade and limited N-supply affect photosynthesis throughout the reproductive phase
- If changes in photosynthesis are reflected in yield formation or yield component adjustment
- The contribution of the different limitations to changes in photosynthesis

Results

- Assimilation under growing irradiances stays remarkably constant under low shade, although yield loss was around 80 % (Fig. 1 & Table 1).
- Mesophyll conductance was the main contributor to PS reduction under light saturated photosynthesis (Fig. 2)
- Under low shade, tiller number was the main contributor to yield loss, where under strong shade, all yield components contributed relatively equally to yield loss (Table 1).
- Dynamics in g_m were nor correlated to leaf thickness (Fig. 3)

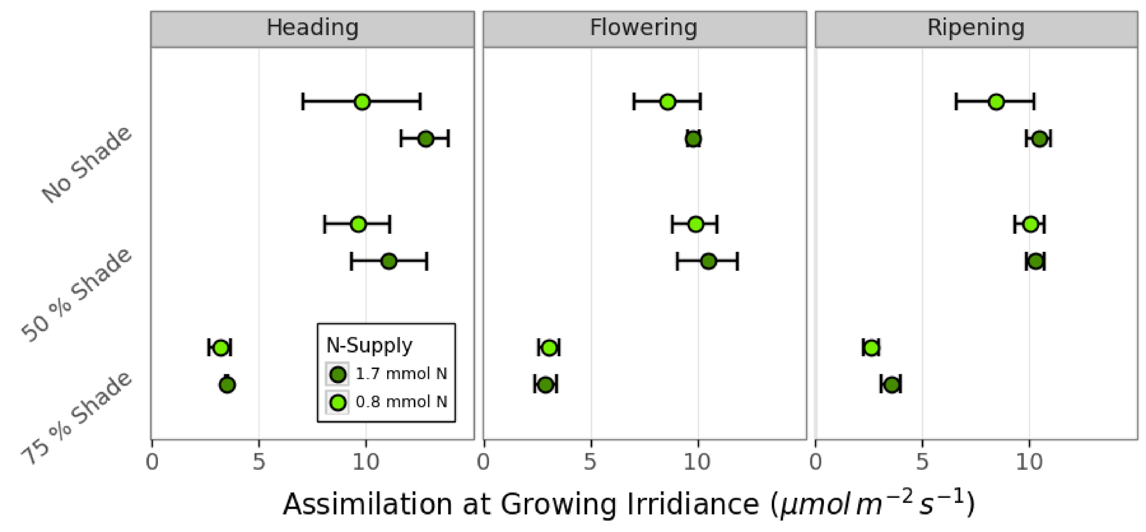

Fig. 1: Photosynthesis rates of rice plants grown under different light conditions and nitrogen supply rates. Measurements were performed under growing irradiances.

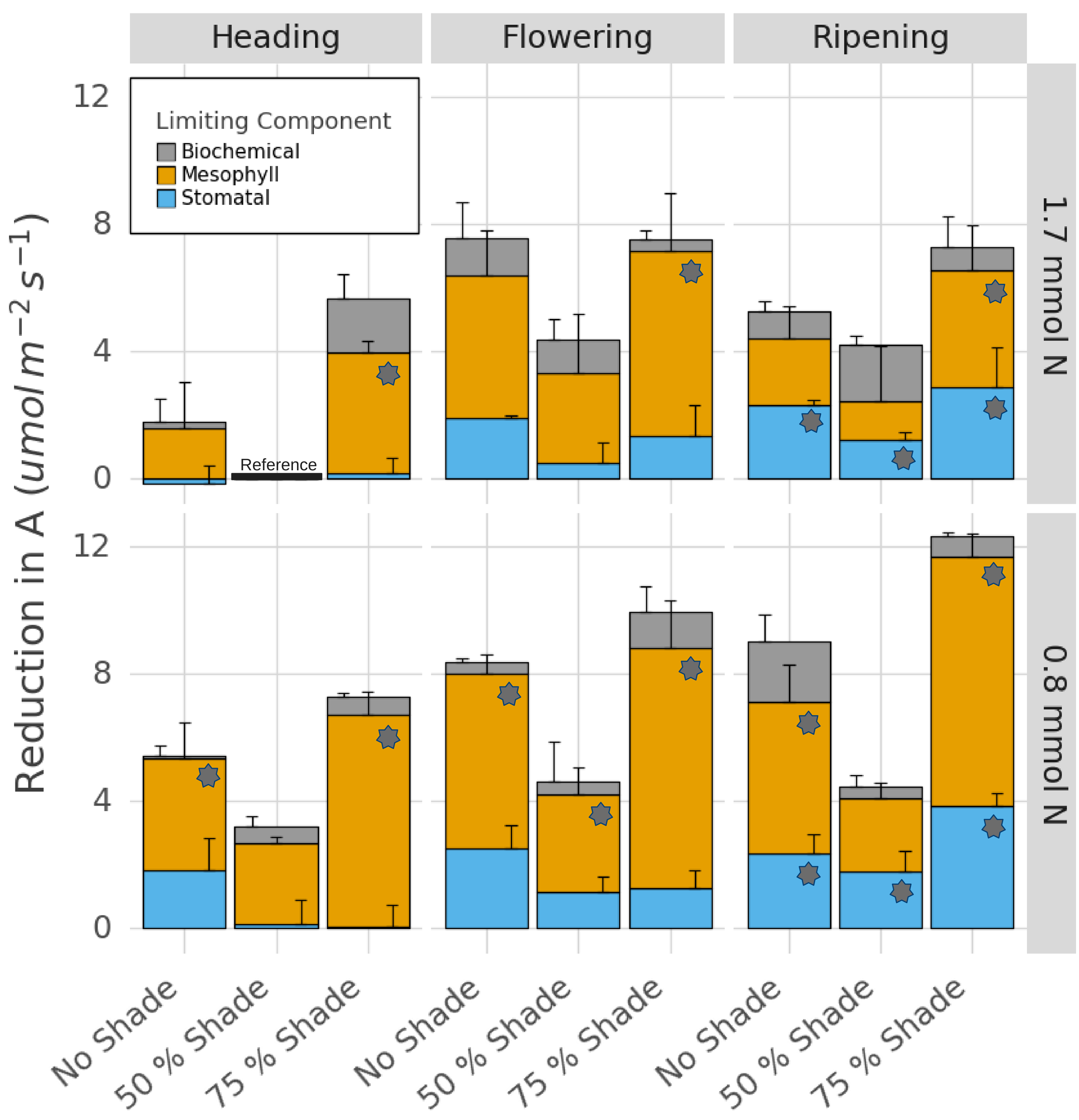

Fig.2: Contribution of different limiting components to the decline in light saturated photosynthesis of shaded and non-shaded rice plants measured during 3 phenological stages. Stars indicate significant differences to the reference value (low shade and high N-supply at heading stage).

Conclusions

- Photosynthesis of flag leaves was strongly decoupled from whole plant yield formation.
- Adjusting mesophyll conductance is part of a compensation mechanism to shade.
- No indication that a change in leaf thickness due to aging or light adaption was causative for the dynamics in g_m, since an underlying relationship between SLA and g_m was not detectable.
- Research should focus on mechanisms involved in adjustment mesophyll conductance

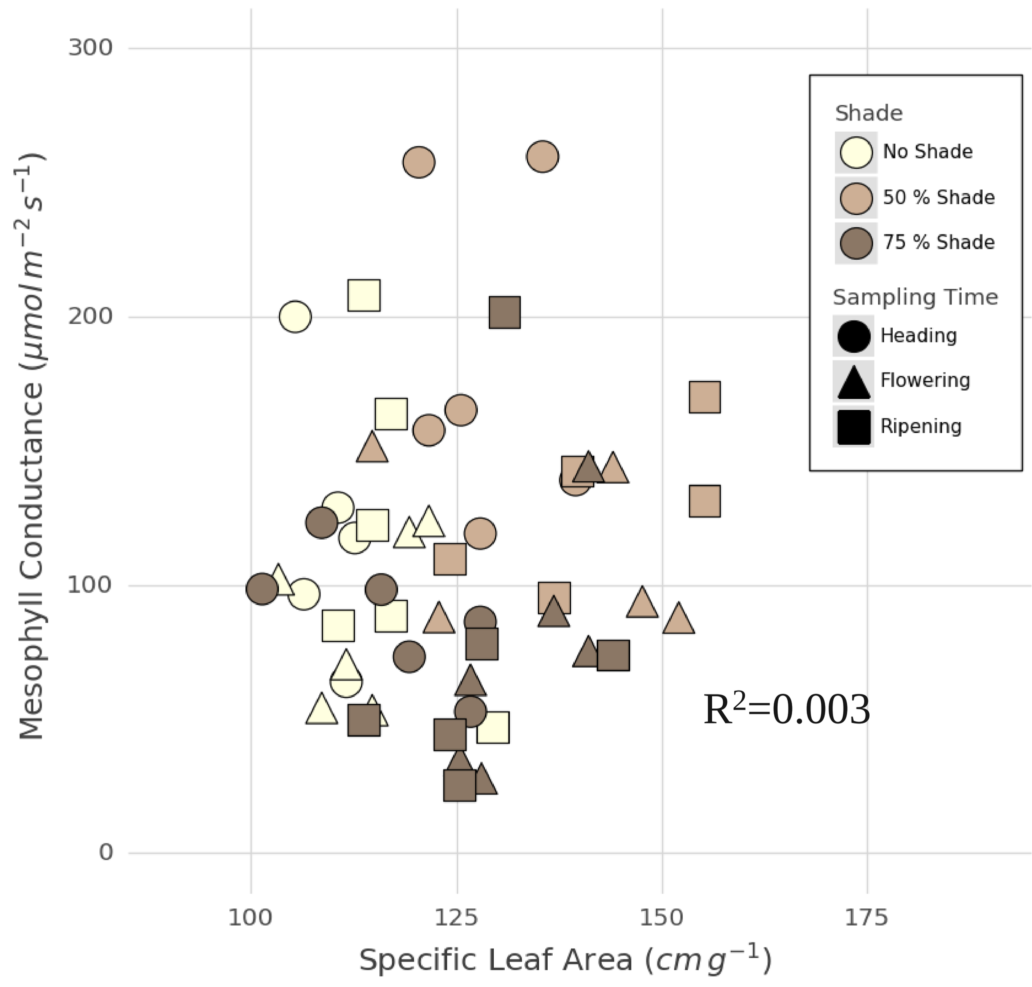

Fig. 3: Mesophyll conductance and SLA of shaded and non-shaded rice plants measured during 3 phenological stages.

Table 1: relative yield loss and contribution of yield components to yield loss of rice plants grown under different irradiances and nitrogen levels.

			Contribution to Relative Yield Loss					
Nitrogen	Light	Relative Yield Loss	Nr. Of Tillers	Prod. Tillers	Kernels per Panicle	Spikelet Filling	Average Kernel weight
	Full light	-	-	-	-	-	-
Full	50 % Shade	0.74	0.58	0.03	0.13	0.04	0.22
	75 % Shade	1.00	0.17	0.22	0.21	0.21	0.18
	Full light	0.01	-0.42	0.31	-0.12	0.08	0.06
Half	50 % Shade	0.80	0.49	0.13	0.04	0.12	0.21
	75 % Shade	1.00	0.19	0.20	0.16	0.22	0.22

Materials and Methods

- 54 plants of a dwarf rice genotype (Id-18h) were grown hydroponically in 18 pots placed in a climate chamber.
- Shading took place via open-top PVC-pipes coated with highly reflected foil and covered with different meshes.
- Nitrogen levels were adjusted via the nutrient solution. Treatments started at panicle initiation.
- Sampling and gas exchange measurements took place during 3 different phenological stages where one plant out of each pot was sampled.
- Gas exchange of flag leaves was measured with a GFS-3000 (Heinz Walz GmbH, Germany).
- A-Ci curves were recorded and biochemical parameters were estimated via a curve fitting method described by Moualeu-Ngangue et al. (2016).
- Photosynthetic limitations were measured under saturating light conditions and calculated as described by Grassi and Magnani (2005).
- Gas exchange data were analyzed via a mixed model considering the 18 pots as a random effect.