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Growth Dynamics and Yield Formation Related to Flag Leaf Photosynthesis and PSii Fluorescence in Rice

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Abstract

The world population is predicted to reach 10 billion people in 2030, requiring a yearly increase in world rice production of more than 1 %. Since urbanisation and land degradation will lead to a severe reduction in growing area in the coming decades, more rice must be produced on less land. On a physiological level, rice yield is determined by the number of reproductive organs per unit ground area and their size. Consistently, most approaches to increase yield target on minimising the difference between the potential and the realised sink size of the plant. While there is a wide agreement in the literature that a high nitrogen content in meristem cells during the early reproductive phase will lead to a greater panicle size, the relation between growth rates during different stages of the reproductive phase and eventual sink size is still unclear. In order to address this question, we conducted a climate chamber experiment comprising 54 rice plants. Growth rates after panicle initiation were manipulated by different levels of irradiance and nitrogen. Destructive samplings and photosynthesis measurements on flag leaves, including fluorescence measurements as well as carbon and light reaction curves were performed at early, mid and late reproductive phase. While growth rates during the early reproductive phase were positively correlated with final yield and yield components, this relation consistently disappeared during later development phases. Correspondingly, correlation between fluorescence and photosynthesis parameters and final sink size was highest when measured pre-heading. Finally, our data indicates that the non-regulated PSII heat-dissipation of flag leaves measured shortly before heading is a promising predictor for constricted sink dimensioning. Remarkably, this is not an effect of stress or N-deficiency induced downregulation of photosystems as will be demonstrated by analysis of supplemental fluorescence and photosynthesis parameters.

Keywords: Non-regulated PSII heat-dissipation, rice, sink dimensioning

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