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"Agricultural development within the rural-urban continuum"

Indoor Plant Production Systems - Effects of Light Quality on Light Transmission Ratio of Rice Canopies

Marc Schmierer, Folkard Asch, Holger Brück

University of Hohenheim, Institute of Plant Production and Agroecology in the Tropics and Subtropics, Germany

Abstract

Climate change related constraints to plant production such as extreme weather events, pests, and soil erosion are stimulating discussions on the feasibility of indoor plant production systems. Concepts are being considered that range from small scale units for specific biochemicals (biofarming) to industrial scale for production of vegetables or ornamental plants. Even though many environmental factors are modifiable in such systems allowing a high degree of control of the growing conditions of plants, artificial environments are far from meeting plant requirements for optimal growth and development. For instance, light intensity and light quality are being kept constant inside a growth chamber for the entire growth cycle despite the fact that light absorption patterns will change as a function of interactions between canopy development and structural components of the growth chamber. Changes in the physical properties of the canopy such as leaf area, leaf angle distribution and the appearance of generative organs may require adjustments over time in both light quality and light intensity to fully meet the requirements for optimal growth and development of the plant

To investigate these kinetics we measured the light distribution above, inside and below a growing rice canopy in a customized growth chamber with specifically developed LED panels. We show that the light transmission ratio of the entire canopy depends on light quality and and on chlorophyll concentration. In addition, we show to what extend the light reflectance and light diffusion properties of the inside of the the growth chamber affect overall light intensity and influence the illumination of lower canopy layers. These results contribute important aspects to the discussion on the optimal light quality for plant growth and specification of future lighting solutions such as LED or sulfur plasma lamps as here the light properties of the entire canopy are taken into account which affect canopy gross photosynthesis (productivity) and phenological development.

Keywords: Canopy extinction coefficient, growth chamber, LED, light penetration, light quality

Contact Address: Marc Schmierer, University of Hohenheim, Inst. of Plant Production and Agroecology in the Tropics and Subtropics, Stuttgart, Germany, e-mail: marc.schmierer@gmail.com