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A hybrid method to estimate light phylloclimate within growth chambers

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In most functional-structural plant models, light is only considered as a consumable resource and plants are usually assumed to be blind to light signals (FSPM04). However, the perception of these signals by the plant is now well documented (e.g. Smith, 1997) and light quality is considered to play a key role in the changes of plant's architecture and the dynamics of vegetation (e.g. Ballaré et al, 1997). In order to introduce the photomorphogenesis process in FSPM, it is necessary to determine how the perception of the light signal occurs on the whole plant. This determination of the perception requires the estimation of light received locally under global controlled environment i.e. in growth chambers.

One way to locally estimate the light is the use of a radiative transfer model based on a virtual plant approach. Such model has to take into account different components such as the light sources characteristics, plant structure and optical properties of the chamber's matters (chelle et al, 2004).

In our study, we present an alternative approach that corresponds to couple measurements with modeling based on the projective method. This approach was first proposed on PAR using a six-face sensor (Chenu et al, 2005). The proposed method improves it by using a home-developed automatic apparatus to characterize not only the spatial variation of light in growth chambers but also its directional (1293 directions) and spectral (300-1100 nm) variation. The used model was VegeStar (Adam et al, 2002).

Results show that the light within a growth chamber varied spatially but also directionally.. The directional variation in the PAR showed higher values of variation coefficient (until 43%) in a field of view of 60° than for grazing directions. Moreover, the contribution of vertical component radiation to hemispherical radiation varied between 31 % close to the wall and 47 % in the center. Using these results, the effect on plant and organ interception estimation in the PAR was analyzed using Vegestar. Assuming a vertical component lead to an underestimation of plant interception compared with the same calculation using the 1293 directions whatever the position in the growth chamber. At an organ scale, as expected, the variability of light interception is higher than at plant scale.

This original approach enables not only to quantify the light spatial, directional and spectral variability but also to bring out the effect of this variability on plant and organ light interception.

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