Basil cultivation without sunlight

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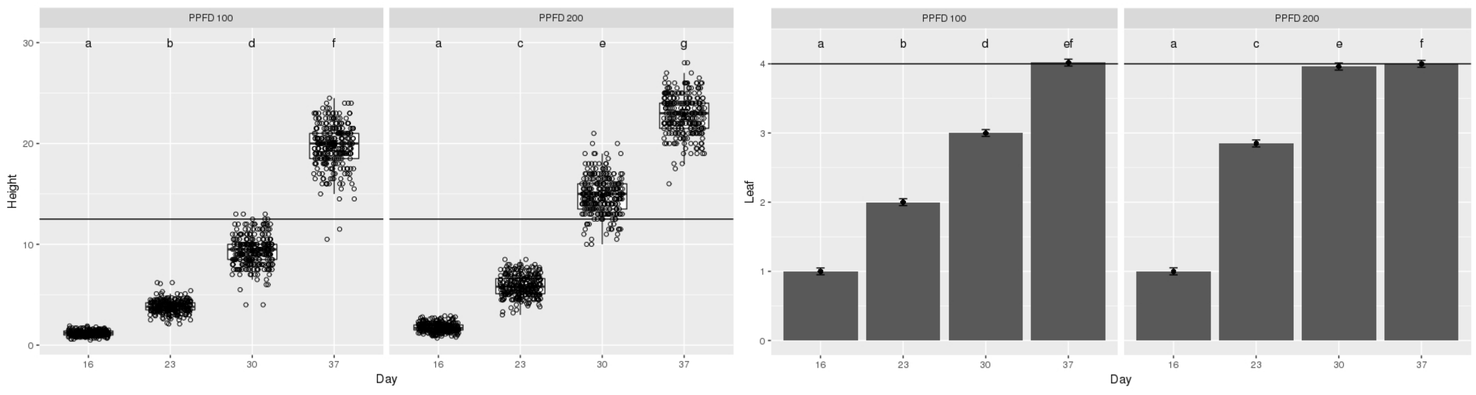
Introduction

To enable a high-quality as well as cost-efficient greenhouse production in Berlin and Brandenburg all year round, an LED light system was developed which optimally reflects the sunlight spectrum in the range of the photosynthetically active (400-700 nm) radiation [Fig.1]. The LED lights also include ultraviolet A and B (280-400 nm) radiation [9,1 and 0,9 W/m^2, respectively], which is believed to increase the production of essential oils and thus the quality of plants.

Material and Methods

To evaluate the effectivity of the LED lights for the cultivation of basil plants, a randomized full-factorial experiment with two different light intensities (PPFD of 100 and 200 µmol/m^2/s) and four independent replications with four basil cultivars (*Ocimum basilicum* L. var. *odoratum* `Anise`, *O. basilicum* L. var. *cinnamomum* `Cinnamon`, *O. basilicum* L. var. *thyrsiflorum* `Thai Magic`, and *O. basilicum* L. var. *purpureum* `Dark Opal`) under the exclusion of natural sunlight was conducted. Weekly, plant height and developmental state of leaves, shoots and flowers of 288 individuals per cultivar and light intensity treatment were assessed. In a second experiment with identical study design, UV-A (315-400 nm) and UV-B (280-315 nm) light were added to the spectrum with the PPFD of 200 µmol/m^2/s. Statistical analyses were performed using the program R. ANOVA with the procedure LME was used to analyze the main effect of light intensity and the measurements over time as well as the main effect of spectral range and chemotype. Differences between treatments were determined by Tukey method at the 5% level ($p \leq 0.05$).

Ocimum basilicum L. var. *odoratum* `Anise`,



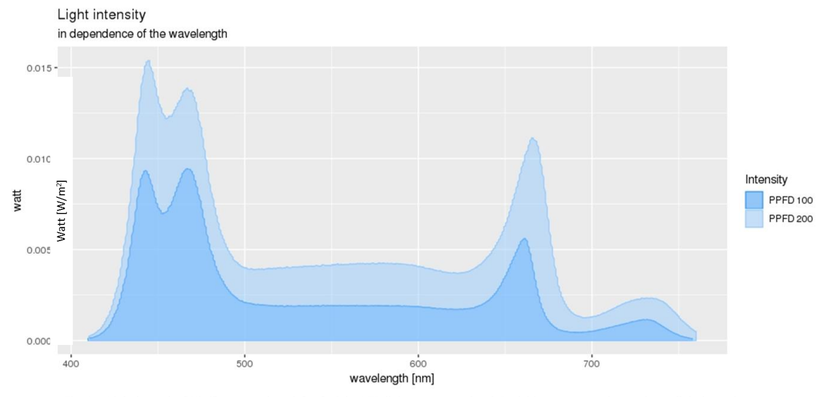
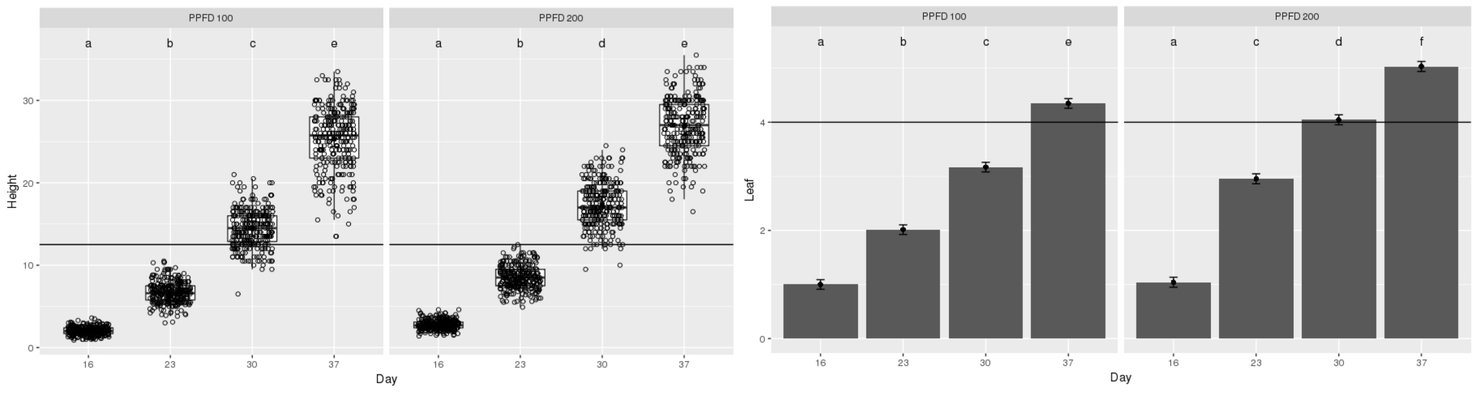
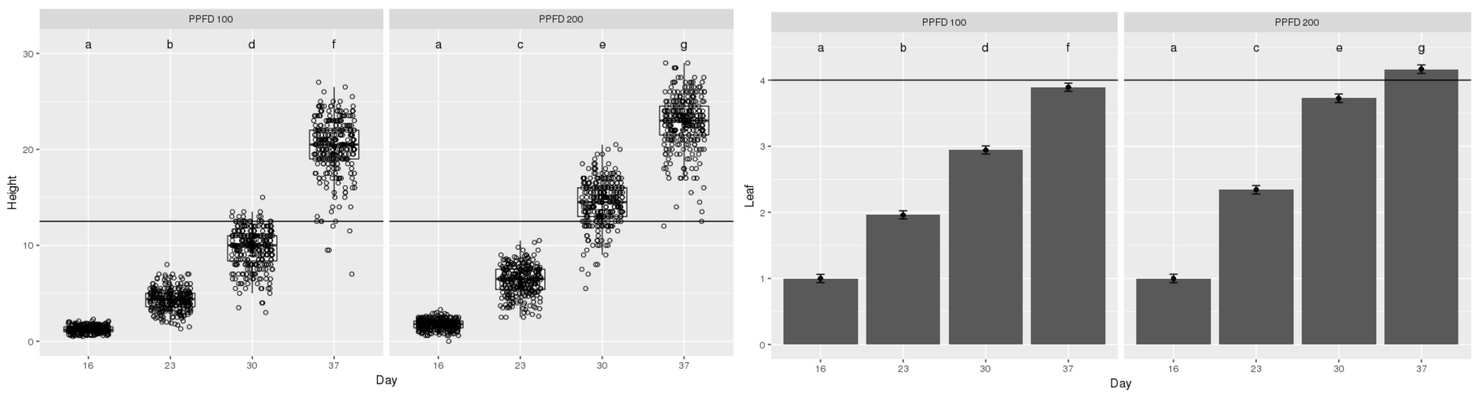


Fig. 1 – Light intensity [W/m²] per wavelength [nm] of the LED lights at canopy level. Dark blue represent the maximum light intensity with a PPFD of 200, light blue depicts the lower light intensity with a PPFD of 100 used in all experiments.

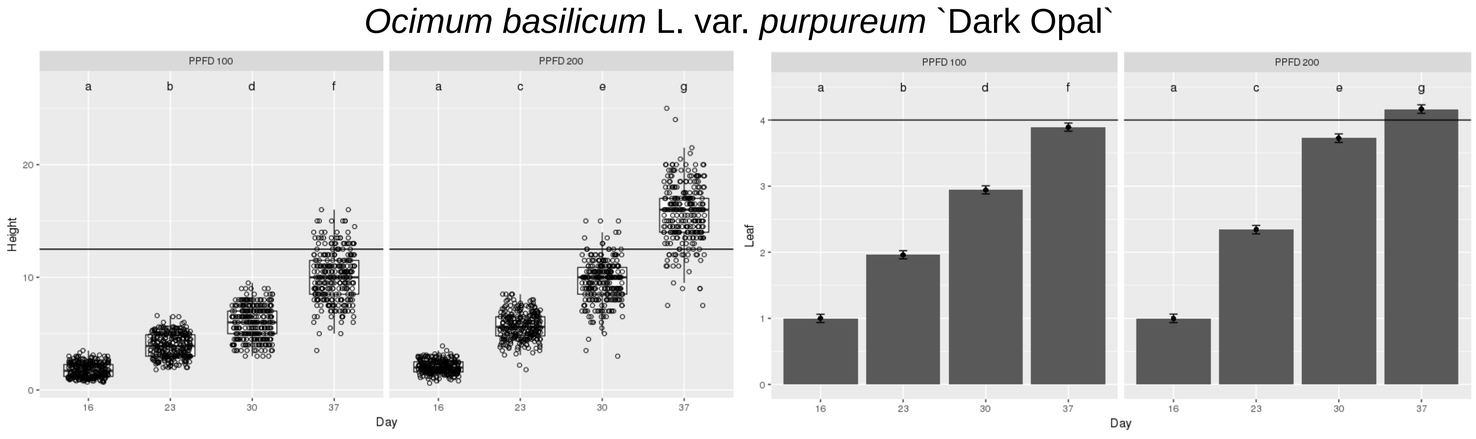
Ocimum basilicum L. var. *cinnamomum* `Cinnamon`

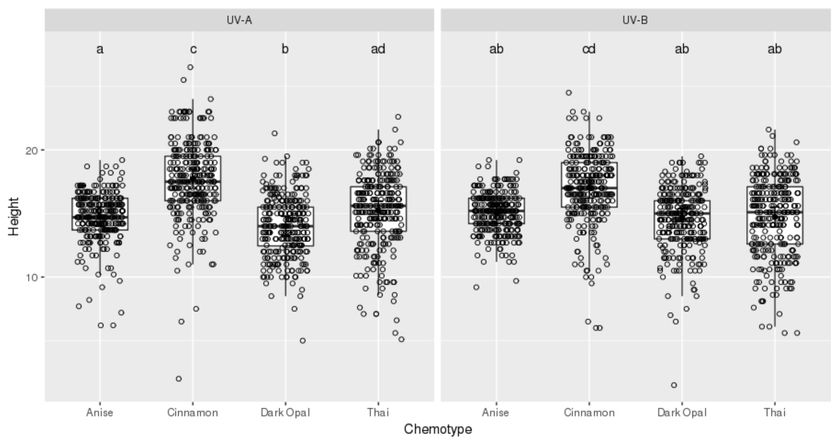


Ocimum basilicum L. var. *thyrsiflorum* `Thai Magic`



Ocimum basilicum L. var. *purpureum* `Dark Opal`





Results I

The weekly assessment demonstrates a significantly faster growth and development of all four basil cultivars when grown under the maximal light intensity with a PPFD of 200 µmol/m^2/s in comparison to basil cultivars grown under the lower light intensity with a PPFD of 100 µmol/m^2/s. Comparable growth results are achieved after not more then one week for basil plants grown under the lower light intensity *(see graphs to the left; black horizontal line represents marketability)*.

Results II

Growth and development of basil cultivars do not differ between both spectral ranges *(see graph below)* but are slowed down by up to nine days in comparison to the results found in the first experiment *(data not shown)*.

Conclusion and Perspective

Within the short cultivation period of four weeks, all basil cultivars grown under the high light intensity reached marketability, which is only met under optimal commercial greenhouse cultivation conditions of the region, and takes up to seven weeks in dependence of the season. A PPFD of 100 µmol/m^2/s as well as the addition of UV radiation delays the development of all four basil cultivars by a maximum of nine days. Under all tested light intensities and spectral ranges, the LED system permits an accelerated as well as target-oriented production of basil under the absence of sunlight. However, a comprehensive final evaluation of the applied LED system will be only possible when the composition of the basil leaves has been properly determined by GC-FID and GC-MS and the outcome of an extensive cost-benefit analysis has been calculated in detail.

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