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ABSTRACT OF PH.D. THESIS: Effect of radiation emitted by light-emitting diodes on photosynthetic metabolism of tomato (*Solanum lycopersicum* L.) plants

Light plays an important role in the regulation of photomorphogenesis related to growth and development and as a source of energy in photosynthesis of diverse plant species. In recent years, light-emitting diodes (LEDs) have been increasingly used for controlled-environment agriculture, as an alternative to other artificial lighting systems. LEDs provide the possibility to regulate the lighting environment during plant cultivation and optimize the spectrum for demands of the different plant species or the stage of ontogenesis. So far, the majority of research have been focused on the effects of red (R), blue (B) and far-red (FR) light and their combination, ignoring the importance of green (G) light, although the G light is an important component of the solar spectrum, and provides energy to drive photosynthesis and signals to control plant development.

The aim of this study was to analyse the effect of light composition emitted by LEDs on the photosynthetic metabolism in the tomato plants (*Solanum lycopersicum* L. cv. Malinowy Ozarowski) and to determine the most optimal ratio of R/G/B light for indoor plants cultivation, with the explicit consideration of the effects exerted by red-to-green light replacement in growth spectrum. Plants were grown in a growth chamber under controlled conditions with constant light intensity and different RB spectrum containing from 0 to 40% of G light replacing R radiation and 25% of B light.

No negative impact on plant growth and development has been noticed due to the replacement of R-to-G radiation in the range of 10 to 30%. On the other hand, the 40% addition of G light to the spectrum induced biomass reduction, elongation of petioles, and upward leaf movement (LIA), collectively referred to as the shade avoidance syndrome (SAS). The addition of G radiation increased the thickness of the spongy mesophyll while reducing the thickness of palisade parenchyma which was more loosely arranged, improving light penetration and increasing the efficiency of G light utilization to drive CO_2 assimilation inside the leaf. Importantly, the G radiation use efficiency was positively correlated with G light percentage in

the applied spectra. The supplementation of G light in the RB spectrum increased plant photochemical efficiency with effective PSII quantum yield (Φ_{PSII}), electron transport rate (ETR_{II}), and chlorophyll fluorescence decrease ratio (R_{Fd}). At the same time, the RGB plants showed reduced accumulation of PsbS protein, violaxanthin deepoxidase (VDE), and PGRL1 protein and in consequence a limitation of non-photochemical energy dissipation (NPQ) rate.

Additionally, the inclusion of G light into the spectrum influenced the geometry of guard cells reducing the stomatal conductance (g_s) and improving water efficiency (*WUE*). At progressively higher G light levels the reduced accumulation of chalcone synthase (CHS) enzyme was also noticed with a concomitant decline of anthocyanins concentration. Such changes were linked to the reduced levels of photoreceptors – cryptochrome (Cry1) and phototropin (Phot1) and the simultaneous accumulation of the PIF5 protein, considered to be a crucial SAS response factor.

In conclusion, the optimization of LED spectrum quality is crucial to adjust the development and growth of plants in order to coordinate the photosynthetic metabolism of CO_2 assimilation and photomorphogenic responses maximizing photosynthetic utilization of light provided in the spectrum.

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