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Light Quality Affects Water Use of Sweet Basil by Changing Its Stomatal Development

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Abstract: Different light qualities affect plant growth and physiological responses, including stomatal openings. However, most researchers have focused on stomatal responses to red and blue light only, and the direct measurement of evapotranspiration has not been examined. Therefore, we quantified the evapotranspiration of sweet basil under various red (R), green (G), and blue (B) combinations using light-emitting diodes (LEDs) and investigated its stomatal responses. Seedlings were subjected to five different spectral treatments for two weeks at a photosynthetic photon flux density of 200 μmol m^{-2} s^{-1}. The ratios of the RGB light intensities were as follows: R 100% (R_{100}), R:G = 75:25 ($R_{75}G_{25}$), R:B = 75:25 ($R_{75}B_{25}$), R:G:B = 60:20:20 ($R_{60}G_{20}B_{20}$), and R:G:B = 31:42:27 ($R_{31}G_{42}B_{27}$). During the experiment, the evapotranspiration of the plants was measured using load cells. Although there were no significant differences in growth parameters among the treatments, the photosynthetic rate and stomatal conductance were higher in plants grown under blue LEDs ($R_{75}B_{25}$, $R_{60}G_{20}B_{20}$, and $R_{31}G_{42}B_{27}$) than in the R_{100} treatment. The amount of water used was different among the treatments (663.5, 726.5, 728.7, 778.0, and 782.1 mL for the R_{100}, $R_{75}G_{25}$, $R_{60}G_{20}B_{20}$, $R_{75}B_{25}$, and $R_{31}G_{42}B_{27}$ treatments, respectively). The stomatal density was correlated with the blue light intensity (p = 0.0024) and with the combined intensity of green and blue light (p = 0.0029); therefore, green light was considered to promote the stomatal development of plants together with blue light. Overall, different light qualities affected the water use of plants by regulating stomatal conductance, including changes in stomatal density.

Keywords: evapotranspiration; stomatal density; green light; *Ocimum basilicum*; load cell; controlled environment

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1. Introduction

Indoor farming has emerged as a new form of agriculture for the future [1]; therefore, considerable effort has been made to understand plant physiology to enhance the productivity of plant production by correctly controlling their growth environment. Artificial light sources have been developed to replace sunlight to grow plants in controlled environmental production systems, and many studies have been conducted to promote the efficiency of the artificial light source and effectively use it for plant production [2,3]. Concurrently, researchers have also aimed to enhance resource use efficiency, including water use efficiency, in indoor farming for sustainable development [4,5].

Plants are greatly affected by light environmental factors, including intensity, direction, wavelength, and light duration. Among these, the study of light quality has been accelerated by the development of light-emitting diode (LED) technology, which is one of the most predominant artificial light sources for plant production [6]. LEDs have many advantages, including small size, durability, low energy consumption, low heat emission, and longevity compared to conventional light sources. LEDs can also provide a specific light spectrum; thus, they are appropriate for studying the effect of light quality on plant behaviors for observing the response of plants to a target wavelength without the interference of other wavelength ranges, and various combinations of light wavelengths can be applied [7].