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Tomato (cv. Bonsai) plant development under different light spectra

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Tomatoes are among the top ten crops most consumed by the population [1,2]. Tomato plants synthesize bioactive carotenoid pigments (lycopene and β -carotene), glycoalkaloids (dehydrotomatine, α -Tomatine and esculoside A), phenolic compounds, and vitamin C [1,3]. These compounds provide antioxidant properties and reduce the risk of cancer developing [4,5]. Growing of tomato plants in controlled conditions of greenhouses gains popularity nowadays, as it allows to get a crop all year round. The light spectrum is an important component that determines plant growth. Therefore the aim of the study was to study the effect of different polychromatic LED light varieties on the growth and development of tomato plants (*Solanum lycopersicum* L. cv. 'Bonsai').

Experiments were carried out in the Federal Scientific Center of the East Asia Terrestrial Biodiversity (FSCATB), Far Eastern Branch of the Russian Academy of Sciences (Vladivostok) in 2019. For the experiment, a different LED light sources were designed and manufactured in the Center of Laser Technologies of the Institute of Automation and Control Processes of the Far Eastern Branch of the Russian Academy of Sciences (IALS RAS, the Far Eastern Branch of the Russian Academy of Sciences). Experimental setup consisted of 4 isolated boxes equipped with LED light sources with different spectral characteristics: full spectrum (FS) - blue+red; RGB - blue+red+green; SunBox (SB) simulating the solar spectrum in the wavelength range of 440–660 nm, and warm white light (WW) used as a control.

The results showed that tomato plants cv Bonsai passed through age-related stages of the seedling and juvenile plant during the first 2 weeks of the experiment. The highest hypocotyl height and cotyledon sizes (length and width) were observed in the seedlings under FS. The maximum length and width of the first leaf of the juvenile plants were also noted in the group of FS box. The minimum sizes of cotyledon leaves and the first leaf were observed in control plants under WW light.

Over the next 1.5 months of development, the plants increased in height by almost 2 times. The maximum height values were typical for plants under FS. Tomatoes grown under RGB light were the leaders in the number of leaves. Values of the leaf size (length and width) and fresh mass of aerial parts were the highest in SB plants. Root fresh mass was identical in plants of all experimental groups, except for the FS plants with the lowest meanings. The maximum ash percentage was observed in FS plants, which was consistent with the data on the amount of water in plants.

When studying stomatal apparatus of leaves, it was shown that the WW light stimulated the stomata formation. The FS light caused the increase in the size of stomata guard cells. The tendency of the inverse relationship between the values of the studied stomata indices remained in all variants of experiment, except the plants under SB, in which the average values of both indices were observed. This combination of stomatal apparatus parameters turned out to be optimal, since SB plants with the largest leaves had the maximum weight of the aerial part.

Thus, the results showed that the spectrum of the FS LED light source provided plant extension, probably due to the greater proportion of red in the spectrum. A 10% decrease in the portion of red light and 10% increase in the portion of green light (RGB light source) led to a development of a larger leaves number and size on tomato plants in comparison with other experimental groups. At the same time, a large portion of green light in the spectrum (40%) contributed to the accumulation of a larger amount of water, which caused the maximum values of fresh aerial and root mass. Meanwhile, the combination of blue, green, and red in SB in proportion of 26%, 41%, 33%, respectively, led to the specific adaptive reaction of the stomatal apparatus in the experiment, which ensured sufficient leaf gas exchange. At the same time, a decrease in blue or green irradiation by 2 times in plants under FS and WW lights caused the formation of a potentially higher stomatal conductivity.

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