The influence of the spectral composition of light on the morphophysiological characteristics of red-leaved basil in hydroponic culture

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Abstract. In this work, morphophysiological reactions to the use of LED-based lamps as a radiation source when grown in an artificial climate on a hydroponic installation are studied using the example of basil plants. Basil plants were grown to technological ripeness. In the experimental samples, the indicators of the accumulation of raw and dry biomass, the area of the leaf surface, etc. were determined. It was found that basil plants can be grown to the stage of technological ripeness in an artificial climate based on light-emitting diodes.

1 Introduction

Increasing yields is one of the priorities of the agricultural complex of Russia. Constantly rising energy prices practically exclude the possibility of off-season production of high-quality vegetables in traditional greenhouse facilities located in areas with extreme natural conditions, even in the volumes necessary to provide fresh vegetables to kindergartens, hospitals and school institutions [6-7].

In the current situation, a systematic approach to the development of scientifically based methods of year-round production of vegetable products in the off-season period directly in the places of its consumption, in areas with extreme natural conditions, becomes a priority for biological and agricultural science. An effective solution to this task will provide an opportunity to organize stable production of a variety of plant products in the conditions of predicted global climate change and environmental degradation.[4-5, 8]

One of the most important stages in the development of an optimal system for growing basil in artificial conditions is the appropriate spectral composition of light. The presence of LEDs with different consecration spectra in the lamp and the technology of independent control of them allows us to study the effect of the spectrum on the efficiency of growing a

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single crop in specific conditions and to develop an optimal balance of the spectral composition of light for better yields [1-3, 10]

The purpose of this work is to study the conditions for the maximum realization of the biological potential of basil plants when grown in artificial agricultural systems with different spectral composition of light on the growth and development of basil plants.

2 Materials and methods

The object of the study was basil plants of the Robin Hood variety grown on hydroponic plants. Robin Hood variety is a plant of medium height, erect. It has a stem strongly colored with anthocyanin. The leaf is medium-sized with a strong anthocyanin color, with a slight undulation along the edge. Petiole of medium length. The color of the corolla is dark purple, the pistil is light purple. The period from full shoots to the beginning of flowering is 65-70 days.

Experimental plants were grown under different spectral compositions in the first variant, light-emitting diodes of red (660 nm) and blue (470 nm) colors were used (Figure1).

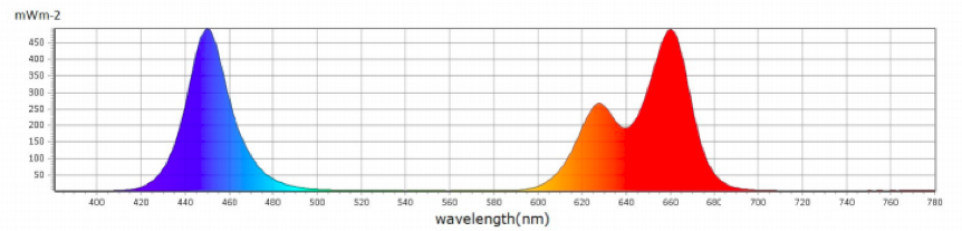


Fig. 1. Spectral composition of light of option No. 1.

In the second variant, light-emitting diodes of white, red (660 nm) and blue (470 nm) colors were used, which was the control (Figure 2).

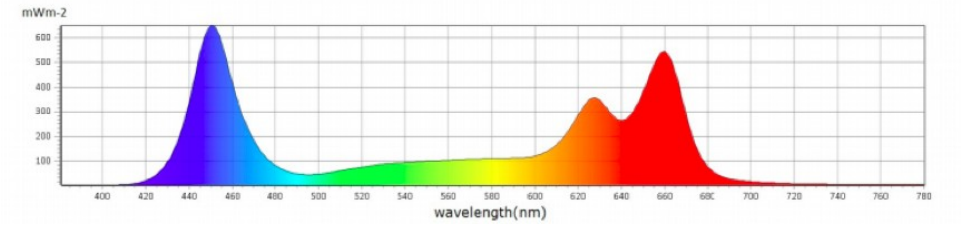


Fig. 2. Spectral composition of the light of option No. 2.

The photon flux density of the used lighting sources was aligned and was 180 micromol/m^2 *s, the established photoperiod was 18 hours. The temperature in the room with plants during the daytime was maintained at 26 °C. At night, the temperature dropped to 18-20 °C.

The plants were grown by the method of flow hydroponics. To prepare a nutrient solution, use a set of FloraSeries fertilizers from the French company GHE, which include all the necessary macro- and microelements [9]. The experimental basil plants were grown by direct sowing of seeds in mineral wool, followed by thinning and leaving 5 plants in each cell. Sampling was carried out twice during the growing season of plants in 15 and 30 and 45 days . The following parameters were studied: determination of leaf area, raw and dry plant mass, etc.

3 Results

The study of biometric indicators allows us to obtain a characteristic of the formation of productivity of the studied plants. The figure shows the dynamics of increasing the height of plants under different spectral composition of light (Figure 3).

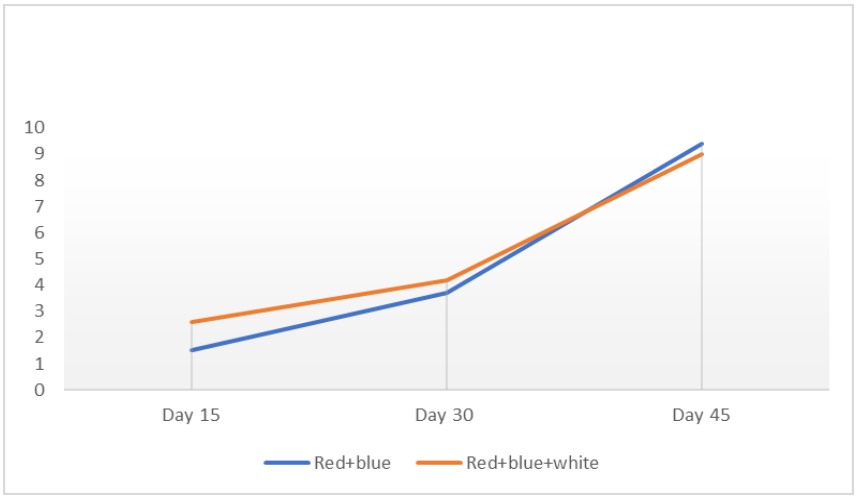


Fig. 3. Dynamics of the increase in the growth of the Robin Hood basil.

The abscissa axis indicates the days of data collection, in this case, on the 15th, 30th and 45th day, on the ordinate axis the height of the basil plant in centimeters. At the end of the growing season, the tallest basil plants were grown under the red and blue spectral composition, which showed more productive results.

In turn, the area of the leaf plate of basil plants changed during the growing season as follows (Figure 4).

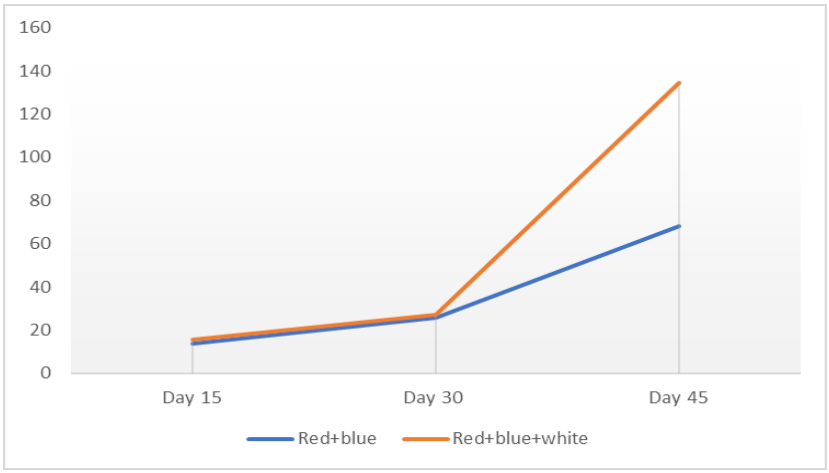
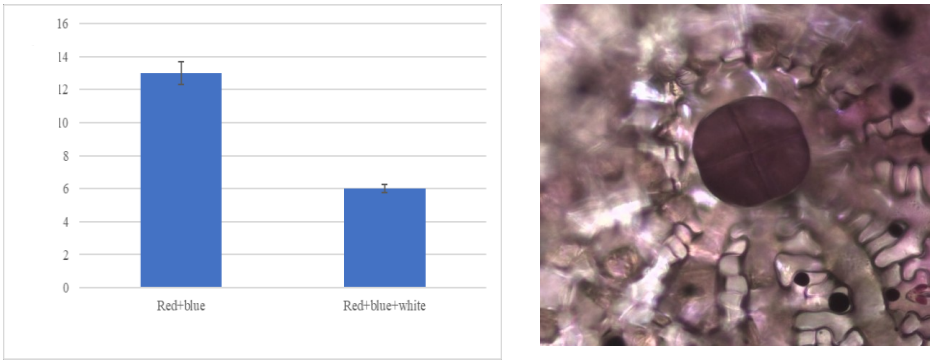


Fig. 4. Dynamics of the increase in the leaf area of the Robin Hood basil.

In the first 15 days, the area of the sheet plate in all the tested samples was at approximately the same level, on the 30th day there were also no serious deviations. The area of the sheet plate was significantly larger in the samples by the 30th day in the

experiment with red, blue and white spectral composition, the result was worse in the sample with red and blue spectrum.

The area of the leaf surface is closely related to the number of essential oil glands (Figure 5b), the larger the area, the more glands. On the 45th day of germination, calculations were carried out in a resolution of 64 microns



a) b)

Fig. 5. a) The effect of the spectral composition of light on the number of essential oil glands; b) The type of essential oil glands under a microscope at a magnification of 640 microns.

From the diagram (Figure 5a) it is clearly seen that in the variant with red, blue and white light, a smaller number of essential oil glands are formed. The largest number of them accounted for the red and blue radiation spectrum.

The data obtained on the height of the plant and the area of the leaf surface help to study the mechanisms of formation of the plant organism, however, the most important indicator that will allow us to assess the phase of commercial ripeness is the dynamics of biomass accumulation (Table 1).

Table 1. Summary table of average values for the main morphological indicators.

Variant	Fresh matter, g		Dry matter, g	
	30 days	45 days	30 days	45 days
Red+blue	0.55 ± 0.12	17.12 ± 3.17	0.03±0.007	0.99±0.18
Red+blue+white	0.49±0.12	24.88 ± 5.70	0.041±0.003	2.2±0.21

In this experiment, a pattern can be traced between the quality of light and the accumulation of raw biomass in plants. In the same way as in the previous experiment with the leaf area on day 45, the red blue and white spectrum showed itself in the best way, red and blue are slightly worse.

4 Discussion

The study of the effect of spectral composition on the morphophysiological reactions of basil plants is still of scientific interest. The basil plants of the Robin Hood variety grown under red, blue and white light increased the raw mass on the 45th day of growing on hydroponics. Also, this lighting contributed to an increase in the area of the leaf surface by 50, 4%. It is important to note that the effect of red and blue without the addition of white light on the number of essential oil glands, which in this variant increased by 44.6%.

5 Conclusion

Thus, it is possible to grow anthocyanin forms of basil under LED lighting with different spectral composition of light. Biometric indicators of basil plants vary in a wide range, depending on the growing conditions. To obtain the greatest aboveground mass, we can use the red, blue and white lighting spectrum, and to obtain more fragrant products, grow basil plants of the Red Ruby variety under the red and blue spectrum.

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