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THE INFLUENCE OF BLUE LIGHT ON THE *Dionaea muscipula* CULTIVATION

ODDZIAŁYWANIE ŚWIATŁA NIEBIESKIEGO NA HODOWLĘ *Dionaea muscipula*

Abstract: Plants use light as a source of energy for photosynthesis, they react to its intensity, the wavelength of light and the direction of light, and it is a kind of environmental signal. Light is received by plant photoreceptors, such as cryptochromes, phototropics and phytochromes, and plants generate a wide range of specific physiological responses through these receptors. Two plant cultures consisting of two varieties of *Dionaea muscipula*: Regular form and Red green were used for the study. One of the cultures was exposed to blue light, and the other one was run under sunlight. Morphological measurements of plants were carried out, such as: length, width and number of leaves, size and color of the trap, the amount of flower shoots produced and the impact of plant extract on pathogenic microorganisms over a period of three months. The studies confirmed differences between the cultivation carried out with the use of blue light and the control culture. Among other things, a significant acceleration of the growth of the assimilatory part of the leaf was observed, as well as a slowdown in the growth of the leaf trap with the loss of its coloring.

Keywords: American flycatcher, blue light, sunlight, morphology of *Dionaea muscipula*

Introduction

There are many biotic and abiotic factors that affect the proper development of plants [1]. In addition to temperature and humidity, the most important of them seems to be light, the most common source of which is the sun having a significant impact on the growth and development of plants. Thanks to the influence of light, the energy of photons is converted into chemical energy [2, 3]. Solar radiation allows the plant to conduct photosynthesis and affects the functioning of genes that control metabolism. The wavelength of light that can regulate the growth of plants and the speed of their growth is the very essence of light. The energy-saving Light Emitting Diode (LED), which allows to shorten the production cycle and gives control over plant growth, enjoys great interest among scientists and producers [3-5]. The range of blue light used in the research is about 420-490 nm.

Dionaea musciupla

Dionaea muscipula of the *Droseraceae* family is a monotypic type of insectivorous plant. Despite its completely different appearance, it is often confused with *Drosera capensis*. In the natural environment, we can encounter it in North and South Carolina, where it is an endangered and protected plant. On an industrial scale, it is propagated by *in vitro* culture, making it easily available for breeders, and this in turn has led to the creation of many new, attractive cultivars [6, 7].

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American flycatcher is very attractive because of its morphology and a characteristic way of eating. The underground part of the plant consists of a bundle root system, a few to a dozen centimetres long, growing from a tuber located up to the maximum of 10 cm below the surface of the ground. The aboveground section is composed of the heart-shaped assimilation part of the leaf and the other element of the leaf which is transformed into a trap. The trap, about 3 cm long, is composed of two blades covered with an average of three sensory hairs each. The blades are completed with about twenty pairs of teeth. At the turn of spring and summer, *Dionaea muscipula* also produces about 30 cm-long flower shoots, this length prevents the capture of insects which pollinate flowers. White flowers of a flycatcher are composed of 5 white petals and a dozen stamens arranged around the post. The plant has a diameter of about 20 cm and matures after 4-5 years [8, 9].

Fig. 1. *Dionaea muscipula:* assimilation part of the leaf and a trap

Blue light

The spectrum of light strongly affects the development and physiology of a plant blue light is involved in many plant processes, such as photo-morphogenesis, phototropism, stomata and photosynthetic functioning. The blue light is free from the harmful effects of ultraviolet radiation. It is located in the spectral range of visible light since its wavelength ranges from 420 to 490 nanometers [10-12].

Materials and methods

In order to start cultivation, 32 items of plants of the *Dionaea musciupula* genus were bought, including 16 items of Regular form and 16 items of Red green. The plants were divided into two cultivations which were subjected to the interaction of different types of light. The plants were grown for three months.

The substrate on which *Dionaea muscipula* developed consisted of a mixture of peat and coarse sand at the ratio of 2:1 at pH 4 and due to the preferences of the plant did not require fertilization. This substrate was put in a plastic, round pot with a diameter of 16 cm,

under which a saucer was placed. The culture was watered with medium frequency every other day using distilled water. The soaking technique was applied that is about 1 cm of distilled water was poured to the stand and the operation was repeated after the excess of previously poured water had dried. The plant was not sprayed from the outside as that could lead to precipitation. Systematic watering of plants enabled them to grow properly. During the three-month observation, the plants were not replanted. In the cultivation test, dead parts of the plants were removed on a current basis due to the risk of mold growing on the surface of the substrate. Removal of the dead parts of the plant was carried out with the use of a scalpel to minimize the risk of damaging healthy parts of the plant.

Both cultivations consisted of 8 plants of the Regular form variety and 8 plants of the Red green one. The first group of plants was subjected to the influence of Osram Lumilux L/36W/67 blue light for 19 hours a day, while the second group was exposed to sunlight.

Results and discussion

The results illustrate the multidirectional influence of blue light on both varieties of *Dionaea muscipula*.

After three months in the culture with the use of blue light, there were on average twice as many leaves as in the control group, where there appeared slightly more of them (Fig. 2).

Changes appeared also in the case of different leaf lengths. Under the influence of blue light, Regular form increased by as much as 5.5 cm, and Red green by 4 cm as compared to sunlight, where the increase for both varieties was 1.5 and 2 cm respectively. The blue light affected the significant accelerated increase in the length of *Dionaea muscipula* leaves of both varieties (Fig. 3).

The blue light caused a loss of ~ 23% of the length of the trap in the case of the Regular form variety and a little smaller one of about ~ 13% in the case of Red green. On the other hand, sunlight caused a slight increase in the length of traps in the case of Red green by ~ 6.5% and did not cause changes in the case of Regular form (Fig. 4).

The assimilation part of the leaf is located below the trap and the widest part of its heart shape was measured. Measurements of the assimilation part of the leaf allowed to conclude that the development of the leaf width after the treatment with blue light was almost inhibited as compared to the control sample with the use of blue light, where the assimilation part of the leaf expanded by 0.5 cm for the Regular form variety and 0.6 cm for the Red green variety (Fig. 5).

It is worth noting that both varieties almost completely lost the colour of the inner side of the traps, red in the case of Regular form and red-burgundy in the case of the Red green variety. This coloration is extremely important in the process of attracting insects. Sunlight did not change the colour of the traps during the observation period (Fig. 6).

In the spring, *Dionaea muscipula* releases flower shoots which produce seeds after pollination. It is one of the most common methods of multiplication of American flycatcher. Blue light compared to the control sample resulted in the creation of ~ 42% more flower shoots in the case of Regular form and ~ 33% in the case of the Red green cultivar over three months of growing (Fig. 7).

In addition, it was proved that plant extracts from the conducted cultivation with the use of blue light give better results in the biting impact on pathogenic microorganisms in comparison to the control sample using sunlight (Fig. 8).

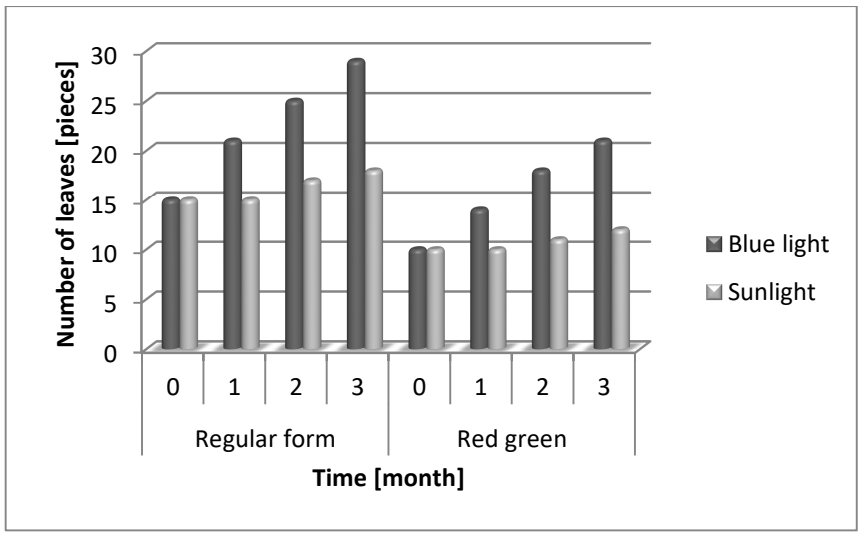

Fig. 2. The number of leaves in cultures containing two varieties of *Dionaea muscipula*: Regular form and Red green, irradiated with blue light and sunlight, within three months

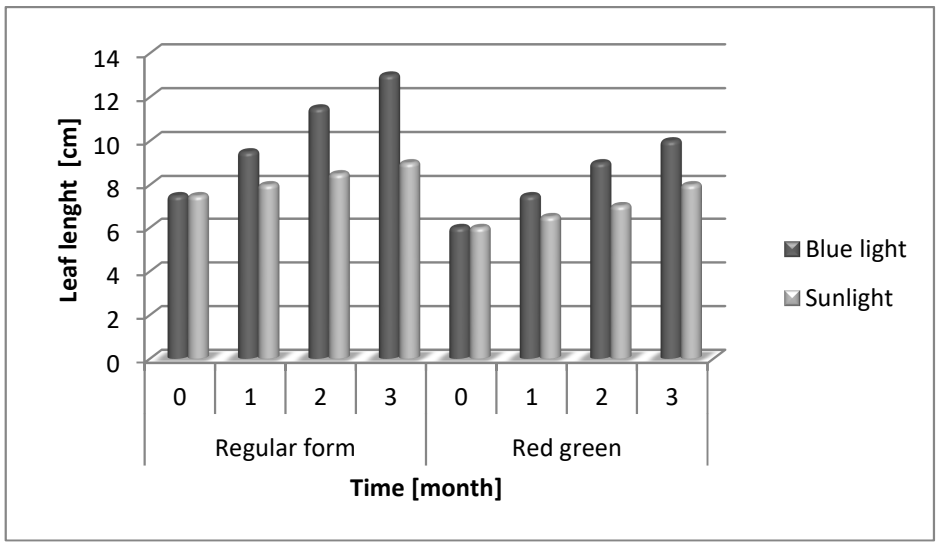

Fig. 3. Mean leaf length in cultures containing two varieties of *Dionaea muscipula*: Regular form and Red green, irradiated with blue light and sunlight, within three months

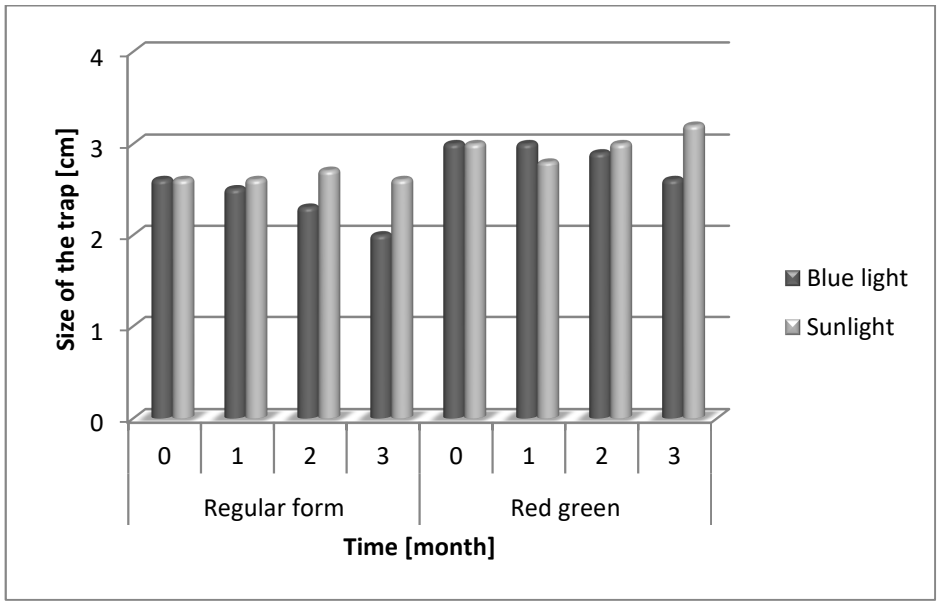

Fig. 4. The average size of traps given in cm in cultures containing two varieties of *Dionaea muscipula*: Regular form and Red green, irradiated with blue light and sunlight, within three months

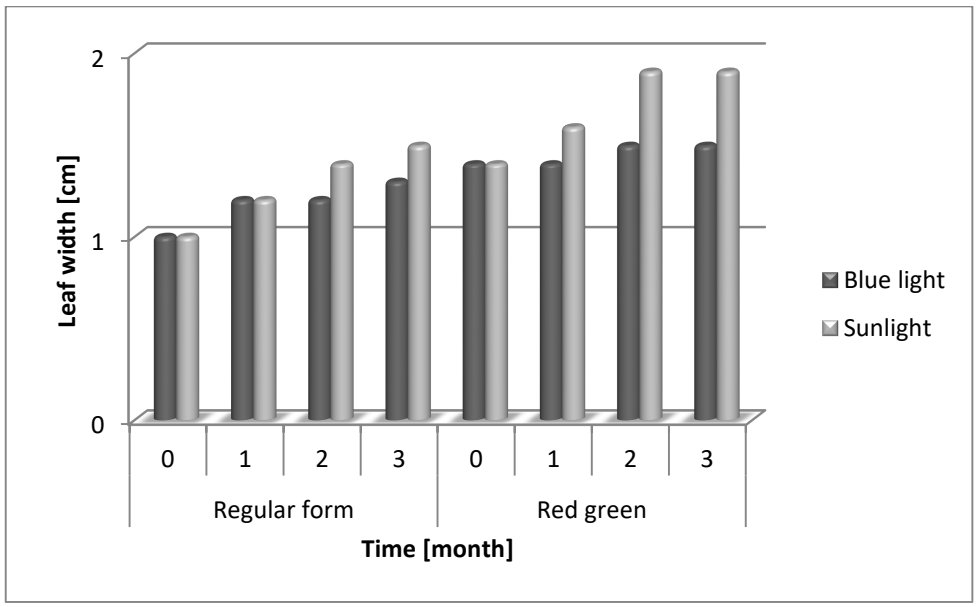

Fig. 5. The average width of the leaf assimilation part in cultures containing two varieties of *Dionaea muscipula*: Regular form and Red green, irradiated with blue light and sunlight, within three months

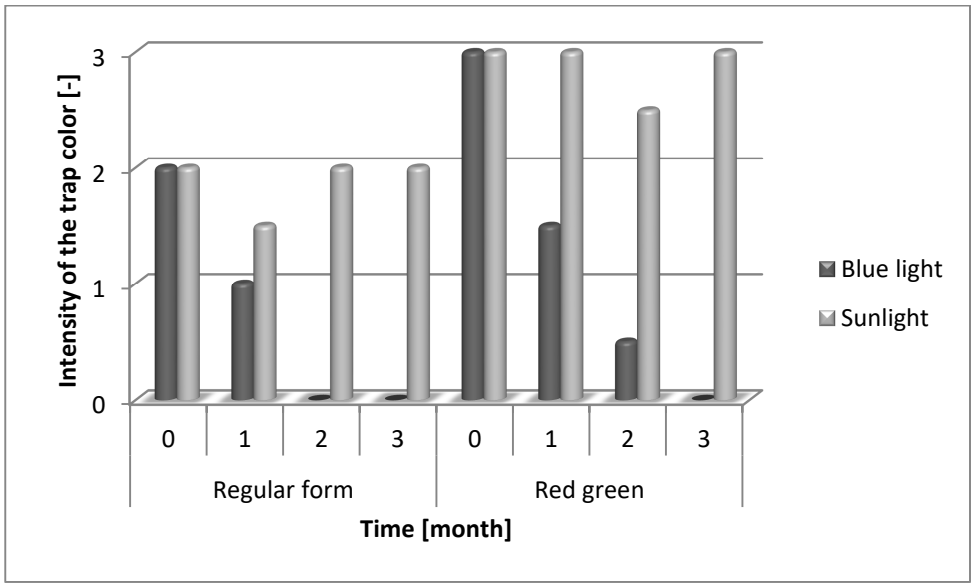

Fig. 6. Intensity of the trap in cultures containing two cultivars of *Dionaea muscipula*: Regular form and Red green, irradiated with blue light and sunlight, within three months on a scale: 0 - no change/staining poorly noticeable; 1 - low intensity; 2 - medium intensity; 3 - high intensity

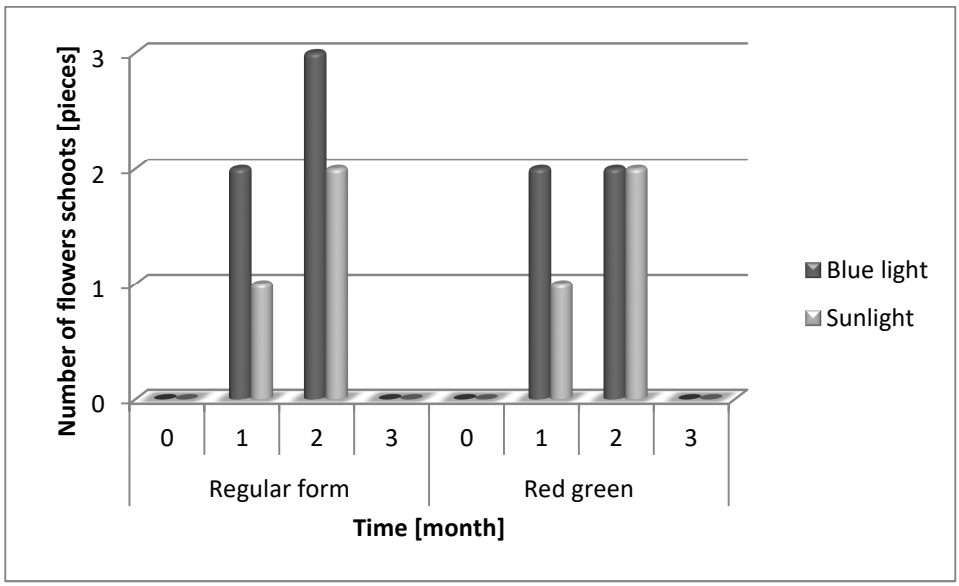

Fig. 7. Number of flower buds in cultures containing two varieties of *Dionaea muscipula*: Regular form and Red green, irradiated with blue light and sunlight, in three months on a scale: 0 - none; 1 - little < 17; 2 - many > 16 ~ < 33; 3 - a lot > 32

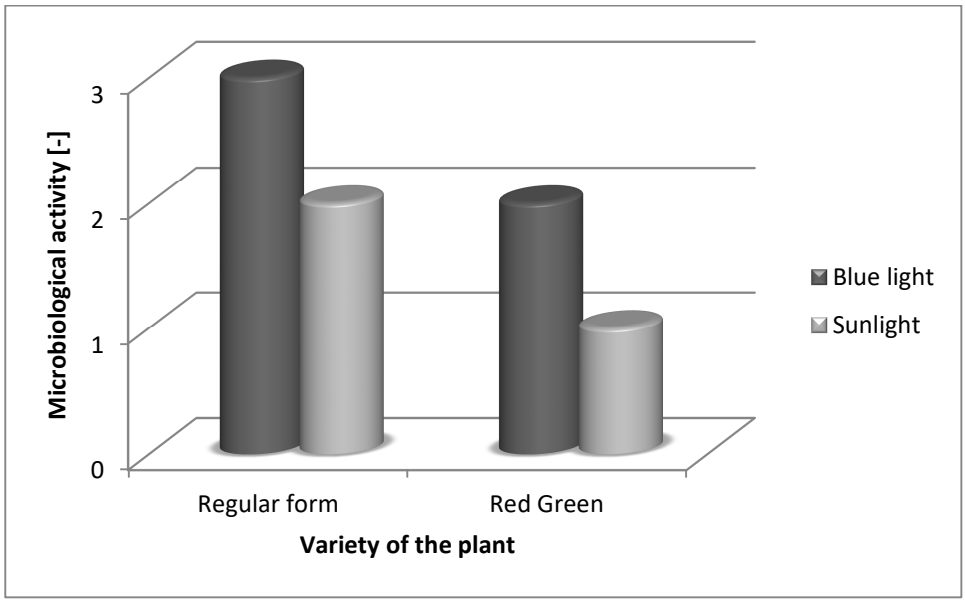

Fig. 8. Biological activity in cultures containing two varieties of *Dionaea muscipula*: Regular form and Red green, irradiated with blue light and sunlight, within three months on a scale: 1 - low activity; 2 - medium activity; 3 - high activity [13]

Most research assessing the effect of blue light (LEDs) on a leaf or the entire plant compared the response to a broadband light source with a response to the lack of blue light [14]. In contrast to many studies carried out by modern scientists in other species, *Dionaea muscipula* reacts very positively after exposure to blue light for three months. This testifies to the different effects of blue light on different species. Not all species research benefit from blue light as *Dionaea muscipula* does [15, 16].

Conclusions

The research shows that plant cultures of *Dionaea muscipula* subjected to the influence of blue light have developed much more, longer leaves than those subjected to the influence of sunlight. There were also definitely more flower shoots in comparison to the control group. The rapid growth of plants irradiated with blue light made it impossible to produce larger sizes of leaves transformed into traps, and the assimilation part of the leaf became narrower. The lack of sunlight led to a loss of color (red or red-maroon) traps. It can be assumed that the part used for catching insects has become less attractive for them, but there is a greater number of traps. Attention should also be paid to the more beneficial effect of plant extracts from *Dionaea muscipula* from cultures exposed to blue light to pathogenic microorganisms. In summary, blue light can be beneficial for plant cultivation *Dionaea muscipula* depending on the effect we want to achieve.

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ODDZIAŁYWANIE ŚWIATŁA NIEBIESKIEGO NA HODOWLĘ *Dionaea muscipula*

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Abstrakt: Rośliny wykorzystują światło jako źródło energii do fotosyntezy, reagują na jego intensywność, długość fali świetlnej i kierunek światła. Jest ono także swoistym sygnałem środowiskowym. Światło jest odbierane przez fotoreceptory roślin, takie jak: kryptochromy, fototropiny oraz fitochromy, a rośliny generują szeroki zakres specyficznych odpowiedzi fizjologicznych przez te receptory. Do badań wykorzystano dwie hodowle roślinne składające się z dwóch odmian muchołówki amerykańskiej - *Dionaea muscipula*: Regular form oraz Red green. Jedną z hodowli poddano oddziaływaniu światła niebieskiego, a drugą - kontrolną prowadzono w warunkach oddziaływania światła słonecznego. Prowadzono pomiary morfologiczne roślin, takie jak: długość, szerokość oraz ilość liści, rozmiar oraz wybarwienie pułapki, ilość wytworzonych pędów kwiatowych oraz oddziaływanie ekstraktu roślinnego na mikroorganizmy patogenne przez okres trzech miesięcy. Badania potwierdziły różnice pomiędzy hodowlą prowadzoną z użyciem światła niebieskiego a hodowlą kontrolną. Zaobserwowano między innymi znaczne przyspieszenie wzrostu części asymilacyjnej liścia oraz spowolnienie wzrostu pułapki liściowej wraz z utratą jej wybarwienia.

Słowa kluczowe: muchołówka amerykańska, światło niebieskie, światło słoneczne, morfologia *Dionaea muscipula*