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POSTHARVEST LONGEVITY OF CUT HYACINTHS DEPENDING ON LIGHT COLOUR AND TYPES OF LAMPS

TRWAŁOŚĆ POZBIORCZA CIĘTYCH HIACYNTÓW W ZALEŻNOŚCI OD BARWY ŚWIATŁA I TYPU LAMP

Abstract

Background. Reports indicate the possibility of extending postharvest longevity of cut flowers using artificial light. Hyacinths are increasingly often used as cut flowers nowadays. There is no information concerning postharvest lightening of these flowers using artificial light. The aim of the study was to assess the effect of light colour and light source on postharvest longevity and quality features of cut hyacinths.

Material and methods. Inflorescence shoots of hyacinth cv. 'Anna Marie' and 'Blue Star' were obtained from plants forced in a greenhouse. They were excised from bulbs. Shoots were cooled at 2°C for 24 h and placed on stands with artificial light. Inflorescence shoots were put into glass vases filled with water. White light, red light and red-blue light were used in the experiment. Philips TLD fluorescent lamps and Leutech LED Tube lamps were used. Quantum irradiance was 20 $\mu mol \cdot m^{-2} \cdot s^{-1}$. Artificial lighting was applied for 9 h a day. Postharvest longevity and quality of inflorescence shoots were evaluated.

Results. Postharvest longevity of inflorescence shoots of hyacinth 'Anna Marie' at the stage of the first dry flower in inflorescence was by about 1.5 days longer after using red-blue and white light than red light. Inflorescence shoots of hyacinth 'Blue Star' at the stage of the first dry flower in inflorescence was approx. 1 day longer when red-blue light colour was used in comparison to white light.

Conclusions. The red-blue colour of light extended postharvest longevity of inflorescence shoots in hyacinth 'Anna Marie' and 'Blue Star'. White colour of light prolonged vase life of hyacinth 'Anna Marie' and at the stage of ⅓ discoloured flowers in the inflorescence in hyacinth 'Blue Star'. The red colour of light increased only shoot length of hyacinth 'Blue Star' at the stage of ⅓ discoloured flowers in the inflorescence. Weight change of inflorescence shoots did not depend on light colour. The source of light (fluorescent vs. LED) had no effect on postharvest longevity, increase in length or weight change of inflorescence shoots in hyacinth 'Anna Marie' and 'Blue Star'.

Keywords: longevity, hyacinth, artificial light

Krzymińska, A., Karasiewicz, M. (2017). Postharvest longevity of cut hyacinths depending on light colour and types of lamps. Nauka Przyr. Technol., 11, 1, 55–64. http://dx.doi.org/10.17306/J.NPT.00175

Introduction

Hyacinths (*Hyacinthus orientalis* L.) are important bulbous plants. In horticultural production they are used primarily for pot culture. In recent years they have been gaining in popularity also as cut flowers. In terms of the turnover value in Holland hyacinths rank among the top ten most important cut plants. In Poland no such ranking is prepared. Leaving a fragment of the basal plate at the hyacinth shoot base promotes the production of cut flowers of superior quality and extended longevity (Swart, 1990). Their vase life is estimated at 7 days (Sacalis, 1998). After harvest cut flowers are typically stored in the dark. Reid and Evans (1986) reported that flower buds of carnations and inflorescence buds of chrysanthemums open more readily and postharvest longevity of cut flowers is extended when they are kept in lighted facilities rather than in the dark. At present when various light sources emitting an extensive range of light colours are available, optimal storage conditions may be specified for cut flower and florist green (Heo et al., 2004; Rabiza-Świder and Skutnik, 2004). In view of the above the aim of this study was to determine postharvest longevity of cut hyacinths lighted using two lamp types and three light colours.

Material and methods

The experiment was run at a growth chamber of the Department of Ornamental Plants, the Poznań University of Life Sciences from 15 February to 15 March 2011. Inflorescence shoots of common hyacinth 'Anna Marie' and 'Blue Star' were obtained from plants forced in a greenhouse. Bulbs of 17-18 cm in diameter were planted on 22 October 2010 to pots filled with deacidified peat at pH 6.5. After cooling in a facility at 9°C for 6 weeks and at 5°C for 8 weeks plants were transferred to a greenhouse on 28 January 2011. Throughout the culture period the temperature was maintained at 14–16°C. Flowers were harvested at the stage of the first coloured and opening flowers in the inflorescence. Shoots were excised from bulbs leaving a fragment of the basal plate at the base. The mean shoot length in 'Anna Marie' was 26 cm, while in 'Blue Star' it was 18 cm, with their mean mass at 62.4 g and 44.8 g, respectively. Shoot bases were washed in water and afterwards shoots were placed in glass vases of 1 dm^3, immersing them in water to a depth of 1.5 cm. Water in the vases was replaced daily. During the first 24 h inflorescence shoots were cooled in the facility with no access to light at a temperature of 2°C, and then placed on stands under artificial lighting. Light sources (the first experimental factor) included Philips TLD fluorescent lamps and Leutech LED Tube lamps. The distance between lamps and shoot tips was regulated to provide the quantum irradiance of 20 $\mu mol \cdot m^{-2} \cdot s^{-1}$. The lighting period was 9 h a day, from 7.00 to 16.00, with the temperature maintained at 16–17°C. The used lamp types emitted light of various colours (the second experimental factor) – white, red and red-blue (1 : 1). Spectral characteristics of these lamps are presented in Figures 1 and 2. One experimental combination comprised three replications, each of three inflorescence shoots.

The following data were recorded in the experiment: the date when vases with cut hyacinths were placed on stands, the date of colour change in ⅓ flowers in inflorescence

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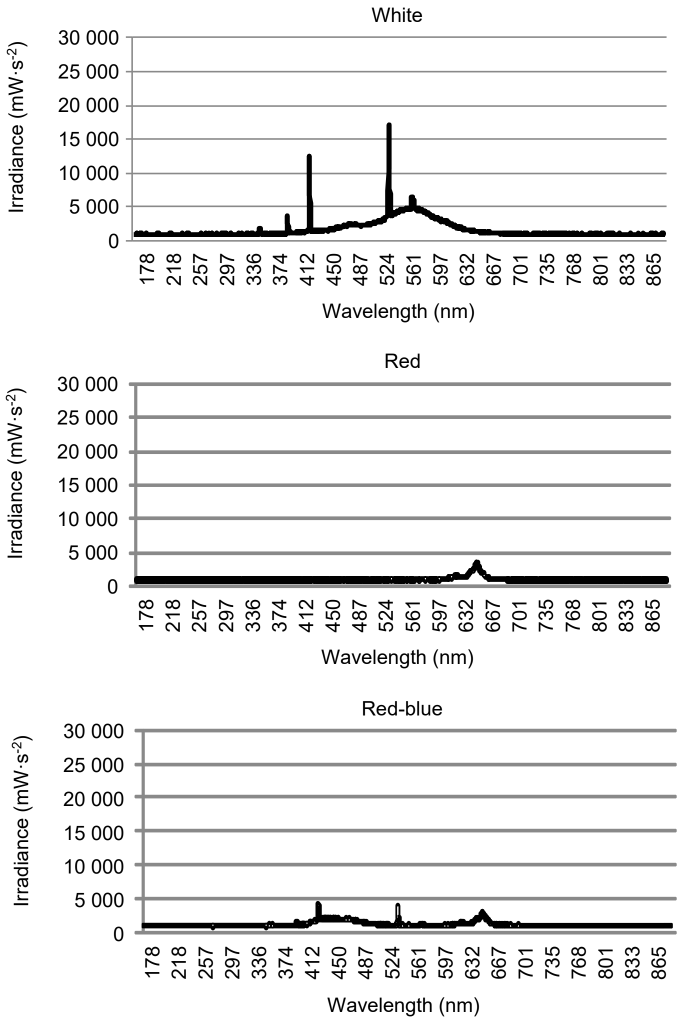

Fig. 1. Spectral characteristic of fluorescent lamps

(showing signs of senescence as dark discolouration of flower margins) and the date of the first dry flower in inflorescence. Inflorescence shoots were measured and weighed at the beginning of the experiment and after the above-mentioned stages were reached. Based on the recorded data postharvest longevity was calculated, expressed in days to the stage of ⅓ discoloured flowers in inflorescence and to the stage of the first dry flower in inflorescence. Moreover, changes in shoot length and mass were also calculated at individual stages in relation to the initial shoot length and mass. These values were expressed in percent. The results were subjected to two-way analysis of variance. The probit (probability integral transformation) analysis according to Bliss was applied for percentage values. Means were grouped using the Duncan test at the significance level $\alpha = 0.05$.

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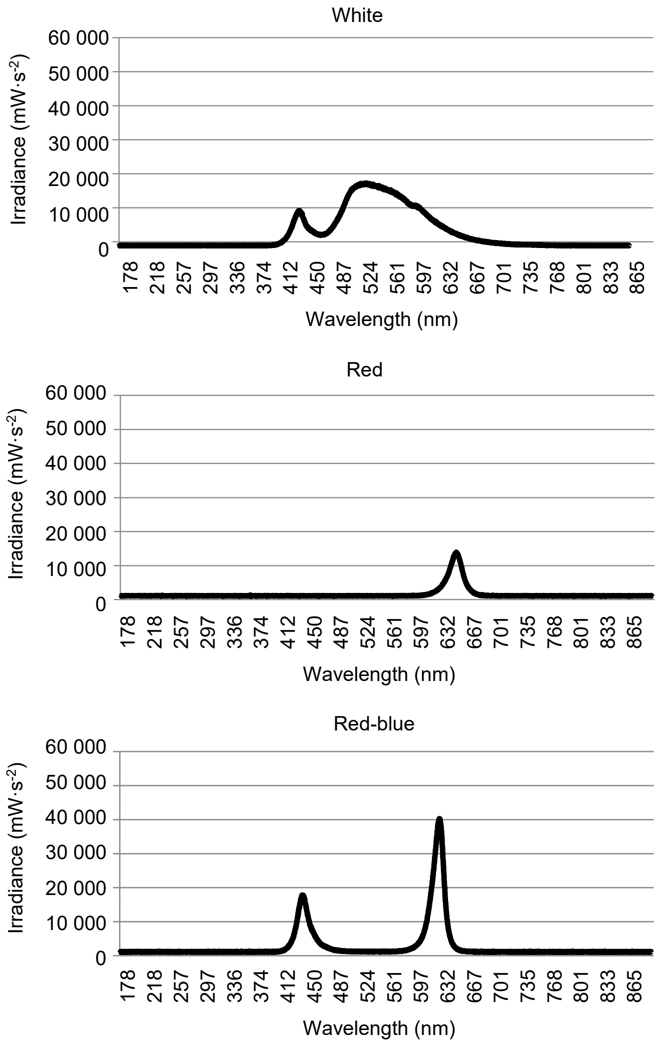

Fig. 2. Spectral characteristic of LED lamps

Results

Inflorescence shoots of hyacinth cv. 'Anna Marie' retained their vase life for approx. 11 day until reaching the stage of ⅓ discoloured flowers in inflorescence (Table 1) and for approx. 15 days to the stage of the first dry flower in inflorescence (Table 2). This period lasted longer when inflorescence shoots were exposed to white and red-blue light rather than red light. The type of lamps had no effect on this characteristic.

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Table 1. Postharvest longevity and quality features of inflorescence shoots of hyacinth 'Anna Marie' at the stage of ⅓ discoloured flowers in inflorescence

Lamp	Light colour			Mean
	white	red	red-blue	
Postharvest longevity (days)				
Fluorescent	11.5 b	9.3 a	11.7 b	10.8 a
LED	11.3 b	10.1 a	11.3 b	10.9 a
Mean	11.4 b	9.7 a	11.5 b	×
Increase of shoot length (%)				
Fluorescent	39.2 a	40.3 a	37.5 a	39.0 a
LED	39.0 a	40.9 a	35.3 a	38.4 a
Mean	39.1 a	40.6 a	36.4 a	×
Increase of shoot weight (%)				
Fluorescent	14.8 ab	16.0 ab	12.6 a	14.5 a
LED	18.9 b	18.9 b	12.6 a	16.8 a
Mean	16.9 b	17.4 b	12.6 a	×

Mean values marked with the same letter do not differ significantly at the level of $\alpha = 0.05$.

Table 2. Postharvest longevity and quality features of inflorescence shoots of hyacinth 'Anna Marie' at the stage of the first dry flower in inflorescence

Lamp	Light colour			Mean
	white	red	red-blue	
Postharvest longevity (days)				
Fluorescent	15.4 cd	13.3 a	15.7 d	14.8 a
LED	14.8 bcd	13.9 ab	14.3 abc	14.3 a
Mean	15.1 b	13.6 a	15.0 b	×
Increase of shoot length (%)				
Fluorescent	40.6 a	39.9 a	38.5 a	39.7 a
LED	39.6 a	41.6 a	33.3 a	38.2 a
Mean	40.1 a	40.7 a	35.9 a	×
Decrease of shoot weight (%)				
Fluorescent	9.0 ab	4.7 b	15.4 a	9.7 a
LED	6.4 b	8.1 ab	9.1 ab	7.9 a
Mean	7.7 a	6.4 a	12.2 a	×

Mean values marked with the same letter do not differ significantly at the level of $\alpha = 0.05$.

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Postharvest longevity of hyacinth 'Anna Marie' at the stage of ⅓ discoloured flowers was shorter when plants were exposed to red light emitted by fluorescent and LED lamps (Table 1). Vase life of inflorescence shoots in that cultivar determined at the stage of the first dry flower in inflorescence did not vary depending on lamp colour when LED lamps were used (Table 2). In the case of fluorescent lamps a significantly shorter postharvest longevity was found for shoots exposed to red light in comparison to white or red-blue light.

Inflorescence shoots of hyacinth 'Anna Marie' elongated in the course of the experiment (Tables 1, 2). The increase in inflorescence shoot length, recorded at the stage of ⅓ discoloured flowers in inflorescence and the first dry flower in inflorescence, was not dependent on the source or colour of light.

The mass of inflorescence shoot was increasing up to the stage of ⅓ discoloured flowers in inflorescence (Table 1). This trait depended only on light colour. A lesser increase in mass was observed for shoots exposed to red-blue light, while it was greater in shoots placed on stands with lamps emitting white- and red-coloured light. The increase in shoot mass in hyacinth 'Anna Marie' at the stage of ⅓ discoloured flowers was comparable when fluorescent lamps were used, irrespective of the light colour. Inflorescence shoots lighted with LED lamps emitting white or red light showed a greater increase in mass in comparison to shoots exposed to red-blue light.

In all the combinations at the stage of the first dry flower in inflorescence the final mass of inflorescence shoot was lower than the initial mass (Table 2). The source and colour of light had no effect on the reduction of inflorescence shoot mass in hyacinth 'Anna Marie'.

Light colour had no effect on the loss of shoot mass at the stage of the first dry flower when LED lamps were used. Lighting of hyacinth 'Anna Marie' with fluorescent lamps emitting red light caused a decrease in shoot mass in comparison to red-blue light.

Vase life of inflorescence shoots in hyacinth 'Blue Star' up to the stage of ⅓ discoloured flowers in inflorescence was on average approx. 11 day (Table 3). The value was greater in the case of lamps emitting white or red-blue light than after the application of red light. Up to the stage of the first dry flower that value was approx. 13 days (Table 4). White light reduced postharvest longevity, while red-blue light extended it. The number of days of vase life obtained under red light did not differ from the other values. The type of lamps had no effect on postharvest longevity.

Vase life at the stage of ⅓ discoloured flowers in hyacinth 'Blue Star' did not vary depending on light colour when shoots were placed under LED lamps. In the case of fluorescent lamps a lower postharvest longevity was recorded for hyacinths exposed to red-coloured light (Table 3). Also at the stage of the first dry flower no differences were recorded in vase life of shoots lighted by LED lamps. The application of fluorescent lamps emitting red-blue light extended postharvest longevity of inflorescence shoots in that cultivar in comparison to the combination with white light (Table 4).

Inflorescence shoots of hyacinth 'Blue Star', similarly as in the other cultivar, were elongating. This trait was influenced solely by the light colour; however, this effect was observed only during the first development stage (Tables 3, 4). A greater elongation was reported in shoots placed on stands exposed to red light, while it was lesser in the case of red-blue light. When applying white-coloured light practically no differences in shoot length were recorded.

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Table 3. Postharvest longevity and quality features of inflorescence shoots of hyacinth 'Blue Star' at the stage of ⅓ discoloured flowers in inflorescence

Lamp	Light colour			Mean
	white	red	red-blue	
Postharvest longevity (days)				
Fluorescent	11.8 b	10.7 a	11.9 b	11.4 a
LED	11.4 ab	11.1 ab	11.8 b	11.4 a
Mean	11.6 b	10.9 a	11.8 b	×
Increase of shoot length (%)				
Fluorescent	36.1 ab	45.1 b	37.7 ab	40.3 a
LED	39.2 ab	39.7 ab	32.5 a	37.2 a
Mean	38.7 ab	42.4 b	35.1 a	×
Change of shoot weight (%)				
Fluorescent	1.7 a	5.6 a	–0.2 a	2.4 a
LED	5.4 a	6.6 a	–1.1 a	3.6 a
Mean	3.5 a	6.1 a	–0.7 a	×

Mean values marked with the same letter do not differ significantly at the level of α = 0.05.

Table 4. Postharvest longevity and quality features of inflorescence shoots of hyacinth 'Blue Star' at the stage of the first dry flower in inflorescence

Lamp	Light colour			Mean
	white	red	red-blue	
Postharvest longevity (days)				
Fluorescent	12.2 a	12.9 ab	13.6 b	12.9 a
LED	13.3 b	13.0 ab	13.8 b	13.4 a
Mean	12.8 a	12.9 ab	13.7 b	×
Increase of shoot length (%)				
Fluorescent	37.6 a	42.0 a	35.3 a	38.3 a
LED	39.0 a	36.3 a	34.1 a	36.5 a
Mean	38.3 a	39.2 a	34.7 a	×
Decrease of shoot weight (%)				
Fluorescent	4.0 a	14.7 a	9.6 a	9.4 a
LED	5.7 a	9.0 a	15.0 a	9.9 a
Mean	4.9 a	11.8 a	12.3 a	×

Mean values marked with the same letter do not differ significantly at the level of α = 0.05.

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The inflorescence shoot mass in hyacinth ‘Blue Star’, determined at the stage of ⅓ discoloured flowers, increased in relation to the initial mass after exposure to white and red light, while it decreased when red-blue light was used (Table 3). However, this change did not depend on light colour or its source.

At the stage of the first dry flower in inflorescence in hyacinth ‘Blue Star’ the initial mass of inflorescence shoot exceeded final mass (Table 4). Neither colour nor source of light had any effect on the reduction of inflorescence shoot mass.

Discussion

Postharvest longevity of tested hyacinth cultivars varied, which confirms previous information that this trait is cultivar-specific (Krzymińska, 2006). Differences in vase life of hyacinth ‘Anna Marie’ and Blue Star’ were evident at the stage of the first dry flower.

Red-blue light extended postharvest longevity of cut inflorescence shoots in both cultivars. This regularity was found both at the stage of ⅓ discoloured flowers and at the stage of the first dry flower in inflorescence. A similar effect was observed after white--coloured light was used; however, in hyacinth ‘Blue Star’ at the stage of the first dry flower in inflorescence vase life was shorter. In that cultivar at the discussed stage postharvest longevity under the influence of red light did not differ from that of shoots exposed to the other light colours. The use of red-coloured light reduced vase life of shoots in hyacinth ‘Anna Marie’ and at the stage of ⅓ discoloured flowers – in hyacinth ‘Blue Star’. Different results were recorded by Rabiza-Świder and Skutnik (2004). The red light colour extended vase life of leaves in calla lily in comparison to the effect of white- or blue-coloured light. Analogously, Heo et al. (2004) stated that red light emitted by fluorescent lamps extended vase life of cut roses and carnations in comparison to white-coloured light.

After excision hyacinth shoots elongated. This property may be observed in many cut flowers. The red-blue colour of light caused a lesser increment in shoot length only in hyacinth ‘Blue Star’ at the stage of ⅓ discoloured flowers in inflorescence. In their experiment Ouzounis et al. (2014) reported growth inhibition in roses and chrysanthemums grown under supplementary artificial lighting using lamps emitting red-blue light in comparison to those emitting red or white light.

Inflorescence shoot mass increased in both hyacinth cultivars up to the stage of ⅓ discoloured flowers in inflorescence. The reduction of mass in comparison to the initial mass was observed in shoots of hyacinth ‘Blue Star’ at the stage of ⅓ discoloured flowers in inflorescence following their exposure to red-blue light, although recorded values did not differ statistically from those in the other combinations. This was probably caused by a smaller increase in shoot length recorded in that cultivar at that stage. In hyacinth ‘Anna Marie’ at both stages and in hyacinth ‘Blue Star’ at the stage of the first dry flower in inflorescence shoot mass decreased in comparison to the initial mass.

The application of fluorescent and LED lamps in this experiment did not cause differences in values of the analysed traits of cut hyacinth inflorescence shoots. Thus it may be stated that LED lamps may be more suitable, as they are characterized by a greater postharvest longevity and a lesser energy consumption (Woźny, 2015).

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Conclusions

1. The red-blue light colour extended postharvest longevity of inflorescence shoots in hyacinth 'Anna Marie' and 'Blue Star', while white light colour extended it in hyacinth 'Anna Marie' and up to the stage of ⅓ discoloured flowers in inflorescence – in hyacinth 'Blue Star'.

2. An increase in shoot length was caused by the red-coloured light only in shoots of hyacinth 'Blue Star' at the stage of ⅓ discoloured flowers in inflorescence. The change in inflorescence shoot mass in the tested hyacinth cultivars did not depend on light colour.

3. The source of light, i.e. fluorescent lamps vs. LED lamps, had no effect on postharvest longevity, increment in shoot length or changes in inflorescence shoot mass in hyacinth 'Anna Marie' and 'Blue Star'.

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TRWAŁOŚĆ POZBIORCZA CIĘTYCH HIACYNTÓW W ZALEŻNOŚCI OD BARWY ŚWIATŁA I TYPU LAMP

Abstrakt
Wstęp. Doniesienia wskazują na możliwość przedłużania trwałości pozbiorczej kwiatów ciętych po zastosowaniu sztucznego oświetlenia. Hiacynty są coraz częściej stosowane jako kwiaty cięte. Brak jest informacji na temat możliwości ich pozbiorczego traktowania światłem sztucznym Celem wykonanego doświadczenia była ocena wpływu barwy i źródła światła na trwałość pozbiorczą i cechy jakościowe ciętych hiacyntów.
Materiał i metody. Pędy kwiatostanowe hiacyntów 'Anna Marie' i 'Blue Star' pozyskano z roślin pędzonych w szklarni. Wycinano je z cebul. Po chłodzeniu przez jedną dobę w pomieszczeniu o temperaturze 2°C ustawiono je na regałach ze sztucznym oświetleniem. Pędy kwiatostanowe były wstawione do szklanych pojemników z wodą. Zastosowano światło o barwie białej, czerwonej i czerwono-niebieskiej. Użyto lamp fluorescencyjnych Philips TLD i lamp diodowych Leutech LED Tube. Natężenie napromienienia kwantowego wynosiło 20 $\mu mol \cdot m^{-2} \cdot s^{-1}$. Oświetlenie stosowano przez 9 h dziennie. Oceniono trwałość pozbiorczą oraz cechy jakościowe pędów kwiatostanowych.
Wyniki. Trwałość pędów kwiatostanowych hiacynta 'Anna Marie' w stadium pierwszego zaschniętego kwiatu w kwiatostanie, gdy zastosowano światło czerwono-niebieskie i białe, była mniej więcej o 1,5 dnia dłuższa od trwałości pędów po zastosowaniu światła czerwonego. Pędy kwiatostanowe hiacynta 'Blue Star' zachowały trwałość pozbiorczą, gdy oświetlano je światłem o barwie czerwono-niebieskiej, mniej więcej o 1 dzień dłużej w porównaniu z pędami oświetlanymi światłem białym.
Wnioski. Czerwono-niebieska barwa światła wydłużyła trwałość pozbiorczą pędów kwiatostanowych hiacyntów 'Anna Marie' i 'Blue Star', a biała barwa światła wydłużyła trwałość pozbiorczą hiacynta 'Anna Marie' oraz trwałość do stadium ⅓ przebarwionych kwiatów w kwiatostanie hiacynta 'Blue Star'. Barwa czerwona miała wpływ na zwiększenie przyrostu długości pędów tylko u hiacynta 'Blue Star' w stadium ⅓ przebarwionych kwiatów w kwiatostanie. Zmiana masy pędów kwiatostanowych odmian hiacynta nie zależała od barwy światła. Źródło światła w postaci lamp fluorescencyjnych i diodowych nie miało wpływu na trwałość pozbiorczą, na przyrost długości ani na zmianę masy pędów kwiatostanowych hiacyntów 'Anna Marie' i 'Blue Star'.

Słowa kluczowe: trwałość, hiacynt, sztuczne światło

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