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The effect of blue light on the height and habit of the tomato (*Lycopersicon esculentum* Mill.) transplant

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ABSTRACT

Transplants of the tomato cultivars 'Recento F_1', 'Tukan F_1', and 'Remiz F_1' were grown under fluorescent lamps emitting daylight and blue light with quantum irradiance 67 μmol m^{-2} s^{-1}. The morphological attributes, as plant height, stem thickness, number of leaves, length of internodes, fresh and dry mass were investigated. Irrespective of the cultivar, favourable influence of the blue light was observed. Those plants were short, with thick and strong stem, shortened internodes, enhanced participation of the dry mass in fresh mass. The first clusters were set considerably lower. The application of the lamps emitting blue light can be an effective and environment-friendly method of controlling the growth of tomato transplant.

INTRODUCTION

In horticultural production an efficient and effective control of plant growth and habit is a very essential mass. The quickest way to obtain the desired effect is to apply chemical growth retardants, however it frequently results in the persistence of harmful residue in the medium (Zalewska et al. 2000). All that justifies a growing interest in methods which would be more yield- and environment-friendly, for example, the application of mechanical stress (Johjima et al. 1992), or methods called 'DIF' and 'Cool Morning' (Myster and Moe 1995). Similarly more and more frequently intended changes are desired in the light quality under covers. An efficient plant growth and development control requires not only an adequate light intensity but also its quality, namely spectral distribution. Changes in the light quality can be introduced with an extra exposure to monochromatic diodes (Brown et al. 1995), placing spectral filters filled with colourful solutions in glasshouse (Mortensen and Strømme 1987), or covering the tunnel with photoselective films (Li et al. 2000). It is also possible to produce transplants in chambers with no access of the natural light but exposed to lamps emitting light of a given colour (Głowacka 2002). The present research aimed at defining the effect of blue light on the transplant growth and habit of three different glasshouse tomato cultivars.

MATERIAL AND METHODS

The experiment was conducted in 2003 in the phytotron and glasshouse of the Department of Ornamental Plants and Vegetable Crops of the Faculty of Agriculture of the University of Technology and Agriculture in Bydgoszcz. The research involved three tomato cultivars which differed in their light requirements and growth intensity: 'Recento F_1', 'Remiz F_1', and 'Tukan F_1'. 'Recento F_1' shows an intensive growth and tolerates unfavourable light conditions even over the initial stages of cultivation, 'Remiz F_1' is a cultivar which is distinctive due to its short internodes, sensitive to light shortage, while 'Tukan F_1' shows a stronger growth than 'Remiz F_1' and does not have very high light requirements. Seedlings, following the development of cotyledons, were planted out one by one into pots. 40 plants representing each cultivar were placed into phytotron exposed to TLD Philips 36W fluorescent lamps, emitting blue light and daylight, with the spectral distribution close to natural light, of the intensity of the quantum irradiance of 67 μmol m^{-2} s^{-1}. The experiment involved artificial light from 7 a.m. to 11 p.m., air temperature of 18^{o}C during the day and 16^{o}C at night, air humidity was maintained at 65%. A plant growth and the occurrence of flower buds were observed. Every week the plant height was measured from the level of the upper pot edge to apex, after seven weeks additionally the stem thickness at the level of cotyledons and the number of leaves were defined. Mean length of internodes was calculated dividing the plant height by the number of leaves. Fresh and dry mass of stems and leaves were determined. The dry mass was determined with the oven-drying method in 105°C. Ten representative plants were planted in glasshouse beds in order to carry out observations of a further growth up to flowering. The experiment consisted of 5 replications, and the results were analysed by the standard statistical procedure with one factorial design. The least significant differences were calculated by Tukey's test at p = 0.05.

RESULTS AND DISCUSSION

Irrespective of the cultivar, a considerable inhibiting effect of blue light on transplant growth was recorded. Differences in the height of plants placed under lamps emitting light of a different colour were noticeable already after the first week of the experiment (Fig. 1).

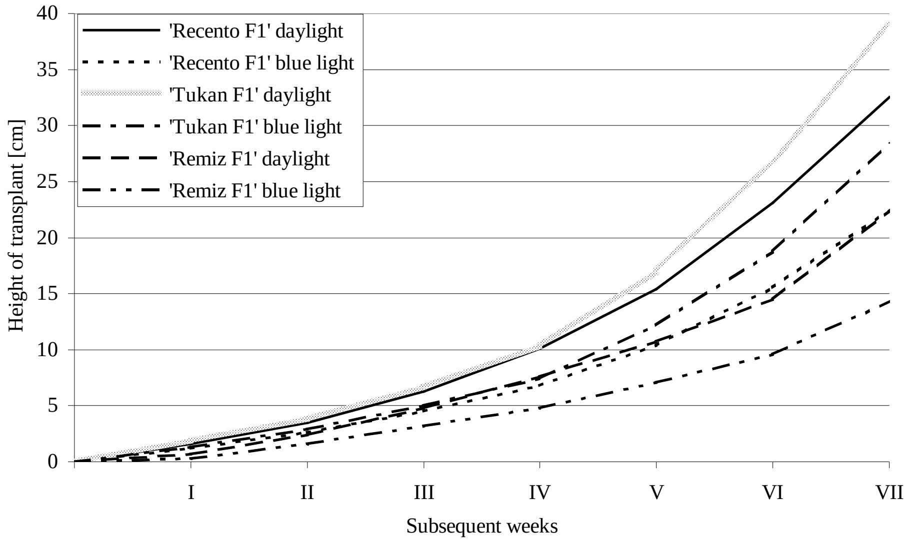

Figure 1. 'Recento F_1', 'Tukan F_1', and 'Remiz F_1' tomato transplant growth dynamics at the subsequent experimental weeks depending on the light colour

The authors researching the effect of the light colour on the plant growth underlined a fast reaction in plants, both when applying light filters with $CuSO_4$ and photoselective film (Rajapakse and Kelly 1992, Li et al. 2000). After seven weeks of the present research the plants exposed to blue light were lower by 30.8%, 26.7%, and 36.2% respectively for 'Recento F_1', 'Tukan F_1', and 'Remiz F_1'. Mean length of internodes in the three cultivars exposed to blue light was, respectively, 24.5%, 24.9%, and 32.7% smaller. The thickness of the stem base as affected by blue light increased by 6.6%, 12.3%, and 3.1%, respectively. In

'Recento F_1' and 'Remiz F_1' there was recorded a lower number of leaves on the plant stem when exposed to blue light, while in 'Tukan F_1' the light colour showed no such effect (Table 1).

Table 1. Morphological characteristics of tomato transplants depending on the light colour

	'Recento F_1'		'Tukan F_1'		'Remiz F_1'	
Light colour	daylight	blue	daylight	blue	daylight	blue
Transplant height [cm]	32.5 a*	22.5 b	38.9 a	28.5 b	22.4 a	14.3 b
Deviation [%]	-	30.8	-	26.7	-	36.2
Length of internodes [cm]	42.1 a	31.8 b	40.9 a	30.7 b	26.3 a	17.7 b
Deviation [%]	-	24.5	-	24.9	-	32.7
Stem thickness [mm]	5.7 a	6.1 b	5.7 a	6.5 b	6.2 a	6.4 b
Deviation [%]	-	6.6	-	12.3	-	3.1
Number of leaves	7.7 a	7.0 b	9.5 a	9.3 a	8.5 a	8.1 b
Deviation [%]	-	9.1	-	2.1	-	4.7

* Different letters stand for significant differences within a given cultivar and the characteristics studied

In an earlier experiment which involved 'Recento F_1' cultivar blue light showed the same effect (Głowacka 2002). Brown et al. (1995) observed 10-35% pepper seedling growth inhibition following the extra light exposure with blue fluorescent lamps. Inhibiting tomato transplant growth by 33% was observed once the plants were placed under light filters filled with water solution of $CuSO_4$ (Mortensen and Strømme 1987). Similar results in pepper transplant were obtained after changing the light quality with blue photoselective films (Li et al. 2000). Numerous authors underlined that blue light did not affect the number of leaves set on the stem and so a decrease in the stem height was a result of shortened internodes (Rajapakse and Kelly 1992, Głowacka 2002).

A decrease of fresh mass of the stem and an increased the share of dry mass in the fresh mass in the shoot and stem were commonly observed (Table 2).

Earlier experiments showed a decrease in the fresh mass of shoot and unchanged dry mass accompanied by an increase its share in the fresh mass as a result of exposure to blue light in 'Recento F_1' (Głowacka 2002). Goins et al. (1997) noticed that adding blue light increased the dry mass of wheat stem, however other reports showed completely different relations. Filters with solutions of $CuSO_4$ and blue photoselective films decreased the dry mass of shoots in pepper (Li et al. 2000), tomato and lettuce (Mortensen and Strømme 1987). The results suggest that the effect of the light colour on fresh and dry mass of plants probably depends considerably on the species, and even cultivar.

Table 2. Fresh and dry mass of a tomato transplants depending on the cultivar and light colour

		‘Recento F_1’		‘Tukan F_1’		‘Remiz F_1’	
		daylight	blue	daylight	blue	daylight	blue
Fresh mass [g]							
	shoot	25.96 a*	20.39 b	26.06 a	25.63 a	23.54 b	25.07 a
	stem	9.04 a	5.58 b	10.72 a	7.86 b	6.20 a	4.50 b
	leaves	6.92 a	14.81 b	15.34 b	17.77 a	17.30 b	20.57 a
Dry mass [g]							
	shoot	2.02 a	1.70 b	2.20 a	2.25 a	1.79 b	2.15 a
	stem	0.57 a	0.41 b	0.69 a	0.57 b	0.36 a	0.33 a
	leaves	1.44 a	1.29 b	1.51 b	1.68 a	1.43 b	1.83 a
Dry mass [%]							
	shoot	7.8 b	8.3 a	8.4 b	8.8 a	7.6 b	8.6 a
	stem	6.3 b	7.3 a	6.4 b	7.3 a	5.8 b	7.2 a
	leaves	8.5 a	8.7 a	9.9 a	9.4 a	8.3 b	8.9 a

* Different letters stand for significant differences within a given cultivar and the characteristics studied

The application of blue light over the transplant production accelerated the formation of flower buds (Fig. 2), however it did not accelerate flowering of the plants in glasshouse.

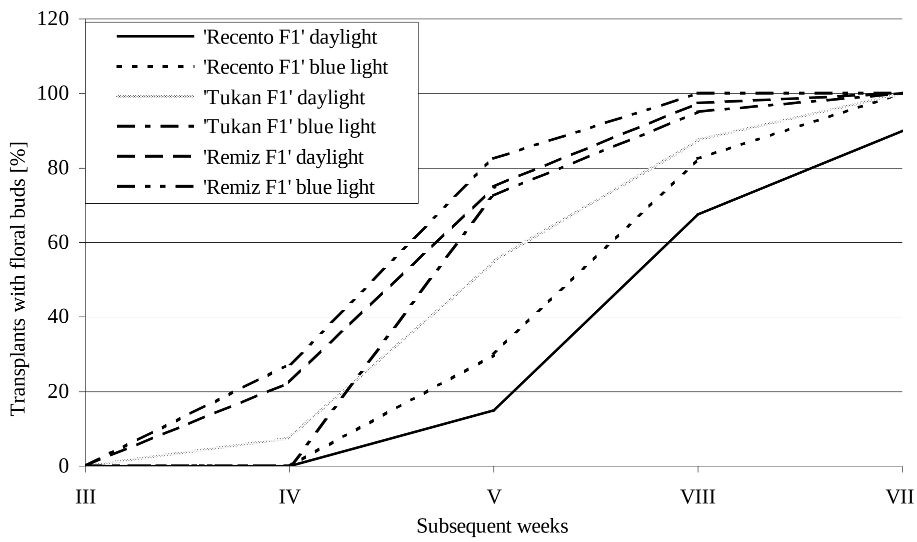

Figure 2. Floral buds formation rate of the ‘Recento F_1’, ‘Tukan F_1’, and ‘Remiz F_1’ tomato transplant at the subsequent experimental weeks depending on the light colour

Similar results with blue light application were reported by Głowacka and Piszczek (2003), and by Del Corso and Lercari (1997), who exposed tomato transplants to ultraviolet light in order to prevent their excessive growth. Irrespective of the cultivar, glasshouse cultivation showed a slower rate of growth for plants obtained under blue light; their first clusters were set considerably lower (Fig. 3). In literature, there are no reports on a further plant growth once the exposure to light of a given colour has been completed.

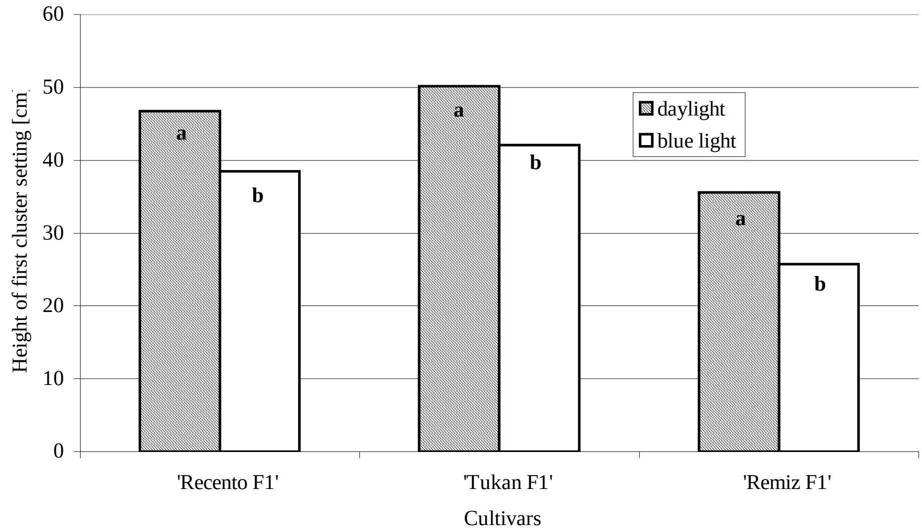

Figure 3. Height of the first cluster setting in three tomato cultivars depending on the light colour. Different letters stand for significant differences within a given cultivar

CONCLUSIONS

1. Irrespective of the cultivar, tomato transplants subjected to the blue light showed a short height and a compact habit, their quality was satisfactory and no delays were recorded in their further development.
2. The application of lamps emitting blue light can be an effective and environment-friendly method of controlling the growth of tomato transplants to be cultivated under covers.

REFERENCES

BROWN C.S., SCHUERGER A.C., SAGER J.C., 1995. Growth and photomorphogenesis of pepper plants under red light-emitting diodes with supplemental blue or far-red lighting. J. Amer. Soc. Hort. Sci. 120(5): 808-813.

DEL CORSO G., LERCARI B., 1997. Use of UV radiation for control of height and conditioning of tomato transplants (*Lycopersicon esculentum* Mill.). Scientia Hort. 71: 27-34.

GŁOWACKA B., 2002. Wpływ barwy światła na wzrost rozsady pomidora (*Lycopersicon esculentum* Mill.). Acta Scien. Pol., seria Hortorum Cultus 1(2): 93-103.

GŁOWACKA B., PISZCZEK P., 2003. Yielding of tomato (*Lycopersicon esculentum* Mill.) cultivated in glasshouse from transplants and cuttings exposed to light of varied colour. Veg. Crops Res. Bul. 59: 61-73.

GOINS G.D., YORIO N.C., SANWO M.M., BROWN C.S., 1997. Photomorphogenesis, photosynthesis, and seed yield of wheat plants grown under red light-emitting diodes (LEDs) with and without supplemental blue lighting. J. Exp. Bot. 48(312): 1407-1413.

JOHJIMA T., LATIMER J.G., WAKITA H., 1992. Brushing influences transplant growth and subsequent yield of four cultivars of tomato and their hybrid lines. J. Amer. Soc. Hort. Sci. 117(3): 384-388.

LI S., RAJAPAKSE N.C., YOUNG R.E., OI R., 2000. Growth responses of chrysanthemum and bell pepper transplants to photoselective plastic films. Scientia Hort. 84: 215-225.

MORTENSEN L.M., STRØMME E., 1987. Effects of light quality on some greenhouse crops. Scientia Hort. 33: 27-36.

MYSTER J., MOE R., 1995. Effect of diurnal temperature alternations on plant morphology in some greenhouse crops – a mini review. Scientia Hort. 62: 205-215.

RAJAPAKSE N.C., KELLY J.W., 1992. Regulation of chrysanthemum growth by spectral filters. J. Amer. Soc. Hort. Sci. 117(3): 481-485.

ZALEWSKA M., JERZY M., PISZCZEK P., 2000. The rosette growth of chrysanthemum (*Dendranthema grandiflora* Tzvelev) cuttings as the consequence of the remains of Topflor in the compost soil. Roczn. AR Poznań, Ogrodnictwo 29: 131-135.

WPŁYW NIEBIESKIEGO ŚWIATŁA NA WYSOKOŚĆ I POKRÓJ ROZSADY POMIDORA (*LYCOPERSICON ESCULENTUM* MILL.)

Streszczenie: Rozsadę pomidora odmian 'Recento F_1', 'Tukan F_1' i 'Remiz F_1' umieszczono pod lampami fluorescencyjnymi emitującymi światło dzienne i niebieskie o natężeniu napromienienia kwantowego 67 μmol m^{-2} s^{-1}. Zbadano morfologiczne cechy rozsady: wysokość roślin, grubość łodygi, liczbę liści, długość międzywęźli oraz świeżą i suchą masę nadziemnej części roślin. Rośliny wszystkich odmian poddane wpływowi niebieskiego światła były niższe, miały grubszą i silną łodygę, skrócone międzywęźla i zwiększony udział suchej masy w świeżej masie niż rośliny rosnące pod lampami emitującymi światło dzienne. Pierwsze grono było osadzone wyraźnie niżej. Zastosowanie lamp emitujących niebieskie światło może stanowić efektywną i jednocześnie bezpieczną dla środowiska metodę kontrolowania wzrostu rozsady pomidora.

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