HLFC series lighting for tomato transplants

Blue light percentage in total light flux is very important for cultivation of qualitative tomato transplants. HLFC series LED lamp spectra is universal for various plants, however the percentage of blue light is very suitable for tomato cultivation. This was also proved by researches, performed at LRCAF Institute of Horticulture (Fig. 1).

Fig. 1. Tomato 'Cunero' F1 transplants, raised under HLFC series LED or high pressure sodium (HPS) lamps in spring of 2014 m. Photosynthetic photon flux density – 150 or 250 µmol m^{-2} s^{-1}.

HPS 150	LED 150	LED 250

Table 1. Biometric parameters of 'Cunero' F1 tomato transplants cultivated under HLFC series LED or high pressure sodium (HPS) lamps, when photosynthetic photon flux density was 150 or 250 µmol m^{-2} s^{-1}.

Biometric parameters	Lighting in greenhouse		
	HPS 150	**LED 150**	**LED 250**
Hypocotyl height, cm	3,6±0,3	**3,0**±0,4[b]	**2,5**±0,3[b]
Hypocotyl diameter, cm	0,40±0,02	**0,52**±0,03[a]	**0,57**±0,03[a]
Plant height, cm	19,3±4,0	21,5±2,3	20,1±0,8
Leaf number, pcs.	6,4±0,1	6,4±0,2	6,4±0,2
Leaf area, cm^2	544,2±43,9	**477,5**±43,5[b]	**464,4**±20,6[b]
Green weight, g	22,59±1,24	14,29±2,02	22,27±1,44
Root green weight, g	5,48±0,34	4,80±0,82	5,86±0,89

a – significantly higher, b – significantly lower, than HPS when $p \leq 0,05$

Tomato transplants, raised under HLFC series LED lamps were slightly taller, as compared to the ones, raised under high pressure (HPS) lamps, however their hypocotyl was signifficantly shorter and thicker. This show high transplant quality, when cultivated under 150 µmol m^{-2} s^{-1} photosynthetic photon flux density. When lighting intensity increased to 250, tomato hypocotyl was formed even shorter and thicker. Leaf area, formed under LED light exposure was 12-15% as compared to transplants, raised under HPS lamps, though this had no remarkable effect on aboveground and root biomass (table 1).

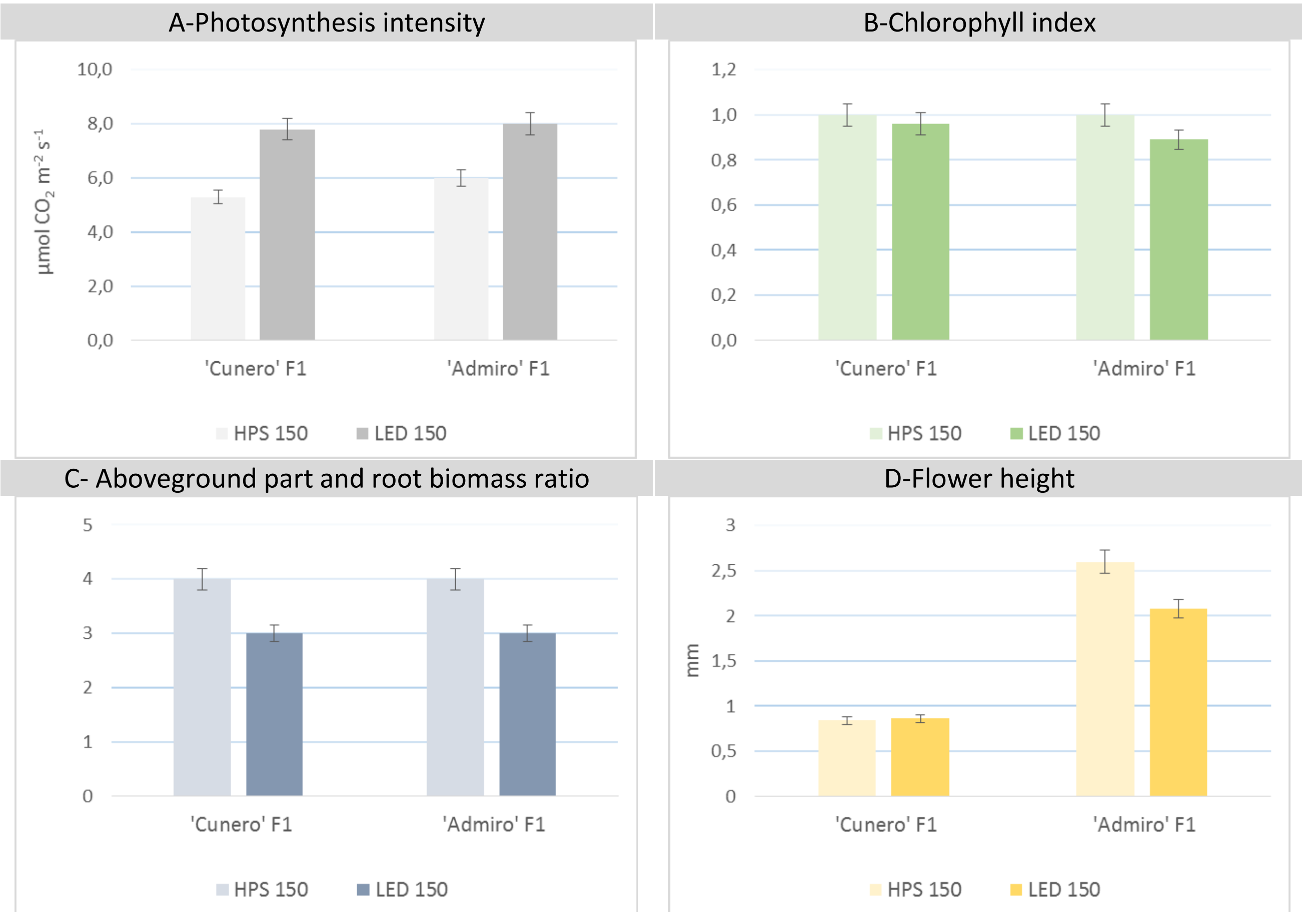
Breslaujos 3-115
LT-44403 Kaunas
Lietuva / Lithuania

phone +370 37 401978
cell +370 698 87770

info@hortiled.lt
www.hortiled.lt

Experiments, performed with transplants of different tomato varieties (Fig. 2) show, that LED lighting is superior regarding tomato photosynthetic activity and plantmorphology. Higher photosynthesis intensity at lower chlorophyll index in leaves, as well as more intense accumulation of primary photosynthesis products – mosaccharides – in leaves, lower aboveground and root biomass ratio, higher uptake of micro and macro elements confirm physiologically favorable lighting conditions, that do not accelerate natural plant senescence (rapid development, stuctural carbohydrate accumulation etc.) The effect of lighting on tomato development and flower formation were differential. Tomato 'Cunero' transplants, resistant for environmental effects, developed equally, despite the applied lighting type. When 'Admiro' transplants, raised under LED formed a bit smaller flowers as compared with HPS illumination – their development lagged.

Fig 2. Physiological indices of tomato transplants of different varieties, raised in spring season under HPS and HLFC series LED lighting. Photosynthetic photon flux density – 150 µmol m^{-2} s^{-1}.



HLFC series lighting for tomato harvesting and fruit quality

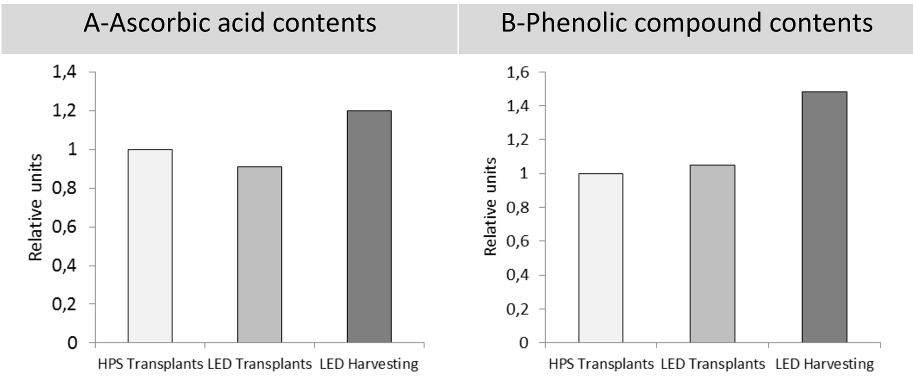
After transplanting in greenhouse, no significant remaining effect of lighting type, applied for transplant cultivation was observed (table 2). When tomato plants were illuminated during harvesting, slight reduction in early harvest was determined, however – total harvest – even slightly bigger than non-illuminated tomatoes.

Table 2. Tomato 'Admiro' F1 harvest indices, when transplants raised under HPS or HFLC series LED lighting (HPS Transplants and LED Transplants) and when plants were illuminated with LED during harvesting in greenhouse. Photosynthetic photon flux density –150 µmol m^{-2} s^{-1}.

Harvest indices	**HPS Transplants**	**LED Transplants**	**LED Harvesting**
Early harvest, kg per plant	0,9±0,1	0,9±0,1	**0,6**±0,1
Total harvest, kg per plant	10±0,8	10±0,5	11±0,5
Fruit weight, g	135±4	130±2	140±4

Evaluating lighting effects on ascorbic acid and phenolic compound contents in fruits, no remaining effect of lighting type, applied in transplant stage was observed. Higher contents of antioxidant compounds were determined in fruits, when LED lighting was applied during harvesting time (Fig. 2).

Fig. 2. Biochemical parameters of tomato 'Admiro' F1 fruits, when transplants were cultivated under HPS or HLFC series lighting, o when LED lighting was applied during harvesting (LED Harvesting). Photosynthetic photon flux density – 150 µmol m^{-2} s^{-1}.



Total light effect on tomato transplant quality both resulted in better mineral element uptake in LED illuminated tomato transplant leaves (table 3). When plants were not illuminated after transplanting, higher concentration of calcium, potassium, zinc, manganese, and especially – iron in tomato leaves during harvesting. However, no higher fluxes of these elements to tomato fruits. When plants were illuminated during harvesting, mineral element contents in leaves were determined lower, as compared to non-illuminated plants.

Breslaujos 3-115
LT-44403 Kaunas
Lietuva / Lithuania

phone +370 37 401978
cell +370 698 87770

info@hortiled.lt
www.hortiled.lt

Table 3. Mineral element contents in tomato leaves and fruits during harvesting. Photosynthetic photon flux density – 150 µmol m^{-2} s^{-1}. Results presented in green weight.

	Elements	HPS Transplants	LED Transplants	LED Harvesting	HPS Transplants	LED Transplants	LED Harvesting
		Leaves			Fruits		
mg g^{-1}	Ca	5,1±0,1	**10,2**±0,1[a]	**6,4**±0,1[a]	0,2±0,0	0,2±0,0	**0,1**±0,0[b]
	K	3,3±0,0	**5,6**±0,0[a]	**3,5**±0,0[a]	3,3±0,0	**1,9**±0,0[b]	2,3±0,0[b]
	Mg	1,4±0,0	**2,7**±0,0[a]	1,7±0,0[a]	0,2±0,0	0,1±0,0	0,1±0,0
	P	0,1±0,0	0,2±0,0[a]	0,2±0,0[a]	0,1±0,0	0,1±0,0	0,1±0,0
	Na	1,1±0,0	**1,6**±0,0[a]	1,0±0,0[b]	0,4±0,0	**0,2**±0,0[b]	0,3±0,0[b]
µg g^{-1}	Fe	9,6±0,1	**26,2**±0,1[a]	**17,6**±0,0[a]	-	0,1±0,0	**1,4**±0,0
	Zn	1,7±0,1	**2,1**±0,1[a]	**1,1**±0,0[b]	1,4±0,0	1,4±0,0	1,3±0,0[b]
	Mn	21,7±0,4	**48,4**±0,5[a]	28,7±0,2[a]	0,6±0,0	**0,9**±0,0[a]	**1,0**±0,0[a]
	B	1,4±0,1	**2,9**±0,0[a]	**6,4**±0,0[a]	-	-	-

a – significantly higher, b – significantly lower than HPS; p≤0,05.

Conclusions

- Independently form applied LED lighting source, lighting spectra and intensity effects are specific for plant species, variety, and developmental level. Preparing plant lighting recommendations for commercial production in greenhouse, they should be adapted according plant morphological, physiological properties. In general, cucumbers are more sensitive to light, than tomato, which natural origin is from mountainous regions with high irradiation level and hybrids and varieties more resistant to unfavorable environmental effects are less sensitive for applied lighting conditions.
- Supplemental LED lighting resulted in higher tomato root biomass formation and better rooting, mineral uptake after transplanting.
- Tomato transplants, raised under LED lights, developed slower, after 2-3 weeks after transplanting in greenhouse, no significant growth differences were observed and total harvest determined even higher.
- Lighting affects assimilate distribution in cucumbers. The lower aboveground plant part and root weight ratio indices the higher material transport rate to roots, what resulted in better plant rooting.
- Properly selected lighting conditions can help minimize fertilizing costs due to higher mineral element uptake rates.

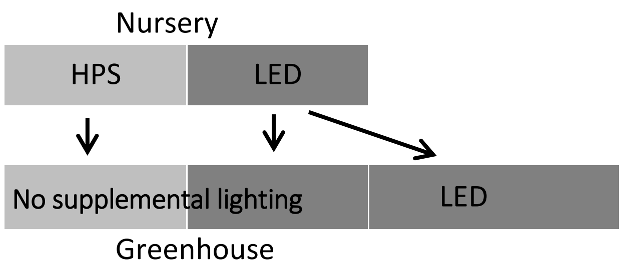
Methods

The objective of studies – tomato hybrids ‘Cunero’ F1 and ‘Admiro’ F1. Experiments were performed in April-May of 2014 and 2015. Transplants were cultivated in heated V-type plastic greenhouse in polymer pots, filled with neutralized peat substrate with fertilizers (PG MIX (NPK

HORTILED

14-16-18; 1,3 kg/m^3)). Together with natural lighting transplants were illuminated with HLFC series LED lamps at photosynthetic photon flux density of 150 or 250 µmol $m^{-2}s^{-1}$ and high pressure sodium lamps for reference (HPS, Son-T Agro 400 W, Philips). Photoperiod – 16 h. Day/night temperatūre 21/17°C.

Tomatoes were transplanted and further cultivated (May-July of 2015) in double plastic covered greenhouse. Tomatoes cultivated in 25L peat bags (2 plants per bag). Plant density –2,5 plants per square meter. Drip irrigation was used for plant nutrition. “Nutrifol” green and brown complex fertilizers, magnesium sulphate, calcium and ammonium nitrate were applied according to the growth stage. EC of nutrition solution – 2,5-2,8, pH 5,5-5,8. The residual LED and HPS lighting effect for transplant harvesting was evaluated, when no further artificial lighting was applied, or when plants were illuminated with HLFC series LED lighting during harvesting time. Photosynthetic photon flux density ~150 µmol m^{-2} s^{-1}.



After lighting experiment, transplant quality was evaluated. The photosynthetic pigment contents were evaluated by spectrophotometric method, biometric measurements were performed. Photosynthesis intensity was measured (Licor LI6400 XT). Micro and macro element contents were determined by ICP-OES method. After transplanting in greenhouse, biometric observations were performed, harvesting recorded. Fruit quality parameters (ascorbic acid, phenolic compound, saccharide contents evaluated. All measurements performed in three repetitions; results presented as average ±standard deviation.

Breslaujos 3-115
LT-44403 Kaunas
Lietuva / Lithuania

phone +370 37 401978
cell +370 698 87770

info@hortiled.lt
www.hortiled.lt

HORTILED

References:

SOLID STATE LIGHTING OPTIMIZATION IN COMMERCIAL GREENHOUSES CULTIVATED SALAD CROPS AND VEGETABLE TRANSPLANTS. Report. 2014. Researches performed at LRCAF Institute of Horticulture, Laboratory of Plant Physiology.

SOLID STATE LIGHTING SYSTEM OPTIMIZATION IN GREENHOUSE: PHOTOPHYSIOLOGICAL EFFECTS DURING DIFFERENT CUCUMBER AND TOMATO ORGANOGENESIS STAGES. 2015. Researches performed at LRCAF Institute of Horticulture, Laboratory of Plant Physiology.

A. Bagdonavičienė, A.Brazaitytė, J.Jankauskienė, V.Vaštakaitė, P.Duchovskis. 2015. EFFECT OF THE PHOTOSYNTHETIC PHOTON FLUX DENSITY OF INDUSTRIAL LIGHT-EMITTING DIODE LAMPS ON ASSIMILATIVE INDICES IN SALAD AND VEGETABLE TRANSPLANTS. Žemės ūkio mokslai, 22(4) p. 173-180.
http://www.lmaleidykla.lt/ojs/index.php/zemesukiomokslai/article/view/3211/2016

A. Bagdonavičienė, A.Brazaitytė, J.Jankauskienė, V.Vaštakaitė, P.Duchovskis. 2015. INDUSTRIAL LIGHT EMITTING DIDOE LAMPS FOR GROWTH OF TOMATO TRANSPLANTS. Žemės ūkio mokslai, 22(2) p. 57-64.
http://www.lmaleidykla.lt/ojs/index.php/zemesukiomokslai/article/view/3110/1937

Breslaujos 3-115
LT-44403 Kaunas
Lietuva / Lithuania

phone +370 37 401978
cell +370 698 87770

info@hortiled.lt
www.hortiled.lt