AGRIVITA Journal of Agricultural Science. 2023. 45(2): 271-277

AGRIVITA
Journal of Agricultural Science
www.agrivita.ub.ac.id

Growth and Yield of Watermelon (*Citrullus lanatus*) in Plastic House in Response to White LED Supplementary Lighting

Wasinee Chamchum[1)], Somchai Glahan[1)], Somsak Kramchote[1*)], Phonkrit Maniwara[2)] and Patcharaporn Suwor[1)]

[1)] Department of Plant Production Technology, School of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand
[2)] Postharvest Technology Research Center, Faculty of Agriculture, Chiang Mai University, Chiang Mai, Thailand

ARTICLE INFO

Keywords:
Fruit quality
Greenhouse crop production
Light-emitting diode
Multivariate analysis
PCA

Article History:
Received: October 20, 2022
Accepted: March 14, 2023

*) Corresponding author:
E-mail: somsak.kr@kmitl.ac.th

ABSTRACT

Watermelon plants cultivar 'Kinaree 457' were grown in plastic house under natural daylight only (control) or with nightly LED supplementary lighting for 6 h (6:00 pm-12:00 pm) or 12 h (6:00 pm-6:00 am) starting from transplanting up to fruit harvest. Plant height, leaf chlorophyll content and fruit yield significantly increased in response to 6 h supplementary LED lighting. Fruit mass, size (length x width) and flesh thickness at 6 h LED treatment were about 2.3 kg, 19.3 ×15.7 cm, and 15.7 cm, respectively, while the fruit of control had 1.7 kg, 16.0 × 14.3 cm, and 13.8 cm, respectively. No significant treatment effect was obtained on peel thickness, flesh color L* and b* values, juice pH and total soluble solids. However, 6 h LED treatment resulted in lower reddening flesh (lower a* values), firmness and higher titratable acidity relative to the control, suggesting the need for improvement in cultural management. Furthermore, multivariate statistics of principal component analysis (PCA) performed on physico-chemical quality revealed the variations among watermelons from lighting and control treatments regardless of lighting hour.

INTRODUCTION

Watermelon (*Citrullus lanatus*) is a popular cucurbit fruit-vegetable with high economic value and is widely grown all over the world (Wei et al., 2020) and in all regions of Thailand. Total production area in Thailand is about 13,740 hectares, with average yield of 21.1 tons per hectare and selling price of about 10.33 THB (0.3 USD) per kilogram (DOA, 2018). Watermelon is mainly consumed as fresh fruit or processed into food products such as watermelon juices and additives. It contains 34 kcal of energy, 92 g water, 0.7 g protein, 0.1 g fat and 7.0 g carbohydrates per 100 g fresh weight. Red-fleshed watermelons are rich in lycopene, which is higher than that in tomatoes. Market demand for watermelon continues to increase (Lignou, Parker, Baxter, & Mottram, 2014).

Growing typical crops in greenhouses protects plants from harsh and unpredictable environments, insect pests and diseases infestations. In Thailand, the use of plastic house as greenhouse structure is now widespread due to its cost effectiveness and lengthy service life. Plastic houses are typically used for a wide variety of crops, particularly watermelons, cucumbers and melons, to obtain high quality products.

Light is the primary environmental factor that regulates plant growth and development (McNellis & Deng, 1995; Fukuda, Fujita, Ohta, Sase, Nishimura, & Ezura, 2008) as it is essential in photosynthetic and morphogenetic processes (Castellano et al., 2008). Three aspects of light affect plant growth - light intensity, light quality or wavelength, and

ISSN: 0126-0537

Cite this as: Chamchum, W., Glahan, S., Kramchote, S., Maniwara, P., & Suwor, P. (2023). Growth and yield of watermelon (*Citrullus lanatus*) in plastic house in response to white led supplementary lighting. *AGRIVITA Journal of Agricultural Science, 45*(2), 271-277.http://doi.org/10.17503/agrivita.v45i2.3967

light duration or photoperiod (Nadalini, Zucchi, & Andreotti, 2017), which can be controlled through artificial lighting to promote growth and increase quality yield of crops.

Light Emitting Diode (LED) is increasingly used to increase crop production efficiency in closed horticultural systems. The LED lamps usually last for 50,000-100,000 h compared to fluorescent lamps which last for only 2,000-3,000 hours. Furthermore, it consumes 81-90% less electricity than fluorescent lamps while produces at least 5 times more light than the conventional lamps and illuminates at least 2 times greater than Compact Fluorescent Lamps (CFL) (Mitchell et al, 2012). LED is also ecologically friendly as it does not emit infrared and ultraviolet rays which can be harmful to human skin and eyes and has no mercury component which makes it not destructive to the environment. LED is considered as a tool to promote and develop efficient plants (Folta, & Carvalho, 2015). It is used as a light source or as supplement to natural lighting (Li, & Kubota, 2009; Johkan, Shoji, Goto, Hashida, Yoshihara, 2010; Samuolienė, Sirtautas, Brazaityte, & Duchovskis, 2012; Choi, Moon, & Kang, 2015) usually under controlled conditions (Folta, & Carvalho, 2015; Yoshida, Hikosaka, Goto, Takasuna, & Kudou, 2012; Lin et al, 2013; Piovene et al, 2015). This study determined the efficacy of LED supplementary lighting in improving growth and fruit yield and quality of watermelon grown in plastic houses.

MATERIALS AND METHODS

Plant Samples

Watermelon cultivar 'Kinaree 457' (Tawantonkla brand) was grown in 2019 in a 7 × 21 m^2 plastic house of the Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang (KMITL), Thailand. The plastic house was covered with 150 µm-thick UV-treated polyethylene sheet. Seeds were sown in seedling tray and the plants with the same size were selected and thereafter transplanted individually into 8 × 15 $inch^2$ black plastic pots. The planting media was 3:1 garden soil:cow manure mixture. The pots were arranged in rows of 10 spaced at 0.4 × 0.6 m.

Experimental Design

A Completely Randomized Design (CRD) was used with the following treatments and every treatment was replicated four times: natural daylight (control), natural daylight plus LED 6 h (6:00 pm – 12:00 pm) and natural daylight plus LED 12 h (6:00 pm-6:00 am). LED lighting was conducted using V-MAX 20W/6500K, size 100 × 100 × 170 mm (V-light brand, Five Lighting Co., Ltd., Thailand). The lighting was provided everyday starting from transplanting to harvest date.

Cultural Management

Fertilizer application, irrigation, weeding and insect pest and disease control followed commercial recommendations for plastic house-grown watermelons. The plants flowered after 20–25 days from transplanting and hand pollination was done to ensure fruit setting. One fruit was maintained per plant. At commercial maturity (about 50 days from fruit setting), the fruits were harvested for quality evaluation.

Data Collection

Plant height was determined using a metric rule (check) starting from 14 to 56 days after transplanting. Chlorophyll content of the 9^{th} leaf from the apical tip was non-destructively measured using SPAD-502 chlorophyll meter (Minolta Camera Co., Japan) starting from 21 to 56 days after transplanting. At harvest, fruit were measured for weight using a digital weighing balance (Adventurer, OHAUS Corp., USA); width (equatorial diameter), length (polar diameter) and thickness of the peel and flesh using a Vernier caliper; color (L*, a*, b*) using a Minolta Chromameter (CR-10); firmness using a penetrometer (Atago TR-53025, Italy); juice pH using a pH meter (Model HI2213, Hanna Instruments, USA); total soluble solids (TSS) using a refractometer (Model PAL-1, Tokyo, Japan); and titratable acidity (TA) by titration against a standard base (0.01N NaOH) using 1% phenolphthalein as indicator.

Statistical Analysis

The results were analyzed by performing analysis of variance (ANOVA) and treatment means were analyzed based on Tukey's HSD test ($p < 0.05$) using Statistix 10 software.

Principal component analysis (PCA) was performed to preliminarily explore watermelon quality variation from all treatments using JMP version 10.0 software (SAS Institute Inc., Cary, NC, USA). The results were presented in score plot and biplot graphss.

RESULTS AND DISCUSSION

Plant Growth

The plants increased in height more rapidly with LED lighting compared to that under natural daylight only (control) (Table 1). This effect was statistically significant after 28-56 days from transplanting. On the 56th and last day, plant height of the control (about 125 cm) was almost similar to that of LED-exposed plants after 28 days from transplanting. Final plant height of LED-treated plants was more than 10 cm longer than that of the control. The effects of 6 h and 12 h LED treatments were comparable, indicating that 6 h LED supplementary lighting was sufficient to promote growth.

Leaf chlorophyll content showed similar trend (Table 2). LED-treated plants had significantly higher chlorophyll content than the control after 21 days and after 42-56 days from transplanting. LED exposure duration did not show significant variations, thus 6 h LED lighting was enough for increasing chlorophyll content. The chlorophyll content decreased along with plant developmental stages. The chlorophyll content of control plant was recorded at 75 and 81-82 SPAD units at LED-treated plants after 21 days from transplanting and decreased to 58 (control) and 65-69 (LED-treated plants) SPAD units after 42-56 days from transplanting.

One of the direct effects of LED supplementary lighting is the increase in plant height. This has been attributed to increased photosynthesis due to increased chlorophyll content. Both effects (increased plant height and chlorophyll content) were also obtained in the present study. As a result of increased photosynthesis, more organic substances such as sugars are produced, which support growth processes as source of energy (ATP) needed for metabolic processes and as carbon skeletons (precursors) of biosynthetic processes. Similar results were obtained in tomato (Watjanatepin, 2019), strawberry (Nadalini, Zucchi, & Andreotti, 2017), sweet pepper (Sobczak, Kowalczyk, Wolska, Kowalczyk, & Niedzi´nska, 2020) and melon (Kramchote, & Glahan, 2020).

Fruit Quality

LED lighting produced bigger and heavier fruits than the control (Table 3). LED exposures for 6 h and 12 h had comparable effect. The fruit weight of LED-treated plants was 2.3-2.5 kg each and had 19-20 cm in length and 16 cm in width which were higher than that of the control (1.65 kg, 16 cm in length and 14 cm in width). Fig. 1 shows the size appearance of the fruits. In addition, fruits from LED-treated plants had thicker flesh (about 16 cm) than that of the control (14 cm) (Table 3). Peel thickness did not significantly vary among the treatments and ranged from 0.38 to 0.55 cm.

Table 1. Plant height (cm) of plastic house-grown watermelon in response to LED supplementary lightings

Treatments	Days after transplanting					
	21	28	35	42	49	56
No LED	75.23^{b}	72.05	77.13	64.68^{b}	62.28^{b}	58.25^{b}
LED 6 h	80.60^{a}	77.23	75.13	71.83^{a}	68.20^{a}	64.73^{a}
LED 12 h	81.70^{a}	79.15	68.48	74.60^{a}	71.48^{a}	69.13^{a}
F-test	*	ns	ns	*	*	*
C.V. (%)	3.96	5.90	6.02	5.85	5.49	6.06

Remarks: Means in the same column followed by the same letter are not significantly different based on Tukey's HSD test; ns = not significant, * = significant at 5%, ** = significant at 1%

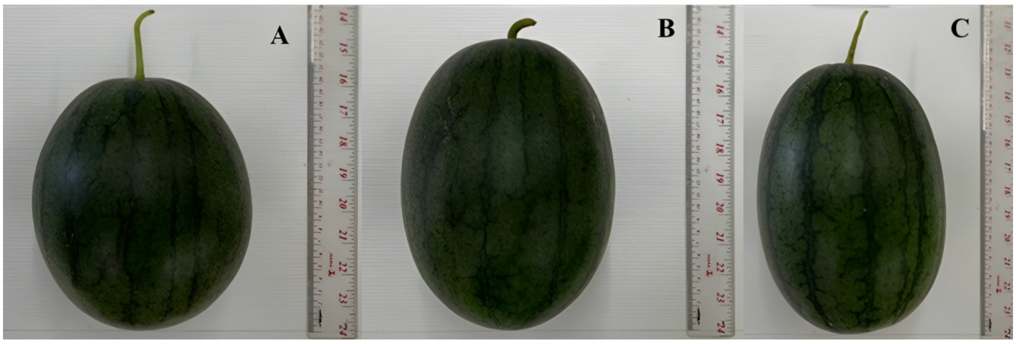
Table 2. Leaf chlorophyll content (SPAD unit) of plastic house-grown watermelon in response to LED supplementary lighting

Treatments	Days after transplanting						
	14	21	28	35	42	49	56
No LED	11.75	72.13	116.75^{b}	120.55^{b}	122.28^{b}	123.50^{b}	124.83^{b}
LED 6 h	14.38	75.13	124.18^{a}	131.23^{a}	133.23^{a}	134.27^{a}	136.30^{a}
LED 12 h	17.75	79.63	127.90^{a}	132.77^{a}	134.82^{a}	136.13^{a}	137.90^{a}
F-test	ns	ns	**	**	**	**	**
C.V. (%)	22.76	5.73	3.21	2.34	2.30	2.01	1.57

Remarks: Means in the same column followed by the same letter are not significantly different based on Tukey's HSD test; ns = not significant, * = significant at 5%, ** = significant at 1%

Fruit flesh color coordinates L* (lightness) and b* (blue to yellow) did not differ statistically among treatments and ranged from 27.81-33.47 and 9.35-10.99, respectively (Table 4). Significant differences were obtained for a* values (green to red) of fruit from 6 h LED treated plants which had lower a* (15.66) indicating less red color than that the control (19.16). LED treatment for 12 h had a* values comparable to the control. Fig. 2 shows the internal appearance of the fruit with the red flesh color appearing lighter in 6 h LED treatment compared to the other two treatments.

Firmness decreased in response to 6 h and 12 h LED treated plants from 12.69 to 7.66-7.90 N from the control (Table 4). Juice pH (5.52-6.87) and TSS (9.3-10.0°B) did not significantly differ among treatments while TA was significantly higher at 6 h LED treated plants (0.22%) relative to the control (0.15%) (Table 4).



Remarks: A = No LED, B = LED 6 h, C = LED 12 h

Fig. 1. External characteristics of plastic house-grown watermelons with or without LED supplementary lighting

Remarks: A = No LED, B = 6 h LED treatment, C = 12 h LED treatment

Fig. 2. Internal characteristics of plastic house-grown watermelons with or without LED supplementary lighting

Table 3. Fruit weight, length, width, peel thickness and flesh thickness of plastic house-grown watermelon in response to LED supplementary lighting

Treatments	Fruit weight (kg)	Fruit length (cm)	Fruit width (cm)	Peel thickness (cm)	Flesh thickness (cm)
No LED	1.65b	15.95b	14.29b	0.38	13.77b
LED 6 h	2.31a	19.25a	15.67ab	0.34	15.71a
LED 12 h	2.51a	20.47a	16.22a	0.55	16.38a
F-test	*	*	*	ns	*
C.V. (%)	17.74	9.42	5.68	53.31	7.27

Remarks: Means in the same column followed by the same letter are not significantly different based on Tukey's HSD test; ns = not significant, * = significant at 5%, ** = significant at 1%

The results show that 6 h LED supplementary lighting was sufficient to increase fruit yield. The increase in fruit weight was due to the increase of fruit size that corresponded to the increase of flesh thickness but not peel thickness. This response to LED lighting supplement has been attributed to the increase of photosynthesis (Shimazaki, Doi, Assmann, & Kinoshita, 2007; Dong, Fu, Liu, & Liu, 2014; Sabzalian et al., 2014). The increase of photosynthetic capacity of LED-treated plants in the present study can be implicated from the increase of plant height and chlorophyll contents. This is in accordance with earlier findings in melon studies (Kramchote, & Glahan, 2020). The fruits produced with 6 h LED lighting were less red in flesh color implying lower lycopene content; softer (reduced firmness); and became more acidic (increased TA content). The sweetness was apparently not affected as TSS content was not changed relative to that of the control. Mechanisms underlying these changes can be examined in future studies.

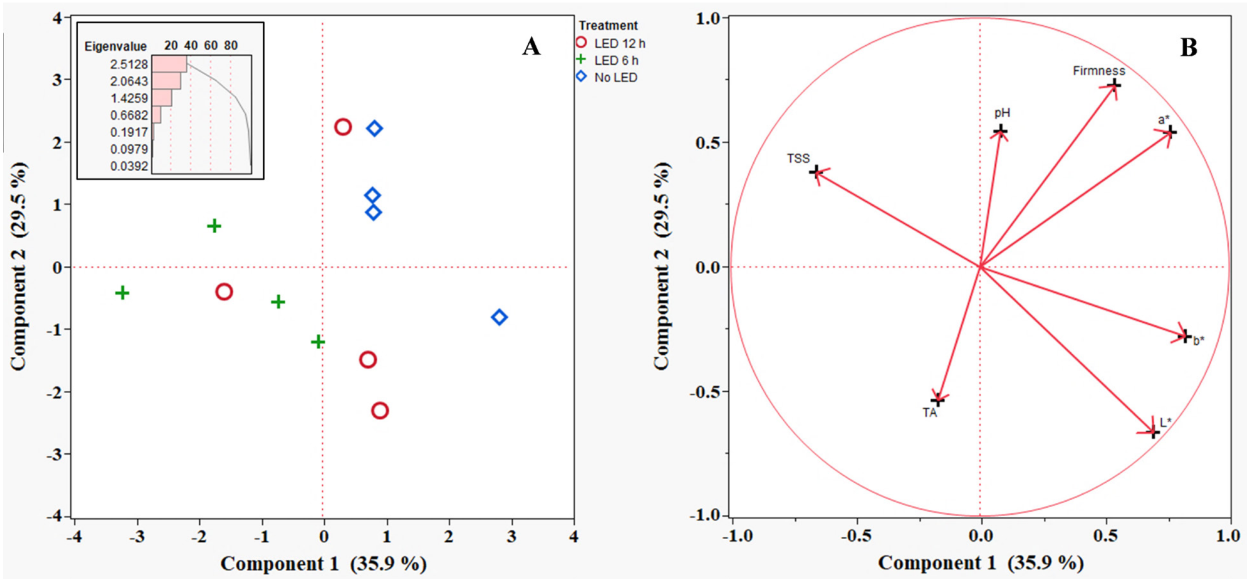


Fig. 3. Score plot (A) of component 1 (PC1) against component 2 (PC2) of watermelon physico-chemical quality (L*, a*, b*, firmness, pH, TSS and TA) obtained from all lighting treatments and biplot illustration (B) of PC1 versus PC2 of quality parameters are also presented

Table 4. Fruit flesh color, firmness, pH, total soluble solids (TSS) and titratable acidity (TA) of plastic house-grown watermelon in response to LED supplementary lighting

Treatments	Color			Firmness (N)	pH	TSS (°Brix)	TA (%)
	L*	a*	b*				
No LED	30.96	19.16a	10.79	12.69a	5.69	9.33	0.15b
LED 6 h	27.81	15.66b	9.35	7.90b	5.52	10.00	0.22a
LED 12 h	33.47	16.66ab	10.99	7.66b	6.87	10.00	0.19ab
F-test	ns	*	ns	*	ns	ns	*
C.V. (%)	14.52	10.14	10.36	24.61	26.62	7.52	15.61

Remarks: Means in the same column followed by the same letter are not significantly different based on Tukey's HSD test; ns = not significant, * = significant at 5%, ** = significant at 1%

Principal Component Analysis (PCA)

A multivariate statistical analysis of PCA was applied to watermelons' physical and chemical quality in order to identify variance of each treatment and the quality parameter that dominantly affected by lighting condition. The study found that the set of two principal components (PC1 and PC2) accounted for 65.4% of total variance, and reached over 85.0% when considered together with PC3. Fig. 3 presents the PCA score plot of all studied parameters, illustrating two distinguishable clusters in the PCA space (Fig. 3A). The scenario suggested that LED lighting provided significant effects on both physical and chemical quality of watermelon regardless of lighting hour (6 and 12 hours). The PCA is often used to explore comprehensive variables and explain similarity or dissimilarity of samples (Kaewpangchan et al., 2021; Giuffrè, 2021). The study of Theanjumpol, & Maniwara, (2020) used PCA to explore quality variations of freshly harvested and 30-day stored pumpkins and discovered that both pumpkins had dissimilarity in most quality parameters especially for texture profiles. Likewise the aforementioned literature, in this study, quality traits from watermelons with no LED clearly showed dissimilarity with those from watermelons with LED exposure as they were clustered in the different side of the plane. Furthermore, according to bioplot graph (Fig. 3B), flesh color values (L*, a*, b*) and firmness were considerably affected by LED lighting.

CONCLUSION

LED supplementary lighting promoted growth and increased fruit yield of watermelons grown in plastic house. LED lighting duration of 6 h was sufficient as extending the exposure period to 12 h had no additional benefit. However, there were demerits of the treatment as the fruits had reduced reddening and firmness and increased acidity which suggest the need for further optimization studies to mitigate these effects.

ACKNOWLEDGEMENT

This work was funded by the School of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang (KMITL), Bangkok, Thailand (grant number 2563-02-04-023).

REFERENCES

Castellano. S., Mugnozza, G. S., Russo, G., Briassoulis, D., Mistriotis, A., Hemming, S., & Waaijenberg, D. (2008). Plastic nets in agriculture a general review of types and application. *Applied Engineering in Agriculture*, 24(6), 799-808. https://doi.org/ 10.13031/2013.25368

Choi, H. G., Moon, B. Y., & Kang, N. J. (2015). Effects of LED light on the production of strawberry during cultivation in a plastic greenhouse and in a growth chamber. *Scientia Horticulturae*, 189(1), 22-31. https://doi.org/10.1016/j.scienta.2015.03.022

DOA. The situation of growing flesh watermelon [Internet]. (2018) [cited 2020 Oct 8]. Available from http:// www.agriinfo.do ae.go.th/year 60/ plant /rortor/ veget/28.pdf,

Dong, C., Fu, Y., Liu, G., & Liu, H. (2014). Growth, photosynthetic characteristics, antioxidant capacity and biomass yield and quality of wheat (*Triticum aestivum* L.) exposed to LED light sources with different spectra combinations. *Journal Agronomy and Crop Science*, 200(3), 219–230. https://doi.org/10.1111/jac.12059

Folta, K. M., & Carvalho, S. D. (2015). Photoreceptors and control of horticultural plant traits. *HortScience*, 50(9), 1274-1280. http://dx.doi.org/10.21273/ HORTSCI.50.9.1274

Fukuda, N., Fujita, M., Ohta, Y., Sase, S., Nishimura, S., & Ezura, H. (2008). Directional blue light irradiation triggers epidermal cell elongation of abaxial side resulting in inhibition of leaf epinasty in geranium under red light condition. *Scientia Horticulturae*, 115(2), 176–182. https://doi.org/10.1016/j. scienta.2007.08.006

Giuffrè, A. M. (2021). *n*-Alkanes and *n*-alkenes in virgin olive oil from Calabria (South Italy): The effects of cultivar and harvest date. *Foods*, 10(2), 290. https://doi.org/10.3390%2Ffoods10020290

Johkan, M,, Shoji. K., Goto, F., Hashida, S. N., & Yoshihara, T. (2010). Blue light-emitting diode light irradiation of seedlings improves seedling quality and growth after transplanting in red leaf lettuce. *HortScience*, 45(12), 1809-1814. https:// doi.org/10.21273/HORTSCI.45.12.1809

Kaewpangchan, P., Phuangsaijai, N., Seehanam, P., Theanjumpol, P., Maniwara, P., & Kittiwachana, S. (2021). Screening of coffee impurity using a homemade NIR sensor system. *Chiang Mai Journal of Science*, 48(2), 292–300. file:///C:/ Users/Administrator/Downloads/cmjs-21-03-29-03-10-20-10a5ab2db3-2.pdf

Kramchote, S., & Glahan, S. (2020). Effects of LED supplementary lighting and NPK fertilization on fruit quality of melon (*Cucumis melo* L.) grown in plastic house. *Journal of Horticultural Research*, 28(1), 111-122. https://doi.org/10.2478/johr-2020-0014

Lignou, S., Parker, J.K., Baxter, C., & Mottram, D. S. (2014). Sensory and instrumental analysis of medium and long shelf-life Charentais cantaloupe melons (*Cucumis melo* L.) harvested at different maturities. *Food Chemistry*, 148(1), 218-229. https://doi.org/10.1016/j.foodchem.2013.10.045

Li, Q., & Kubota, C. (2009). Effects of supplemental light quality on growth and phytochemicals of baby leaf lettuce. *Environmental and Experimental Botany*, 67(1), 59-64. https://doi.org/10.21273/HORTSCI.50.9.1274

Lin, K. H., Huang, M. Y., Huang, W. D., Hsu, M. H., Yang, Z. W., & Yang, C. M. (2013). The effects of red, blue, and white light-emitting diodes on the growth, development, and edible quality of hydroponically grown lettuce (*Lactuca sativa* L. var. *capitata*). *Scientia Horticulturae*, 150(1), 86-91. https://sci.bban.top/pdf/10.1016/dx.doi.org/10.1016/j.scienta.2012.10.002

McNellis, T. W., & Deng, X. W. (1995). Light control of seedling morphogenetic pattern. *Plant Cell*, 7, 1749-1761. https://doi.org/10.1105%2Ftpc.7.11.1749

Mitchell, C., Both, A. J., Bourget, M., Burr, J., Kubota, C., Lopez, R., Morrow, R., & Runkle, E. (2012). LEDs: The future of greenhouse lighting!. *Chronica Horticulturae*, 52(1), 6-12. http://www.actahort.org/...ch5201.pdf

Nadalini, S., Zucchi, P., & Andreotti, C. (2017). Effects of blue and red LED lights on soilless cultivated strawberry growth performances and fruit quality. *European Journal of Horticultural Science*, 82(1), 12-20. https://doi.org/10.17660/eJHS.2017/82.1.2

Piovene, C., Orsini, F., Bosi, S., Sanoubar, R., Bregola, V., Dinelli, G., & Gianquinto, G. (2015). Optimal red:blue ratio in led lighting for nutraceutical indoor horticulture. *Scientia Horticulturae*, 193(1), 202-208. https://sci.bban.top/pdf/10.1016/dx.doi.org/10.1016/j.scienta.2015.07.015

Sabzalian, M. R., Heydarizadeh, P., Zahedi, M., Boroomand, A., Agharokh, M., Sahba, M. R., & Schoefs, B. (2014). High performance of vegetables, flowers, and medicinal plants in a red-blue LED incubator for indoor plant production. *Agronomy for sustainable development*, 34(4), 879–886. https://dx.doi.org/10.1007/s13593-014-0209-6

Samuolienė, G., Sirtautas, R., Brazaityte, A., & Duchovskis, P. (2012). LED lighting and seasonality effects antioxidant properties of baby leaf lettuce. *Food Chemistry*, 134(3), 1494-1499. http://dx.doi.org/10.1016/j.foodchem.2012.03.061

Shimazaki, K. I., Doi, M., Assmann, S. M., & Kinoshita, T. (2007). Light regulation of stomatal movement. *Annual Review of Plant Biology*, 58(1), 219–247. https://doi.org/10.1146/annurev.arplant.57.032905.105434

Sobczak, A., Kowalczyk, K., Wolska, J. G., Kowalczyk, W., & Niedzi´nska, M. (2020). Growth, Yield and Quality of Sweet Pepper Fruits Fertilized with Polyphosphates in Hydroponic Cultivation with LED Lighting. *Agronomy*, 10(10), 1-15. https://doi.org/10.3390/agronomy10101560

Theanjumpol, P., & Maniwara, P. (2020). Physico-chemical and cooking qualities of fresh and stored pumpkins. *Horticulture, Environment and Biotechnology*, 63, 101–113. https://doi.org/10.1007/s13580-021-00385-4

Watjanatepin, N. (2019). Effect of three specific spectra of LED light on the growth, yield, and fruit quality of Sida tomato. *Institute of Advanced Science Extension*, 6(6), 15-21. https://doi.org/10.21833/ijaas.2019.06.003

Wei, H., Wang, M., & Jeong, B. R. (2020). Effect of supplementary lighting duration on growth and activity of antioxidant enzymes in grafted watermelon seedlings. *Agronomy*, 10(337), 1-18. https://doi.org/10.3390/agronomy10030337

Yoshida, H., Hikosaka, S., Goto, E., Takasuna, H., & Kudou, T. (2012). Effects of light quality and light period on flowering of everbearing strawberry in a closed plant production system. *Acta Horticulturae*, 956, 107-112. https://doi.org/10.17660/ActaHortic.2012.956.9