# Light Colour Effects on the Performance of Vegetables Grown in a Confined Environment

[1]Toyese F. Oyewusi, [2]Tolulope E. Aremu, and [3]Matthew A. Oke
[1]Department of Agricultural Engineering, Osun State University, Osogbo, Osun State, Nigeria
[2]Department of Agricultural Engineering, Adeleke University, Ede, Osun State, Nigeria
[3]Department of Agricultural and Biosystems Engineering, Bells University of Technology, Ota Ogun State, Nigeria
toyese.oyewusi@uniosun.edu.ng|aremu.tolulope@adelekeuniversity.edu.ng|amoke@bellsuniversity.edu.ng

Received: 13-MAY-2026; Reviewed: 15-AUGUST-2026; Accepted: 30-AUGUST-2026
https://dx.doi.org/10.46792/fuoyejet.v11i3.1588

**ORIGINAL RESEARCH**

**Abstract**— Light serves as both an energy source for carbon oxidation during photosynthesis and a signal to activate and control a number of other critical processes involved in plant growth and development, making it one of the key environmental factors regulating plant physiology throughout the entire plant life cycle. The objective of this study was to investigate the effects of different light colours (red, blue, and white) on the growth parameters of some vegetables. Three species of vegetables, namely Celocia agentea (Soko), Amaranthus species (Tete), and Corchorus spp (Jute Leaf) were planted under three types of light colour (blue, red and white). Data taken were Plant height (PH), Stem girth (SG), Leaf area (LA), Leaf Branches (LB) and Number of Leaves (NL). Celosia agentea and Amaranthus spp performed better under blue light for plant height (10.5 cm and 11.3 cm respectively). Although Amaranthus spp had the largest leaf area across all light treatments, the highest value was recorded under blue light (19 cm²). Among the vegetables, Celosia agentea had the largest stem girth under white light, with an average of 0.26 cm. Amaranthus spp showed consistent stem girths across all light treatments, with blue light resulting in the largest average girth of 0.28 cm. Celosia agentea, under blue light had the highest number of leaves. Overall, it was confirmed that blue light promotes the growth of Celosia agentea and Amaranthus spp. However, white light supported the growth of Corchorus spp.

**Keywords**— Amaranthus spp, Celosia agentea, Light colour, Vegetables

## 1 INTRODUCTION

The continued increase in human population means achieving food security is the most important task of the 21st century. With the growing global populations, it is projected that food production has to increase by 69% by the year 2035 (Ouzounis et al., 2015). Meanwhile, currently, food producers are facing vast amounts of issues due to changes in the climate and issues in the global supply chains. These challenges include but are not limited to erratic weather conditions, increasing scarcity of farmable land, water scarcity, pest and diseases and gradual decline of the ecosystem (Mu et al., 2018).

Indoor farming has been proposed as one of the viable solutions to this problem as it eliminates many of the challenges associated with the conventional agriculture and has tremendous benefits in terms of sustainability of the system and control of the variables important for plant growth (Lalge, 2017). Of these variables, light is one of the most important (Wang et al., 2016).

Light serves as both an energy source for carbon oxidation during photosynthesis (assimilative function) and a signal to activate and control a number of other critical processes involved in plant growth and development (control function), making it one of the key environmental factors regulating plant physiology throughout the entire plant life cycle (Devlin et al., 2007 and Yang et al., 2016). Photosynthetic carbon assimilation only takes place with the presence of light, which is regulated by a variety of outside elements, but most crucially, light (Choi et al., 2016). It has been discovered that for plants to grow robust and healthily, there should be at least 10 to 14 hours of daylight each day (Arena et al., 2016). Since light is the key factor that drives the process of photosynthesis and plant growth, there is a need to understand how it can be efficiently utilized for optimal plant growth and yield in a confined environment. Although, several studies have investigated the photosynthetic ability of plants grown in confined environment using different light colours (Bridgen, 2016, Efremova et al., 2020, Hogewoning et al., 2012, and Kim, 2004), however, more information is needed on the response of different vegetables to red, blue and white light. Therefore, the aim of this study was to determine the effects of light colour on the performance of vegetables in a confined environment while the objectives were to a) to design a compact space with artificial lighting system for vegetable growth. b) to plant and raise vegetables using both artificial lighting (different colors of light) and sunlight to serve as control and c) to compare the growth of the vegetables raised under these conditions.

## 2 MATERIALS AND METHODS

### 2.1 Experimental site

The study was carried out at the Farm electrification laboratory of the department of Agricultural Engineering, Faculty of Engineering, Adeleke University, Ede, Osun State.

### 2.2 Materials used in the study

The following materials were used in the construction of the confined spaces and experimental set-up.

Corresponding Author:
**Section A-** AGRICULTURAL ENGINEERING & RELATED SCIENCES
**Can be cited as:**
Oyewusi T. F., Aremu T. E., and Oke M. A. (2026). Light Colour Effects on the Performance of Vegetables Grown in a Confined Environment. FUOYE Journal of Engineering and Technology (FUOYE**JET**), **11(3), 369-372.**
https://dx.doi.org/10.46792/fuoyejet.v11i3.1588

© 2026 The Author(s). Published by Faculty of Engineering, Federal University Oye-Ekiti.
This is an open access article under the CC BY NC license. (https://creativecommons.org/licenses/by-nc/4.0/)

1. 9 wooden boxes- 3 boxes were fixed with one of the light colour bulbs
2. 9 light bulb sockets- one each for the boxes
3. 9 light bulbs
4. Electric cables: This was used for electrical connection from the power source through the switch to the LEDs.
5. Electric switch: It was used to turn on and turn off the LEDs to manually control the timing of exposure to light
6. Polythene bags: This housed the soil that was used for planting the vegetables.
7. Seeds of *Amaranthus spp, Corchorus spp* and *Celosia spp*: Seeds of these vegetables were obtained from a local seed vendor.
8. 50 litres water tank: This was used for irrigating the plants
9. 1 inch water hose: Was used to convey water from the tank to the drippers and emitters
10. Emitters: These were used to facilitate drip irrigation

### 2.3 Experimental Procedure

The factors in this study were light colour (3) and vegetables (3) leading to a 3x3 factorial experiment. Therefore, there were 9 units in total. White light bulbs were fixed in 3 boxes. Same for blue and red light. *Amaranthus spp*, *Celocia argentea* and *Corchorus olitorus* planted in polyethene bags were placed in each of the boxes. Polythene bags were filled to 2/3 of their volume with sandy loam soil. 12 polythene bags containing soil and germinated vegetables were placed in each box. The seeds were sown outdoors under natural conditions and were taken to the units after germination. Once in the boxes, they were irrigated daily. The plants were exposed to 13 -14 hours of light daily. After maturation, the vegetables from different compartments were harvested and the following parameters were measured:

1. Plant height (PH)
2. Stem girth (SG)
3. Leaf area (LA)
4. Leaf area index (LAI): Calculated using the formula below:

$$LAI = \frac{Total\ leaf\ area\ (cm^2)}{Ground\ surface\ area\ (cm^2)} \quad (1)$$

5. Leaf Branches (LB)
6. Number of Leaves (NL)

## 3 RESULTS AND DISCUSSION

### 3.1 Plant Height Measurements

Table and Figure 3.1 present the plant height measurements. Among the different light conditions, blue light consistently resulted in the tallest plant heights for all three varieties. The average plant heights under blue light were 10.93 cm (*Celosia agentea*), 4.93 cm (*Amaranthus spp*), and 5.9 cm (*Corchorus spp*). This corresponds with several studies where exposure of plants to blue light increased stomata opening (Hernández et al., 2016), leaf development (Fukuda et al., 2016), and nutritional quality of the plant (Fang et al., 2020). Red light also promoted considerable growth, with average plant heights of 9.9 cm (*Celosia agentea*), 4.53 cm (*Amaranthus spp*), and 5.47 cm (*Corchorus spp*). White light resulted in slightly shorter plant heights, with averages of 9.6 cm (*Celosia agentea*), 4.47 cm (*Amaranthus spp*), and 4.73 cm (*Corchorus spp*). The control plants grown under normal light exhibited comparable plant heights to those grown under white light. Overall, blue light showed the most significant positive effect on plant height across all three varieties.

Table 1(3.1). Summary of the measured Plant Height (cm)

| Variety of vegetables | Replicate | Red Light | Blue Light | White Light | Normal Light (Control) |
|---|---|---|---|---|---|
| *Celosia agentea* (Soko) | 1 | 8 | 10.2 | 9 | 11 |
| | 2 | 8.2 | 11.3 | 9.8 | |
| | 3 | 8.5 | 11.5 | 10.5 | |
| *Amaranthus spp* (Tete) | 1 | 4.3 | 5.3 | 4.3 | 10 |
| | 2 | 4.2 | 5.1 | 4.6 | |
| | 3 | 4.1 | 4.7 | 4.5 | |
| *Corchorus spp* (Jute leaf) | 1 | 5.1 | 6 | 4.8 | 10 |
| | 2 | 5.3 | 6.2 | 4.5 | |
| | 3 | 4.9 | 6.5 | 4.9 | |

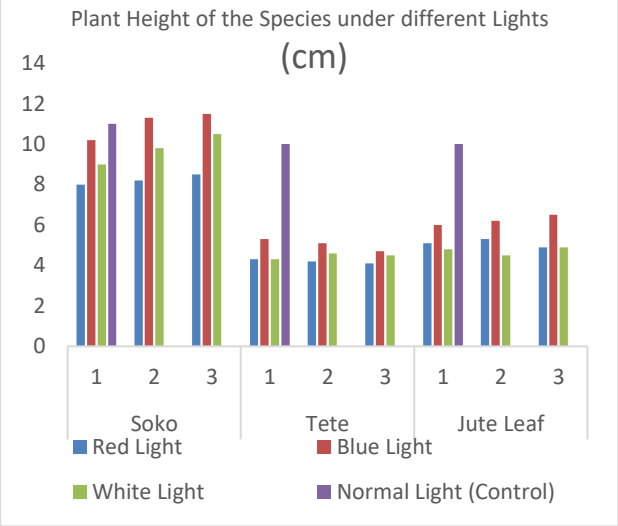


Fig. 1. (3.1) Variation of plant height with different light colours

### 3.2 Leaf Area ($cm^2$) Measurements

Table 3.2 and Figure 3.2 display the measurements of leaf area ($cm^2$) and leaf area index (LAI). *Celosia agentea*, under blue light exhibited the highest leaf areas with an average of 14.87 $cm^2$ and an LAI of 4.85. Red light and white light also contributed to significant leaf area with averages of 14.69 $cm^2$ (LAI 4.79) and 14.87 $cm^2$ (LAI 4.85), respectively. The control plants had a slightly larger leaf area of 16 $cm^2$ (LAI 5.33) which is as a result of a more balanced spectrum that white light provides (Hernández et al., 2016). Regarding *Amaranthus spp*, the control plants had the largest leaf areas, averaging 16.77 $cm^2$ (LAI 5.77). However, blue light also showed positive effects with an average leaf area of 11.93 $cm^2$ (LAI 4.16). For *Corchorus spp*, the control plants had the largest leaf areas with an average of 156.67 $cm^2$ (LAI 3.13). Blue light treatment also resulted in substantial leaf areas, averaging 125 $cm^2$ (LAI 2.5). Overall, blue light and the control plants demonstrated the most favorable outcomes in terms of leaf area and leaf area index for all three varieties.

© 2026 The Author(s). Published by Faculty of Engineering, Federal University Oye-Ekiti.
This is an open access article under the CC BY NC license. (https://creativecommons.org/licenses/by-nc/4.0/)

http://dx.doi.org/10.46792/fuoyejet.v11i3.1588 engineering.fuoye.edu.ng/journal

Table 2. (3.2) Leaf Area ($cm^2$) measurements

| Variety of Vegetables | Replicate | Red Light | Blue Light | White Light | Control |
|---|---|---|---|---|---|
| *Celosia agentea* (Soko) | 1 | 14.45 | 15.03 | 14.59 | 20 |
| | 2 | 15.3 | 14.5 | 13.88 | |
| | 3 | 11.5 | 15.5 | 15.03 | |
| *Amaranthus spp* (Tete) | 1 | 13.11 | 10.5 | 11.2 | 25 |
| | 2 | 10.15 | 13.3 | 11.11 | |
| | 3 | 11.16 | 12.11 | 13 | |
| *Corchorus spp* (Jute leaf) | 1 | 120 | 110 | 100 | 200 |
| | 2 | 200 | 190 | 180 | |
| | 3 | 150 | 145 | 140 | |

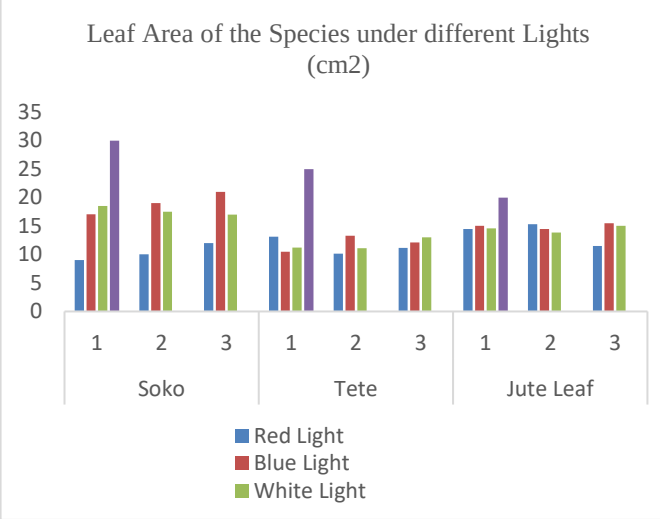


Fig. 2. (3. 2) Chart showing the Leaf Area

### 3.3 Stem Girth (cm) Measurements

Table 3.3 and Figure 3.3 represent the stem girth measurements in centimeters. *Celosia agentea* exhibited the largest stem girth under white light with an average of 0.18 cm. Red light treatment resulted in slightly smaller stem girths with an average of 0.17 cm, while blue light exhibited the smallest stem girth with an average of 0.16 cm. The control plants showed the largest stem girths with an average of 0.78 cm. For *Amaranthus spp*, the control plants had the largest stem girths with an average of 0.8 cm. Among the light treatments, red light showed the smallest stem girths with an average of 0.2 cm, while blue light and white light had similar stem girths of approximately 0.21 cm. *Corchorus spp* exhibited the largest stem girths under white light with an average of 0.26 cm. Blue light and red light treatments also promoted substantial stem girths, averaging 0.28 cm and 0.25 cm, respectively. The control plants also exhibited the largest stem girths with an average of 0.9 cm suggesting more biomass accumulation due to wider light spectrum of the sunlight (Kami et al., 2010).

Table 3. (3. 3) Stem Girth (cm) Measurements

| Variety of Vegetable | Replicate | Red Light | Blue Light | White Light | Control |
|---|---|---|---|---|---|
| *Celosia agentea* (Soko) | 1 | 0.17 | 0.16 | 0.18 | 0.78 |
| | 2 | 0.18 | 0.16 | 0.17 | |
| | 3 | 0.16 | 0.17 | 0.19 | |
| *Amaranths spp* (Tete) | 1 | 0.22 | 0.19 | 0.18 | 0.8 |
| | 2 | 0.21 | 0.2 | 0.19 | |
| | 3 | 0.19 | 0.23 | 0.21 | |
| *Corchorus spp* (Jute leaf) | 1 | 0.25 | 0.28 | 0.26 | 0.9 |
| | 2 | 0.2 | 0.29 | 0.25 | |
| | 3 | 0.22 | 0.25 | 0.23 | |

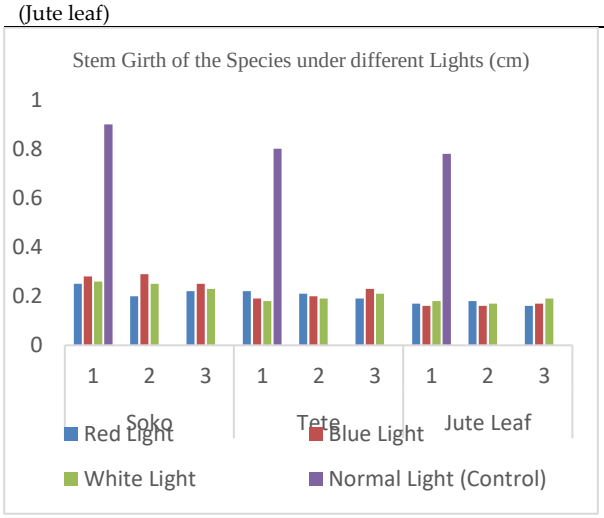


Fig. 3 (3. 3) Chart showing the Stem Girth

### 3.4 Leaf Branches

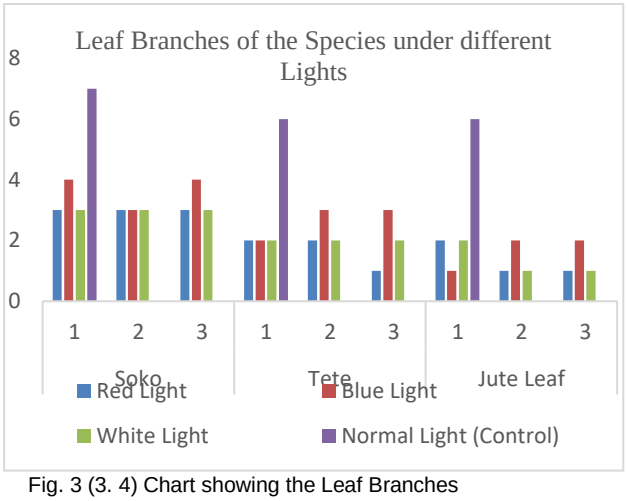


Fig. 3 (3. 4) Chart showing the Leaf Branches

Table and Figure 3.4 provides the counts of leaf branches for each variety. *Celosia agentea* exhibited the highest number of leaf branches under blue light, with an average of 1.33 branches. The control plants showed the highest number of leaf branches with an average of 6 branches. *Amaranths spp* had consistent leaf branch counts across all light treatments, averaging 2 branches. *Corchorus spp* exhibited the largest number of leaf branches under the control condition, averaging 8 branches. Blue light and white light treatments resulted in similar leaf branch counts, averaging 3 branches. Red light showed the lowest leaf branch counts, with an average of 2 branches. Overall, the control plants and blue light treatment promoted the highest number of leaf branches for the respective varieties.

Table 4. (3.4) Leaf Branches Measurements

| Variety of Vegetable | Replicate | Red Light | Blue Light | White Light | Control |
|---|---|---|---|---|---|
| *Celosia agentea* (Soko) | 1 | 2 | 1 | 2 | 6 |
| | 2 | 1 | 2 | 1 | |
| | 3 | 1 | 2 | 1 | |
| *Amaranths spp* (Tete) | 1 | 2 | 2 | 2 | 6 |
| | 2 | 2 | 3 | 2 | |
| | 3 | 1 | 2 | 1 | |
| *Corchorus spp* | 1 | 4 | 3 | 3 | 8 |
| | 2 | 3 | 3 | 3 | |

© 2026 The Author(s). Published by Faculty of Engineering, Federal University Oye-Ekiti.
This is an open access article under the CC BY NC license. (https://creativecommons.org/licenses/by-nc/4.0/)

http://dx.doi.org/10.46792/fuoyejet.v11i3.1588 engineering.fuoye.edu.ng/journal

| | | | | |
|---|---|---|---|---|
| (Jute leaf) | 3 | 2 | 2 | 2 |

### 3.5 Number of Leaves

Table 3.5 and Figure 3.5 shows the counts of leaves for each variety. *Celosia agentea* showed the highest number of leaves under blue light and the control condition, averaging 3.67 and 3.67 leaves, respectively. *Amaranthus spp* had varying leaf counts, with the control plants exhibiting the highest average of 3.67 leaves. *Corchorus spp* exhibited consistent leaf counts across all light treatments, averaging 3 leaves. The control plants also had the highest number of leaves for *Corchorus spp*, with an average of 6 leaves. Red light and white light treatments resulted in similar leaf counts across all three varieties, ranging from 1 to 4 leaves. Overall, blue light and the control condition tended to promote higher leaf counts for most of the varieties.

Table 3. (3. 4) Number of Leaves

| Variety of vegetable | Replicate | Red Light | Blue Light | White Light | Control |
|---|---|---|---|---|---|
| *Celosia agentea* (Soko) | 1 | 3 | 4 | 3 | 7 |
| | 2 | 3 | 3 | 3 | |
| | 3 | 2 | 4 | 3 | |
| *Amaranths spp* (Tete) | 1 | 2 | 3 | 2 | 6 |
| | 2 | 2 | 2 | 1 | |
| | 3 | 1 | 2 | 1 | |
| *Corchorus spp* (Jute leaf) | 1 | 3 | 3 | 2 | 6 |
| | 2 | 3 | 4 | 4 | |
| | 3 | 2 | 3 | 3 | |

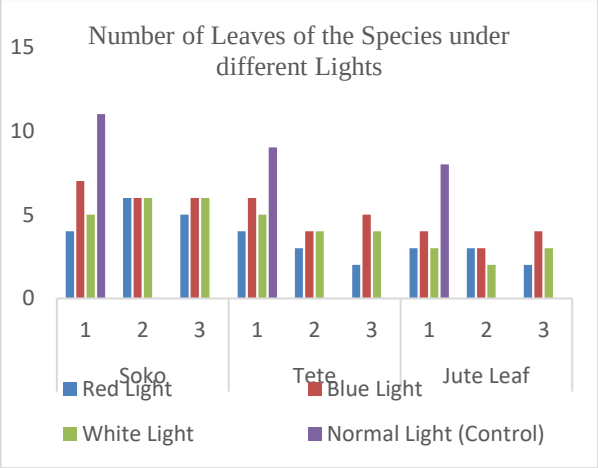


Fig. 5. (3.5) Variation of Number of leaves with different light colours

## 4.0 CONCLUSION

The study aimed to investigate the effects of different light wavelengths (red, blue, and white) on the growth parameters of three vegetable varieties, namely *Celocia agentea (Soko), Amaranthus species (Tete),* and *Corchorus spp* (Jute Leaf). Overall, blue light appeared to be beneficial for promoting plant height and leaf area in *Celosia agentea* and *Amaranthus spp*. White light showed positive effects on plant height and stem girth in *Corchorus spp*. It was concluded that there are specific light requirements for each vegetable species when designing artificial lighting systems for indoor cultivation. Blue light can be advantageous for promoting plant height while white light may benefit stem girth. However, natural sunlight remains essential for achieving robust growth and development. Further experimentation and fine-tuning of light conditions can lead to improved cultivation practices for *Celosia agentea, Amaranthus spp,* and *Corchorus spp*.

## REFERENCES


Arena, C., Tsonev, T., Doneva, D., Balotin, L., & Velikova, V. (2016). Growth, chlorophyll fluorescence, leaf anatomy, and antioxidants in tomato plants under different light-emitting diodes. *Photosynthetica*, 54(4), 548-556.

Bridgen, M. P. (2016). The greenhouse response to ultraviolet-B radiation: from chloroplasts to genomes. *Springer*.

Choi, H. W., Kim, H. H., Moon, B. Y., Cheon, Y. W., & Kim, K. M. (2016). Effects of LED light on the length of petioles and width of leaflets in strawberry plantlets in vitro. *Journal of Agriculture & Life Science*, 50(4), 37-43.

Devlin, P. F., Christie, J. M., & Terry, M. J. (2007). Many hands make light work. *Journal of Experimental Botany*, 58(2), 307-315.

Efremova, N. N., Kulikova, A. V., Konovalov, D. A., & Tikhomirova, N. A. (2020). Efficiency of different light sources for plant growth in closed space. *Proceedings of the 3rd International Conference on Biomedical Engineering and Bioinformatics* (ICBEB 2020).

Fang L., Ma Z., Wang Q., Nian H., Ma Q., Huang Q., Mu Y. (2020). Plant growth and photosynthetic characteristics of soybean seedlings under different led lighting quality Conditions. Journal of Plant Growth Regulation. 40:668–678. doi: 10.1007/s00344-020-10131-2.

Fukuda N., Ajima C., Yukawa T., Olsen J.E. (2016). Antagonistic action of blue and red light on shoot elongation in petunia depends on gibberellin, but the effects on flowering are not generally linked to gibberellin. *Journal of Environmental Experimental Botany*. 121:102–111. doi: 10.1016.

Hernández R., Eguchi T., Kubota C. (2016). Growth and morphology of vegetable seedlings under different blue and red photon flux ratios using light-emitting diodes as sole-source lighting. *Acta Horticulturae*.1134:195200.doi:10.17660.

Hogewoning, S. W., Wientjes, E., Douwstra, P., Trouwborst, G., van Ieperen, W., & Croce, R. (2012). Photosynthetic quantum yield dynamics: from photosystems to leaves. *Plant, Cell & Environment*. 35(4), 571-581.

Kami C., Lorrain S., Hornitschek P., Fankhauser C. (2010). "Light regulated plant growth and development," in *Plant Development. Current Topics in Developmental Biology*. ed. Timmermans M. C. P., *Vol*. 91 (San Diego: Elsevier), 29–66.

Kim, S. J. (2004). Effect of light quality on growth and development of high-quality vegetable seedlings for year-round cropping. PhD thesis, Seoul National University, Seoul, Korea.

Lalge, A., Cerny, P., Trojan, V., & Vyhnánek, T. (2017). The effects of red, blue and white light on the growth and development of Cannabis sativa L. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 65(4), 1291-1298.

Mu, M. M., Mohd, F., Ahmad, H., Nur, N. I., & Kesavan, L. (2018). Review on the effect of ultraviolet A (UVA) light towards plant growth. In IOP Conference Series: *Materials Science and Engineering* 368:012046). IOP Publishing.

Ouzounis, T., Fretté, X., & Rosenqvist, E. (2015). The effect of low intensity narrow-band blue-light photoperiod on green-house tomato production and quality. *Scientia Horticulturae*, 181:93-103.

Wang, H., Gu, M., Cui, J., Shi, K., Zhou, Y., & Yu, J. (2016). Effects of different light qualities on growth, chlorophyll concentration and chlorophyll biosynthesis precursors of non-heading Chinese cabbage (Brassica campestris L.). *Journal of Plant Growth Regulation*, 35(3): 635-644.

Yang, Y., Zhang, Y., Chen, X., & Xu, X. (2016). Effects of light quality on growth, photosynthetic characteristics, and secondary metabolism of Prunella vulgaris L. seedlings. *Frontiers in Plant Science*. 7:13-16.


© 2026 The Author(s). Published by Faculty of Engineering, Federal University Oye-Ekiti.
This is an open access article under the CC BY NC license. (https://creativecommons.org/licenses/by-nc/4.0/)