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Effects of different Light-Emitting Diodes (LEDs) Lights on the Growth Response of Leafy Vegetables in a Closed-Type Plant Factory System

Ju-hyun Park, Sang-woo Lee, Su Yeon Lee, Soon Jae Kim, Kyu-hyun Hwang, Suk-woo Jang, and Gee Young Lee

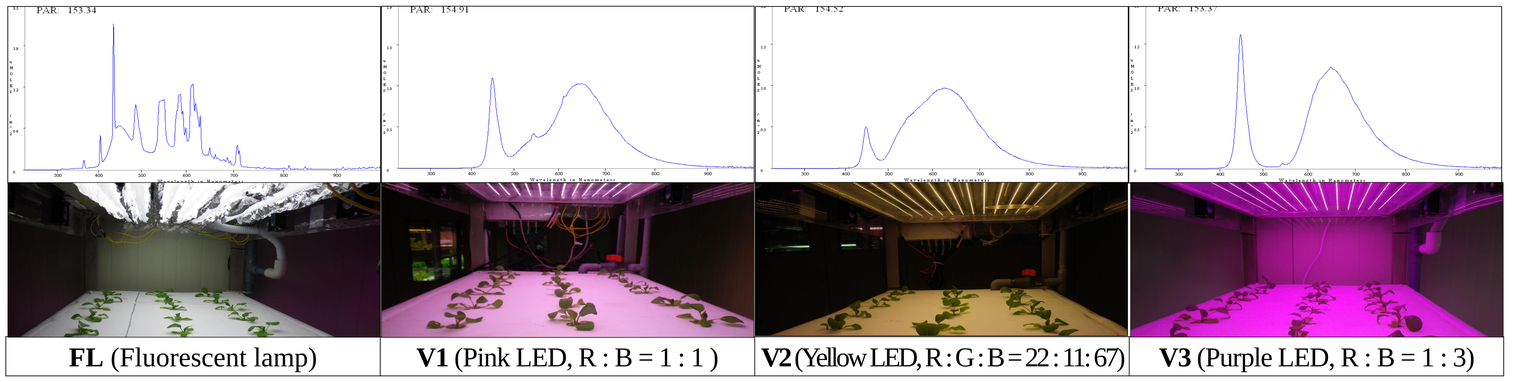
Horticultural Research Division, Gyeonggi-do Agricultural Research & Extension Services, Hwaseong 445-784, Korea

Introduction

Light conditions is one of the most important environmental variables in regulating vegetable growth and development. Light emitting diodes (LEDs) are an alternative light source and provide many advantages as plant lighting. Their small size, durability, long lifetime, cool emitting temperature, and the option to select specific wavelength for targeted plant response make LEDs more suitable for plant-based uses than many other light sources. But there are difficulties that are slowing their implementation for horticultural applications. The primary difficulty is high cost. The specific LEDs chips used for plant cultivation were made by shifting green wavelength to yellow or red in order to promote plant growth and decrease cost. Growth of leafy vegetables as endive (*Cichorium endiva* L.), pak-choi (*Brassica campestris* var. *chinensis*), kale (*Brassica oleracea* var. *acephala*) , arugula (*Eruca sativa*), and Treviso (*Cichorium intybus* L.) were investigated under different types of light sources in a closed-type plant factory system.

Materials and Methods

- Plants
  - *Cichorium endivia* L. (Endive)
  - *Brassica campestris* var. *chinensis* (Pak-choi)
  - *Brassica oleracea* var. *acephala* (Kale)
  - *Eruca sativa* (Arugula)
  - *Cichorium intybus* L. (Treviso)
- Experimental condition : Closed-type plant factory
  - Temperature : 23±2 ℃
  - Relative humidity : 60~80 %
  - CO_2 concentration : 1,000 μmol·mol^{-1}
  - Light intensity : 100~120 μmol·m^{-2}·s^{-1}
  - Photo period : 16/8hr (day/night)



FL (Fluorescent lamp) | **V1** (Pink LED, R : B = 1 : 1) | **V2** (Yellow LED, R : G : B = 22 : 11: 67) | **V3** (Purple LED, R : B = 1 : 3)

Fig. 1. Spectral distribution of light sources used in this study

Results

Table 1. Effects of light source on growth of leafy vegetables measured at 42 days after sowing

Species	Light source[z]	Plant height (cm)	Leaf area (cm^2)	No. of leaves	Chlorophyll content (SPAD value)	Fresh weight (g)
Cichorium endivia L.	FL	21.0 b[y]	596 b	25.9 b	38.0 a	30 b
	V1	25.5 a	731 a	26.2 b	35.7 a	37 ab
	V2	25.4 a	759 a	26.8 b	35.9 a	39 a
	V3	26.3 a	820 a	30.0 a	36.4 a	43 a
Brassica campestris var. *chinensis*	FL	22.2 a	738 b	22.0 c	40.6 a	68 c
	V1	22.3 a	832 a	23.0 bc	40.2 a	71 bc
	V2	22.6 a	862 a	23.6 ab	41.2 a	77 ab
	V3	22.7 a	864 a	24.6 a	40.5 a	83 a
Brassica oleracea var. *acephala*	FL	23.4 b	535 a	14.1 a	41.1 a	29 a
	V1	29.2 a	560 a	14.2 a	40.2 a	29 a
	V2	30.0 a	561 a	14.3 a	42.9 a	29 a
	V3	30.6 a	578 a	14.6 a	40.1 a	30 a
Eruca sativa	FL	20.0 b	325 b	14.0 b	49.2 a	17 b
	V1	21.0 b	366 ab	15.3 ab	48.4 a	22 ab
	V2	25.7 a	465 ab	16.5 ab	48.6 a	30 a
	V3	26.8 a	491 a	17.5 a	49.2 a	31 a
Cichorium intybus L.	FL	30.1 b	734 b	25.0 ab	49.9 a	31 b
	V1	33.3 a	877 ab	22.8 b	48.7 a	35 ab
	V2	33.6 a	878 ab	22.8 b	48.3 a	33 ab
	V3	34.0 a	894 a	27.9 a	49.6 a	38 a

[z]The light source used were FL, fluorescent lamp; V1, pink LED; V2, yellow LED; and V3, purple LED
[y]Different letters within the column indicate significant differences at P<0.05 according to Duncan's multiple range test

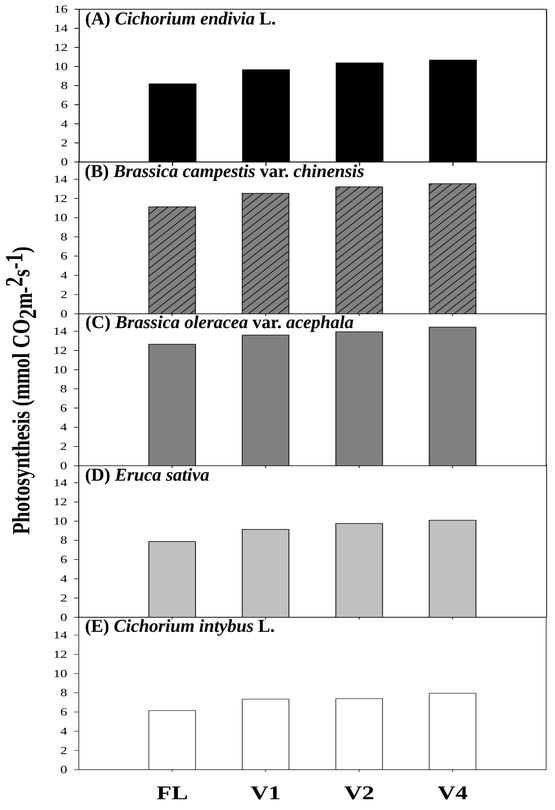


Fig. 2. Effect of light source on photosynthesis of leafy vegetables measured at 35 days after sowing

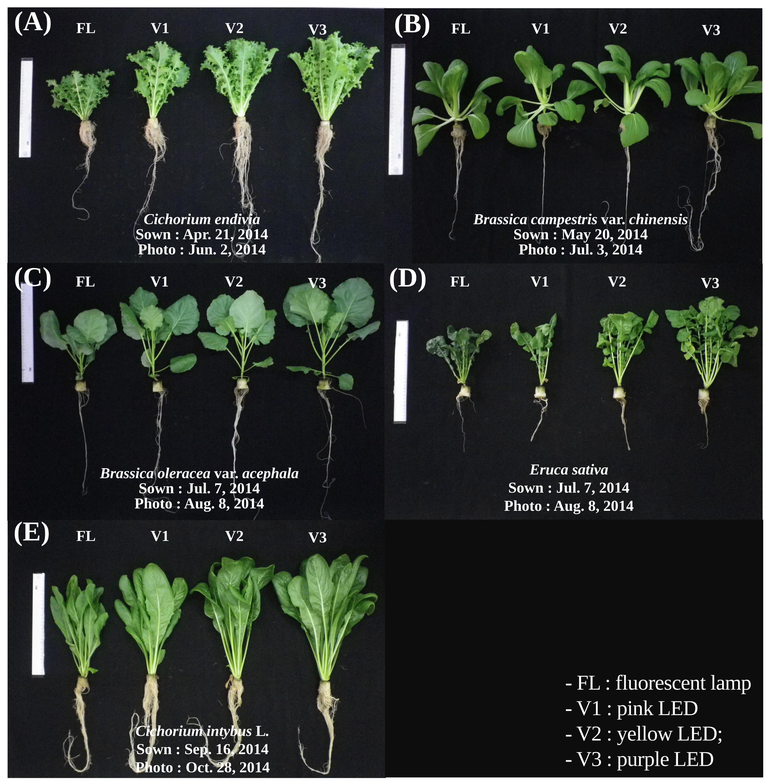


Fig. 3. Effects of light source on growth of leafy vegetables measured at 42 days after sowing

Fresh weight , plant height, leaf length and width of all the tested species treated with V3 were the greatest among all the tested light treatments. The number of leaves all tested species was greater in LEDs treatments than that in FL. Leaf area of all tested species was the greatest at V3. Chlorophyll content (SPAD) was not significantly affected by the light source. Photosynthetic rate was affected by light source. Photosynthetic rate of plant grown under the LEDs was higher in the FL. At *Cichorium endivia* L., photosynthetic rate was the greatest in plants grown under the V3 and showed similar results with other species.

Conclusions

These results suggested that the V3 which is composed of red and blue wavelengths (1:3) provided the most the suitable light condition for vegetative growth of several leafy vegetables among the tested light sources.

Ju-hyun Park* T. 82-31-229-1809 jnjworld@gg.go.kr