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Effect of Light Quality on the Three Selected Microgreen Species Under Ambient Conditions

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ABSTRACT

A study on the use of different (red + blue (RB), white + red (WR), white + blue (WB), and white + red + blue (WRB)) light-emitting diodes (LEDs) on three microgreen species (amaranth, cabbage, and lettuce) was conducted. The study was conducted to evaluate the effect of LEDs on shoot system, root length, and fresh weight of the three microgreen species. Microgreens were grown under ambient conditions (temperature: 28± 2 °C; relative humidity: 65 ± 5%) and arranged in a Completely Randomized Design with four replications. Microgreens were harvested at 14 days after sowing. Results show that hypocotyl and shoot lengths of amaranth were not affected by any of the LEDs. But for cabbage, either RB, WR, or WB was used for longer hypocotyls and shoots, whereas for lettuce, WB was needed to obtain longer hypocotyls, but none of the LEDs produced longer shoots. LEDs such as WRB produced longer roots across microgreen species. None of the LEDs showed an impact on shoot fresh weight across microgreen species.

Keywords: *Amaranth Microgreens, Cabbage Microgreens, Functional Food, Indoor Microgreen Cultivation, Lettuce Microgreens*

INTRODUCTION

Microgreens are tiny plants with or without the true leaves and usually harvested between 7 and 21 days after sowing, depending on the species. The demand for microgreens is increasing it was reported that it provides health benefits due to their nutritional composition, such as minerals, antioxidants, and vitamins, but it varies depending on the species and growing management (Kaya and Yardimci, 2025). Some of the antioxidants and vitamins that can be found in microgreens are carotenoids, phenolic compounds, flavonoids, ascorbic acid, anthocyanin, and tocopherols (Gonzalez and Vargas, 2025; Kowitcharoen et al., 2021). Microgreens that can be grow are from the families of Brassicaceae, Leguminosae, Convolvulaceae, and Malvaceae (Kowitcharoen et al., 2021).

However, the growth of microgreens is affected by complex factors, such as species, light quality, nutrient solution application, and levels; in this study, it concentrated on the species and light quality. Microgreen species, such as kale, displayed heavier shoot fresh weight when grown under RB than under white light, and this trend was the same as in collard and cabbage (Haghighi et al., 2025). They also reported that the shoot dry weight of these microgreens was higher in RB than in white light. Kale shoots were longer under combined red and blue (RB) light than under white light; collard and cabbage showed no differences

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under these lights. Specific light quality can have different effects on the morphological characteristics of different leafy cabbage cultivars. Red and blue light treatment was most effective in improving shoot and root growth traits in kale cultivars, whereas in cabbage cultivars it increased leaf count and chlorophyll index (Haghighi, M. et al., 2025). The lighting conditions during the cultivation of microgreens, if optimally selected, can have a positive effect by further increasing their nutritional value.

In another study, different red and blue lights did not significantly affect the fresh weight and water content of the whole plant (Chen et al., 2026). However, red light significantly increased the hypocotyl length and edible rate by 56.64% and 8.75, respectively. Monochromatic red or blue light significantly decreased chlorophyll and carotenoid contents, whereas their content under mixed red-blue light treatment showed no significant alterations. Another study showed that white LED had shorter microgreens and hypocotyls than the other LEDs. Whereas the leaves were longer in microgreens under blue and RB LEDs than under the white LED, the former LEDs showed a similarity with the red LED (Gudayen et al., 2026). Moreover, a high root count was observed in microgreens with blue and RB LEDs, which was higher than with red LEDs. Whereas the white LED produced a higher chlorophyll content based on its high SPAD index. Red and RB LEDs produced a higher fresh weight of microgreens than white LEDs. Light quality did not affect yield in any species. However, red light increased cotyledon area in arugula by 50 to 60% and promoted hypocotyl elongation in both arugula and radish, whereas white light resulted in the longest hypocotyls in mustard (Gonzalez et al., 2026). Photosynthetic pigment composition responded differently among species. In mustard, WB increased the chlorophyll a/b ratio (1.12 to 1.18). These studies proved that light quality plays a significant role in the growth characteristics and phytochemicals in microgreens, but this study only evaluated the effect of light quality on the growth of three microgreen species.

METHODS

Seed preparation and growing conditions

Seeds (Red amaranth, Green Gold F_1 cabbage, and Green Rapids lettuce) were acquired from a local farm supply in Apayao, Philippines. The seeds were sterilized using sodium hypochlorite (200 ml/ liter). The sodium hypochlorite was added at the end of the soaking period, and distilled water was used to rinse the seeds three times before air-drying. Seeds (4 g) were sown in 24 cm x 33 cm x 5 cm (L x H x W) with 500 grams of cocopeat. Newly sown seeds were exposed to LEDs with a photoperiod of 16h/8h until harvesting (14 days after sowing). The distance between the tray and light source was 1.5 ft. Microgreens were grown under ambient conditions (temperature 28± 2 °C and relative humidity 65 ± 5%).

Shoot, root, and microgreen lengths

Shoot length was measured using a ruler from above the substrate up to the tip of the leaf, while root length was measured from the shoot attachment down to the root tip. Microgreen length was measured using the total lengths of the shoot and root. Measurements were done at harvesting (14 DAS).

Hypocotyl and leaf lengths, and chlorophyll content

Hypocotyl length was measured using a ruler from the base of the shoot up to the point of leaf attachment, while leaf length was measured from the hypocotyl attachment up to the leaf tip at 14 DAS. Ten freshly harvested microgreens were used to measure the leaf chlorophyll content using a chlorophyll meter (SPAD-502 Plus) at 14 DAS.

Shoot, root, and microgreen fresh weights

Using an analytical balance, shoots and roots of 10 randomly harvested microgreens were weighed separately at 14 DAS. The total weights of shoots and roots were used for the microgreen fresh weight.

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Shoot, root, and microgreen dry weights

The samples used for fresh weights were used for the dry weights of shoots, roots, and microgreens. Oven-drying was done at 60 °C for 48 h (Imran et al., 2018).

Root-to-shoot ratios

Root-to-shoot length ratio was measured by dividing the root length by the shoot length. The root-to-shoot weight ratio was measured by dividing the root dry weight by the shoot dry weight.

Statistical analysis

All data were analyzed using the analysis of variance for the factorial completely randomized design in three replicates. STAR–v2.0.1 developed by the International Rice Research Institute was used to analyze the data. Differences among treatment means were determined using the Least Significant Difference test at the 5% level.

RESULTS AND DISCUSSION

Shoot, root, and microgreen lengths

Shoot length varied among the three microgreen species. Cabbage microgreens had longer shoots than amaranth and lettuce under all LEDs except WRB (Figure 1A). Microgreen species grown under WRB showed a comparable shoot length. However, only cabbage had a positive response in shoot elongation, resulting in longer shoots when grown under RB, WR, and WB. Results signify that RB, WR, and WB induced longer shoots in cabbage microgreens. Thus, to produce longer shoots of cabbage microgreens, these LEDs are recommended. It was previously reported that red light alone induced shoot elongation in tomato, while blue light alone inhibited growth (Arif et al., 2024). This report contradicted the other study where white light favored shoot elongation in bamboo (Goncalves et al., 2023). In another study, shoot length of cabbage (*B. oleracea* var. *viridis*) grown under different LEDs, such as white, RB, blue, and red, showed no significant variation (Haghighi et al., 2025). A previous study reported that RB light promoted shoot elongation (Kong and Zheng, 2023). These varying effects showed that the effect of LEDs on shoot length was species-dependent.

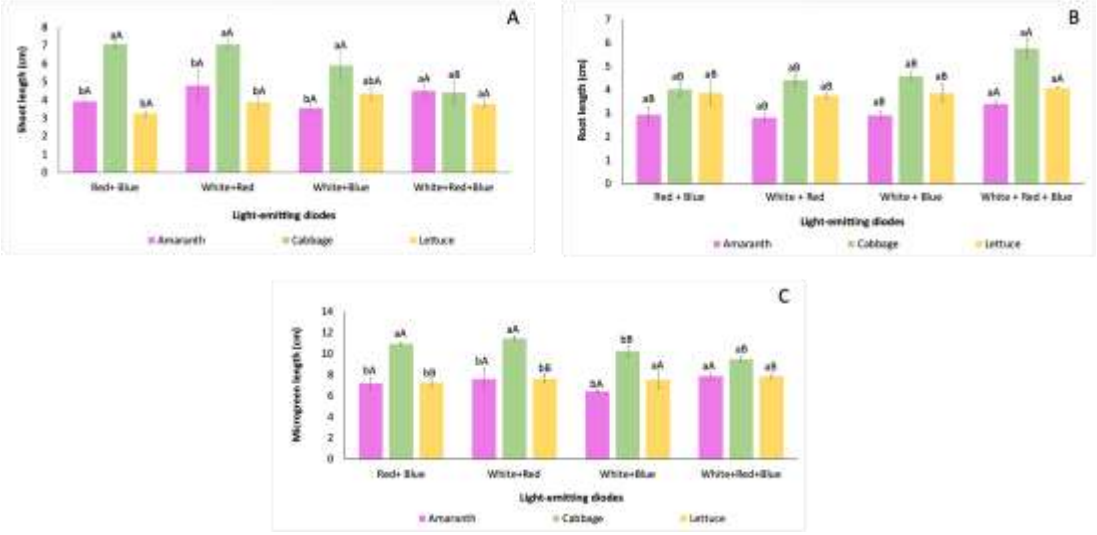


Figure 1. *Effect of light-emitting diodes (LEDs) on shoot length (A), root length (B), and microgreen length (C) of three microgreen species. Bars with lowercase and uppercase letters indicate significant differences among microgreen species and LEDs, respectively, at the 5% level using the Least Significant Difference test.*

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Hypocotyl and leaf lengths, and chlorophyll content

Amaranth and cabbage showed longer hypocotyls in RB and WR (Figure 2A). Whereas amaranth was longer in hypocotyls as compared to the other microgreen species under WRB light. Any of the light qualities, except WRB, can be used in obtaining longer hypocotyls for cabbage. While for amaranth and lettuce all of the light qualities showed a comparable hypocotyl length. On the other hand, leaf length was not affected by any of the light qualities, and there was no variation among the microgreen species (Figure 2B). However, the chlorophyll content among the microgreen species showed no variation (Figure 2C).

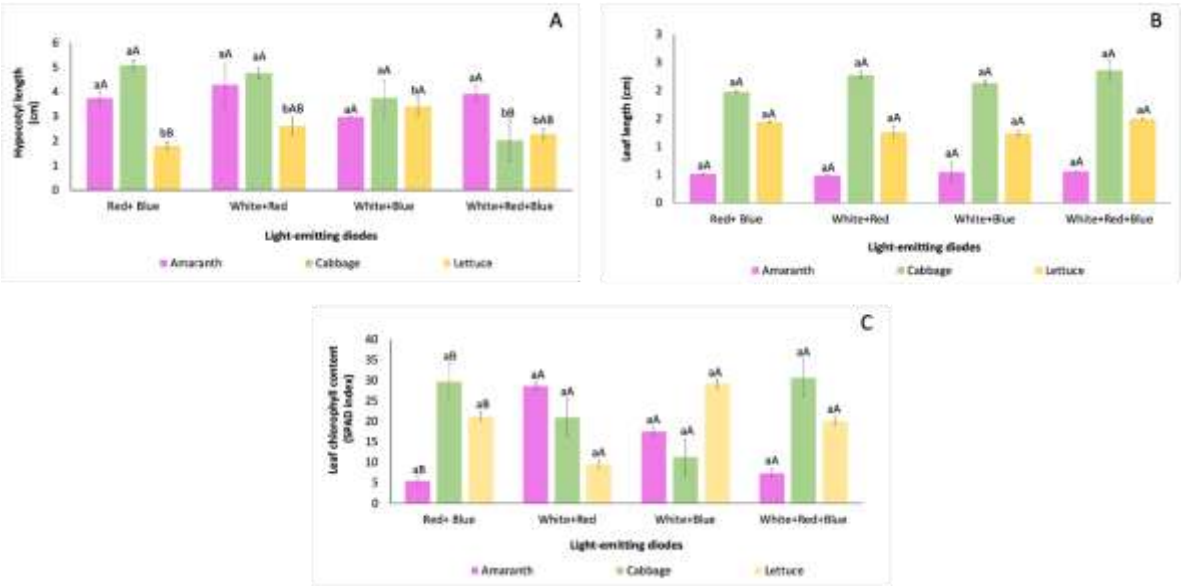


Figure 2. *Effect of light-emitting diodes (LEDs) on hypocotyl length (A), leaf length (B), and chlorophyll content (C) of three microgreen species. Bars with lowercase and uppercase letters indicate significant differences among microgreen species and LEDs, respectively, at the 5% level using the Least Significant Difference test.*

Shoot, root, and microgreen fresh weights

Shoot fresh weight of microgreen species grown in different light qualities exhibited no significant variation (Figure 3A). Whereas light quality matters in root fresh weight, cabbage microgreens consistently displayed heavier fresh roots than the other microgreens (Figure 3B). Heavier fresh roots were obtained by using WRB light for cabbage and lettuce, and any of the light qualities (except WR) for amaranth. Microgreen fresh weight for the microgreen species was heavier in WRB light condition(Figure 3C).

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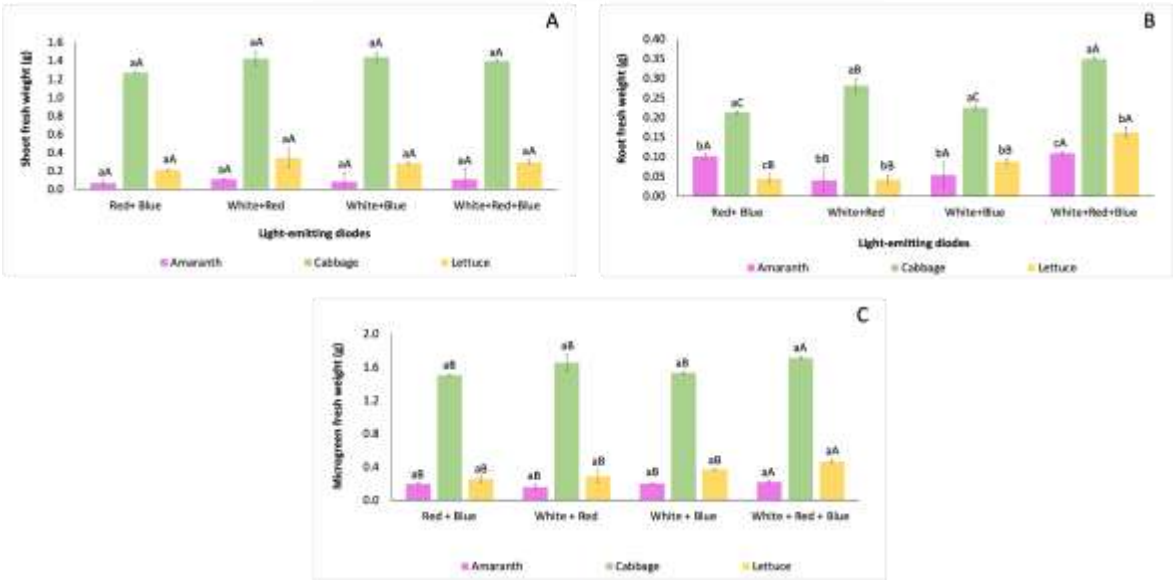


Figure 3. *Effect of light-emitting diodes (LEDs) on shoot fresh weight (A), root fresh weight (B), and microgreen fresh weight (C) of three microgreen species. Bars with lowercase and uppercase letters indicate significant differences among microgreen species and LEDs, respectively, at the 5% level using the Least Significant Difference test.*

Shoot, root, and microgreen dry weights

Microgreen species exhibited a similar shoot dry weight across light qualities (Figure 4A). Amaranth microgreens grown under WR had lighter weight than the other light qualities. The root dry weight of microgreen species was similar to each other, irrespective of the light qualities (Figure 4B). However, cabbage microgreens displayed heavier dry roots in WB and WRB. Lettuce microgreens showed heavier dry roots in WB than in the other light qualities. Microgreen dry weight of amaranth, cabbage, and lettuce was higher in WB or WRB, WB, and WRB, respectively (Figure 4C).

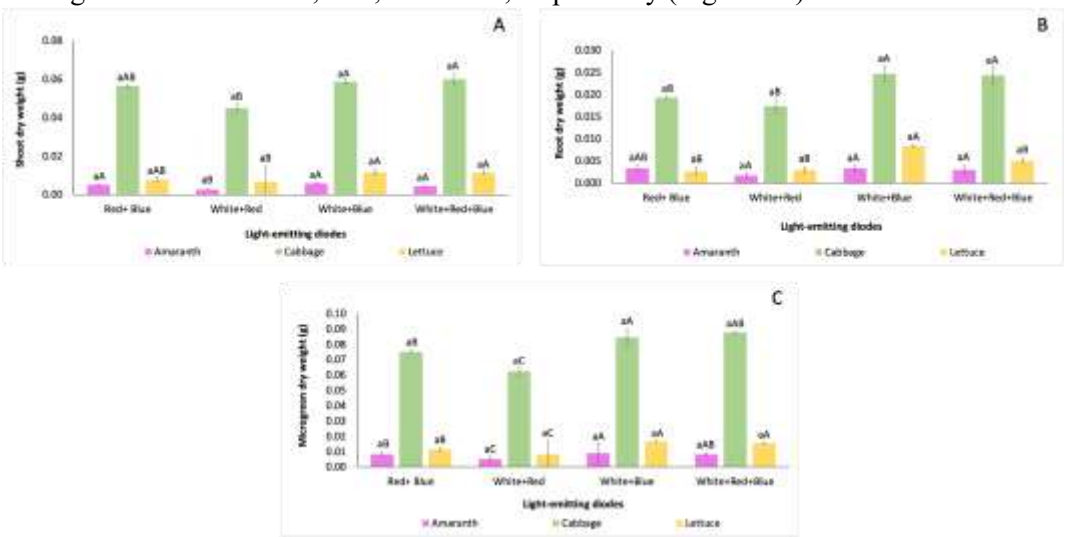


Figure 4. *Effect of light-emitting diodes (LEDs) on shoot dry weight (A), root dry weight (B), and microgreen dry weight (C) of three microgreen species. Bars with lowercase and uppercase letters indicate significant differences among microgreen species and LEDs, respectively, at the 5% level using the Least Significant Difference test.*

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Root-to-shoot ratios

The root-to-shoot length ratio of lettuce was higher than that of the other microgreen species under RB (Figure 5A). Cabbage microgreens showed a higher root-to-shoot length ratio under WRB light conditions. To obtain a high root-to-shoot length ratio, WRB for cabbage, and RB or WRB for lettuce.

On the other hand, amaranth showed a higher root-to-shoot weight ratio across light qualities, except WB (Figure 5B). Under WB light conditions, cabbage showed a lower root-to-shoot ratio as compared to lettuce, but they were comparable to amaranth. WB light displayed a higher root-to-shoot ratio than the other light conditions for lettuce. Light conditions or qualities did not affect the root-to-shoot ratios of amaranth and cabbage microgreens.

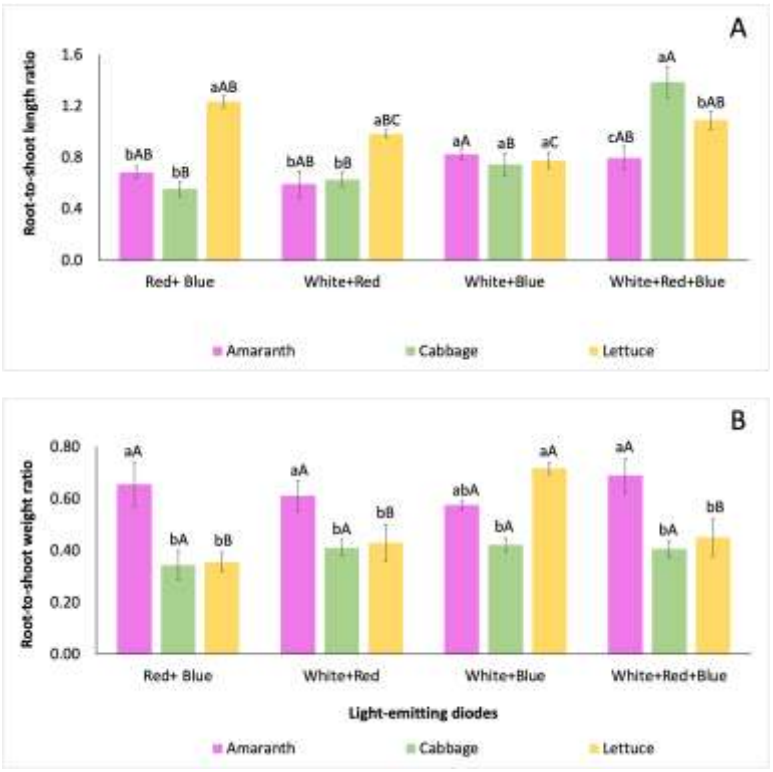


Figure 5. *Effect of light-emitting diodes (LEDs) on shoot-to-root length ratio (A) and shoot-to-root weight ratio (B) of three microgreen species. Bars with lowercase and uppercase letters indicate significant differences among microgreen species and LEDs, respectively, at the 5% level using the Least Significant Difference test.*

CONCLUSION

RB, WR, and WB induced greater shoot and hypocotyl elongation than WRB light for cabbage. Any of the light qualities, except RB, can be used for longer shoots in lettuce. Longer hypocotyls were obtained in all of the light conditions, except RB. Leaf length was not affected by light quality and showed no microgreen species variations. No improvement in shoot fresh weight was observed in the three microgreen species under any light conditions.

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