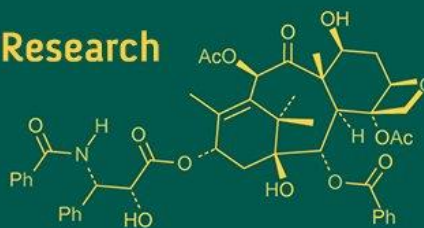


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Guruprasadh V
UG Students, School of
Agricultural Sciences,
Dhanalakshmi Srinivasan
University, Trichy,
Tamil Nadu, India

Harini M
UG Students, School of
Agricultural Sciences,
Dhanalakshmi Srinivasan
University, Trichy,
Tamil Nadu, India

Harini S
UG Students, School of
Agricultural Sciences,
Dhanalakshmi Srinivasan
University, Trichy,
Tamil Nadu, India

Harini V
UG Students, School of
Agricultural Sciences,
Dhanalakshmi Srinivasan
University, Trichy,
Tamil Nadu, India

Hari Prasath E
UG Students, School of
Agricultural Sciences,
Dhanalakshmi Srinivasan
University, Trichy,
Tamil Nadu, India

Mangaiyarkarasi R
Assistant Professor
(Horticulture), School of
Agricultural Sciences,
Dhanalakshmi Srinivasan
University, Trichy,
Tamil Nadu, India

Chozhan K
Dean, School of agricultural
sciences, Dhanalakshmi
Srinivasan University, Trichy,
Tamil Nadu, India

Corresponding Author:
Mangaiyarkarasi R
Assistant Professor
(Horticulture), School of
Agricultural Sciences,
Dhanalakshmi Srinivasan
University, Trichy,
Tamil Nadu, India

Effect of different light regimes and growing media on growth, yield attributes of radish microgreens

Guruprasadh V, Harini M, Harini S, Harini V, Hari Prasath E, Mangaiyarkarasi R and Chozhan K

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Abstract

Microgreens have gained immense popularity as functional foods owing to their high nutritional density, intense flavours, and rapid production cycles. The optimization of controlled environment agriculture (CEA) parameters, specifically lighting and substrate, is critical for maximizing both yield and phytochemical content. This comprehensive study outlines a 3×3 Factorial Complete Randomized Design (FCRD) to evaluate the interactive effects of three light sources (Natural Sunlight, White LED, and Red + Blue LED) and three growing media (Vermicompost, Coir Peat, and Pot mixture in a 1:1 ratio) on the growth, biomass, and yield of microgreens. Vermicompost provides rich microbial and nutrient profiles, coir peat offers high porosity and moisture retention, and pot mixture acts as a traditional, well-draining organic baseline. Concurrently, distinct light spectra drive different photomorphogenic responses; White LEDs deliver balanced photosynthetically active radiation (PAR), while R + B combinations may elicit secondary metabolite production through mild abiotic stress. The experiment comprises nine treatment combinations evaluated over a standard 7-day microgreen cultivation cycle. The highest germination percentage (3.25%), plant height (15.55 cm), root length (2.4cm), fresh weight (18.85 cm), dry weight (9.25 cm) was observed in L1M1 (Natural light + Cocopeat). This research will provide actionable insights for commercial urban farmers seeking to manipulate environmental variables to balance rapid vegetative growth with enhanced nutritional profiles.

Keywords: Radish, light, media, growth, yield, cost

Introduction

Microgreens are tender, immature greens produced from the seeds of vegetables, herbs, or grains, typically harvested 7 to 21 days after germination at the emergence of the first true leaves. They act as an intermediate stage between sprouts and baby greens. Due to their rapid growth cycle and low space requirements, microgreens are highly suitable for urban and vertical farming systems. Microgreens are characterized by a concentrated nutrient profile, often containing 10 to 40 times higher levels of vitamins (such as ascorbic acid, phyloquinone, and tocopherols), minerals, and bioactive compounds compared to their mature counterparts.

Light is the primary environmental factor regulating plant growth, driving photosynthesis, and directing photomorphogenesis. In controlled environments, the intensity, duration (photoperiod), and quality (spectrum) of light directly dictate carbon assimilation rates, internode elongation, and the synthesis of structural carbohydrates. The increasing demand for nutrient-rich, safe, and sustainably produced foods has led to growing interest in microgreens as functional foods. However, the growth, nutritional quality, and commercial value of microgreens are strongly influenced by environmental factors, particularly light regimes and growing substrates. Radish microgreens contain powerful health advantages, including high levels of antioxidants, immune support, and improved digestion. Identifying the optimal combination of these factors is essential for maximizing biomass, enhancing nutritional composition, and improving value-added products. Multivariate analysis enables the simultaneous evaluation of multiple growth and quality traits, providing a comprehensive understanding of the relationships among these characteristics. Therefore, this research is necessary to identify the most suitable light regime and substrate combination for producing

high-quality microgreens with greater nutritional and economic value, thereby supporting sustainable urban agriculture and commercial microgreen production.

Materials and Methods

Location: The experiment was conducted in Horticulture lab, School of Agricultural Sciences, Dhanalakshmi Srinivasan University, Samayapuram.

Seed materials: Seeds of microgreen species were used in the experiment: Radish (*Raphanus sativus*).

Treatment Details

Crop-Radish

Factor A-Light Source (3 levels):	L ₁ : Natural sunlight	L ₂ : White LED light	L ₃ : Red + Blue LED light
Factor B-Growing Media (3 levels):	M ₁ : Cocopeat	M ₂ : Vermicompost	M ₃ : Soil + Sand + FYM (1:1:1)

Design of the experiment: FCRD (Factorial Completely Randomized Design)

Total number of treatments: 9

Total number of replications: 2

Preparation of cocopeat

Cocopeat was prepared from dried coir pith obtained as a by-product of the coconut fibre industry. The coir pith was soaked in clean water for 24-48 hours to remove excess salts and impurities. The soaked material was washed thoroughly with fresh water until the electrical conductivity (EC) reached an acceptable level (below 1.0 mS cm⁻¹, if measured). Excess water was drained, and the cocopeat was air-dried under shade to achieve a moist but friable texture. Large fibres and debris were removed by sieving through a 2-5 mm mesh to obtain a uniform growing medium.

Experimental setup

The experiment was conducted using plastic germination trays filled with the respective growing media. After sowing, each tray was placed inside a cardboard enclosure to provide a controlled lighting environment and to minimize interference from external light sources. LED lights (white, red, and blue) were fixed securely at the top of the cardboard enclosure, maintaining a uniform distance from the tray surface to ensure equal light distribution across all seedlings. Separate cardboard chambers were used for each light treatment to prevent light contamination between treatments. Trays assigned to the natural light treatment were placed under ambient sunlight and were not enclosed. The light treatments were maintained throughout the experimental period, while moisture was maintained by spraying water as required.

Healthy and uniform seeds of each crops were surface-cleaned and sown uniformly in plastic trays filled with the respective growth media (vermicompost, sand, or cocopeat). The trays were maintained under four different light treatments: white LED, red and blue LED, and natural sunlight. All treatments were arranged in a factor completely randomized design with three replications. Moisture was maintained by spraying water twice daily, and no additional fertilizers were applied during the growth period. The experiment was conducted under controlled environmental conditions. Microgreens were harvested 7-8 days after sowing, depending on the crop, when the

cotyledons were fully expanded and the first true leaves had just emerged. Growth observations such as germination percentage, shoot length, root length, fresh weight, dry weight, and chlorophyll content were recorded at harvest.

Statistical analysis

The experimental data were statistically analysed using analysis of variants (ANOVA) under a Factorial completely randomized design (FCRD). Treatment means were compared using Duncan's Multiple Range Test (DMRT) at a 5% level of significance ($p < 0.05$) with the help of SPSS statistical

Results and Discussion

Result

Days to Germination

The effect of different light sources and growing media on the days required for germination of radish microgreens is presented in Table 1.

Among the light source treatments, L₃ (Red + Blue LED light) recorded the shortest mean germination period (2.17 days), followed by L₂ (White LED light) with 2.33 days, while L₁ (Natural light) required the longest period (2.62 days). This indicated that the use of LED light sources accelerated seed germination compared to natural light.

Among the growing media, M₁ (Cocopeat) resulted in the earliest germination with a mean of 1.67 days, followed by M₂ (Vermicompost) with 2.42 days, whereas M₃ (Soil + Sand + FYM) recorded the longest germination period (3.03 days).

Considering the interaction effect, the minimum number of days to germination (1.60 days) was observed in both L₂M₁ (White LED light + Cocopeat) and L₃M₁ (Red + Blue LED light + Cocopeat), whereas the maximum germination period (3.25 days) was recorded in L₁M₃ (Natural light + Soil + Sand + FYM). These results clearly indicate that the combination of LED lighting and cocopeat created the most favourable conditions for rapid seed germination.

Germination Percentage

The germination percentage of radish microgreens was significantly influenced by different light sources, growing media, and their interaction (Table 1).

Among the light source treatments, Natural light (L₁) recorded the highest mean germination percentage (79.67%), followed by Red + Blue LED light (L₃) (72.57%), whereas White LED light (L₂) recorded the lowest germination percentage (70.23%).

Among the growing media, Cocopeat (M₁) produced the highest mean germination percentage (82.32%), followed by Soil + Sand + FYM (M₃) (74.07%), while Vermicompost (M₂) recorded the lowest mean germination percentage (65.78%).

The interaction effect showed that the highest germination percentage (87.85%) was recorded in the treatment combination L₁M₁ (Natural light + Cocopeat), followed by L₂M₁ (White LED light + Cocopeat) with 83.25% and L₁M₃ (Natural light + Soil + Sand + FYM) with 81.05%. The lowest germination percentage (63.60%) was observed in L₃M₂ (Red + Blue LED light + Vermicompost), which was statistically comparable with L₂M₂ (63.65%) and L₂M₃ (63.80%). These findings demonstrate that the combination of Natural light and Cocopeat provided the most favourable conditions for achieving maximum germination in radish microgreens.

Fresh Weight

The fresh weight of radish microgreens was significantly influenced by different light sources, growing media, and their interaction (Table 2).

Among the light source treatments, L1 (Natural light) recorded the highest mean fresh weight (14.03 g), which was significantly superior to the other treatments. This was followed by L2 (White LED light) with a mean fresh weight of 9.71 g, whereas the lowest fresh weight (8.33 g) was observed under L3 (Red + Blue LED light).

Regarding the growing media, M2 (Vermicompost) produced the highest mean fresh weight (11.87 g), followed by M1 (Cocopeat) (11.28 g). The lowest fresh weight (8.93 g) was recorded in M3 (Soil + Sand + FYM).

Among the interaction treatments, the maximum fresh weight (18.85 g) was recorded in L1M2 (Natural light + Vermicompost), followed by L1M1 (Natural light + Cocopeat) with 15.15 g. The minimum fresh weight (7.45 g) was observed in L3M2 (Red + Blue LED light + Vermicompost). The results indicate that Natural light combined with Vermicompost was the most effective treatment for enhancing fresh biomass production in radish microgreens.

Dry Weight

The dry weight of radish microgreens was significantly influenced by different light sources, growing media, and their interaction (Table 2).

Among the light source treatments, L2 (White LED light) recorded the highest mean dry weight (5.21 g), followed by L3 (Red + Blue LED light) (4.03 g), whereas L1 (Natural light) recorded the lowest mean dry weight (3.86 g).

With respect to the growing media, M3 (Soil + Sand + FYM) produced the highest mean dry weight (7.76 g), which was significantly superior to the other growing media. This was followed by M2 (Vermicompost) with 2.73 g, while M1 (Cocopeat) recorded the lowest dry weight (2.62 g).

Among the interaction treatments, the highest dry weight (9.95 g) was observed in L2M3 (White LED light + Soil + Sand + FYM), followed by L3M3 (Red + Blue LED light + Soil + Sand + FYM) with 9.25 g. The lowest dry weight (1.40 g) was recorded in L3M2 (Red + Blue LED light + Vermicompost), which was closely followed by L3M1 (Red + Blue LED light + Cocopeat) with 1.45 g. These results indicate that the combination of White LED light and Soil + Sand + FYM was the most effective treatment for enhancing dry matter accumulation in radish microgreens.

Seedling Length

The seedling length of radish microgreens was significantly influenced by different light sources, growing media, and their interaction (Table 3).

Among the light source treatments, L3 (Red + Blue LED light) recorded the highest mean seedling length (12.35 cm), followed by L2 (White LED light) with 11.93 cm, whereas the lowest mean seedling length (10.48 cm) was observed under L1 (Natural light).

Among the growing media, M1 (Cocopeat) recorded the highest mean seedling length (13.18 cm), followed by M3 (Soil + Sand + FYM) (11.92 cm), while M2 (Vermicompost) recorded the lowest mean seedling length (9.67 cm).

The interaction effect showed that the maximum seedling length (15.55 cm) was recorded in L3M3 (Red + Blue LED light + Soil + Sand + FYM), followed by L2M1 (White LED light + Cocopeat) (13.90 cm) and L1M1 (Natural light + Cocopeat) (13.80 cm). The minimum seedling length (8.40 cm) was observed in L1M3 (Natural light + Soil + Sand + FYM). These results indicate that the combination of Red + Blue LED light and Soil + Sand + FYM significantly enhanced seedling growth compared with the other treatment combinations.

Hypocotyl length

The hypocotyl length of radish microgreens was significantly influenced by the interaction between light source and growing medium (Table 3). Among the light treatments, White LED light (L2) produced the highest mean hypocotyl length (11.05 cm), followed by Red + Blue LED light (L3) (10.83 cm), while Natural light (L1) recorded the lowest mean value (9.48 cm).

Among the growing media, Cocopeat (M1) recorded the highest mean hypocotyl length (11.55 cm), followed by Soil + Sand + FYM (M3) (10.73 cm), whereas Vermicompost (M2) produced the lowest mean value (9.08 cm).

The interaction effect revealed that the highest hypocotyl length (13.60 cm) was observed in the treatment combination L3M3 (Red + Blue LED + Soil + Sand + FYM), followed by L2M1 (White LED + Cocopeat) with 12.20 cm and L1M1 (Natural light + Cocopeat) with 11.60 cm. The lowest hypocotyl length (7.55 cm) was recorded in L1M3 (Natural light + Soil + Sand + FYM).

Root length

The root length of radish microgreens was significantly influenced by the light source, growing medium and their interaction (Table 4). Among the different light treatments, L2 (White LED light) recorded the highest mean root length of 1.30 cm, followed by L1 (Natural light) with 0.88 cm, while L3 (Red + Blue LED light) recorded the lowest mean of 0.78 cm.

Among the growing media, M1 (Cocopeat) recorded the highest mean root length of 1.72 cm, whereas M2 (Vermicompost) and M3 (Soil + Sand + FYM) recorded lower mean root lengths of 0.67 and 0.58 cm, respectively.

The interaction between light source and growing medium showed considerable variation in root development. The maximum root length of 2.40 cm was recorded in L2M1 (White LED × Cocopeat), followed by L1M1 (Natural light × Cocopeat) with 1.95 cm. The minimum root length of 0.25 cm was observed in L1M3 (Natural light × Soil + Sand + FYM).

The superior root development under white LED light may be attributed to the relatively uniform light environment, which can support photosynthetic activity and assimilate production during early seedling growth. The better performance of cocopeat may be associated with its favourable physical characteristics, particularly high porosity, good aeration, moisture retention and low bulk density, which facilitate root penetration and elongation. The highest value under L2M1 indicates that the combination of white LED illumination and cocopeat provided favourable conditions for root development.

Yield

Yield showed significant differences among the light sources and growing media (Table 4). Among the light treatments, L1 (Natural light) recorded the highest mean yield of 14.03 g, followed by L2 (White LED light) with 9.71 g, whereas L3 (Red + Blue LED light) recorded the lowest mean yield of 8.33 g.

Among the growing media, M2 (Vermicompost) recorded the highest mean yield of 11.87 g, followed by M1 (Cocopeat) with 11.28 g. The lowest mean yield of 8.93 g was recorded in M3 (Soil + Sand + FYM).

The highest yield of 18.85 g was recorded in L1M2 (Natural light × Vermicompost), followed by L1M1 (Natural light × Cocopeat) with 15.15 g. The lowest yield of 7.45 g was observed in L3M2 (Red + Blue LED × Vermicompost).

Discussion

Days to Germination

The present study revealed that the light source, growing medium and their interaction significantly influenced the time required for germination of radish microgreens. Red + Blue LED light (L3) resulted in the shortest mean germination period (2.17 days), followed by White LED light (L2), whereas Natural light (L1) required a longer period. At the substrate level, cocopeat (M1) resulted in the earliest germination, and the combination of LED lighting with cocopeat produced the fastest germination. These results indicate that both light environment and substrate characteristics contributed to early establishment of radish microgreens.

The faster germination observed under red + blue LED light may be associated with the influence of light quality on seedling establishment and early plant development. Light is perceived through photoreceptors and can regulate developmental processes through light-signalling pathways. Research on radish microgreens has demonstrated that changes in LED spectral composition can significantly modify early growth and root development, confirming that spectral quality is an important environmental factor in controlled microgreen production.

The superior performance of cocopeat in reducing the number of days to germination may be attributed mainly to its favourable physical properties. Cocopeat has good moisture-holding capacity, porosity and aeration, which can maintain a suitable moisture environment around the seeds while allowing adequate oxygen availability for germination. Dalal *et al.* (2022) ^[7] reported favourable performance of microgreens grown in soilless media containing cocopeat and concluded that soilless media could provide suitable conditions for microgreen production.

The present finding is further supported by Thanusha *et al.* (2026) ^[10], who evaluated seed enhancement and growing media for radish microgreens and identified cocopeat-based media as one of the most suitable substrates for radish microgreen production. Their study also demonstrated that growing medium selection can substantially influence emergence, seedling growth and yield.

Germination Percentage

The present experiment demonstrated that germination percentage was significantly affected by light source, growing medium and their interaction. Natural light (L1) recorded the highest mean germination percentage (79.67%), while cocopeat (M1) recorded the highest

germination percentage among the growing media (82.32%). The maximum germination percentage (87.85%) was obtained from L1M1 (Natural light + Cocopeat). These results suggest that cocopeat provided a favourable substrate environment, while natural light under the experimental conditions supported a high proportion of successful seedling establishment.

The high germination percentage under natural light may be associated with the suitability of the prevailing light intensity and spectrum during the germination and early seedling phase. However, it is important to recognize that the response to artificial light depends on its spectral composition, intensity, photoperiod and timing of exposure. Studies on microgreens have demonstrated that different light spectra can produce markedly different responses in growth and yield, and that there is no universally superior spectrum for all species or developmental stages.

The superior germination percentage under cocopeat can be explained by its favourable moisture and aeration characteristics. Adequate moisture is essential for seed imbibition, while sufficient air-filled pore space is necessary for respiration during germination. A suitable growing medium therefore helps maintain the balance between water availability and oxygen supply. The use of cocopeat and other soilless substrates has been reported as a suitable approach for microgreen production, including radish. Dalal *et al.* (2022) ^[7] found better performance of microgreens in soilless media compared with soil-based conditions.

The findings are also in agreement with Thanusha *et al.* (2026) ^[10], who reported that growing medium significantly affected the production of radish microgreens and identified a cocopeat-based medium containing cocopeat and vermicompost as the best medium among the tested substrates. Their results reinforce the importance of selecting a substrate with appropriate physical and nutritional characteristics for successful radish microgreen production.

Fresh Weight

The present study revealed that light source, growing medium and their interaction significantly influenced the fresh weight of radish microgreens. Natural light (L1) recorded the highest mean fresh weight (14.03 g), while vermicompost (M2) recorded the highest mean among the growing media (11.87 g). The highest fresh weight (18.85 g) was recorded in L1M2 (Natural light + Vermicompost), whereas the lowest (7.45 g) was observed in L3M2 (Red + Blue LED + Vermicompost). These findings demonstrate that biomass accumulation was strongly dependent on the combination of the light environment and growing medium.

The greater fresh weight under natural light may be associated with the favourable light conditions prevailing during the experimental period. Light intensity and spectral composition influence photosynthetic carbon assimilation and consequently biomass production. Although red and blue wavelengths are important for photosynthesis, the response of plants depends on the intensity, duration and spectral balance of the supplied light. Borrelli *et al.* (2026) ^[15] reported that manipulation of light intensity and spectrum can substantially modify growth and metabolic responses in microgreens. Therefore, the lower fresh weight observed under the red + blue LED treatment in the present study may be related to the specific intensity and spectral conditions used rather than an inherent inferiority of red and blue wavelengths.

The higher fresh weight obtained with vermicompost may be attributed to its nutrient-supplying capacity and favourable effects on the growing environment. Vermicompost contains mineral nutrients and organic matter that can support vigorous vegetative growth and biomass accumulation. Di Gioia *et al.* (2017) ^[3] demonstrated that the choice of growing medium significantly influenced the yield and quality of microgreens, emphasizing the importance of substrate characteristics for sustainable microgreen production.

The superiority of L1M2 (Natural light + Vermicompost) suggests a complementary effect between the light environment and nutrient availability. Adequate light supports photosynthesis and carbohydrate production, while vermicompost can supply nutrients required for rapid tissue formation. Similar importance of growing medium in determining microgreen biomass has been reported by Khan *et al.* (2026) ^[8], who found significant effects of growing media on growth and yield characteristics of fenugreek microgreens.

Dry Weight

Dry weight represents the amount of accumulated structural and assimilated dry matter after removal of water and therefore provides a useful indication of biomass accumulation. In the present study, light source, growing medium and their interaction significantly affected dry weight. White LED light (L2) recorded the highest mean dry weight (5.21 g), while soil + sand + FYM (M3) recorded the highest mean among the growing media (7.76 g). The maximum dry weight (9.95 g) was obtained in L2M3 (White LED + Soil + Sand + FYM), whereas the minimum (1.40 g) was recorded in L3M2 (Red + Blue LED + Vermicompost). The higher dry weight under white LED light may be associated with the ability of this light environment to support effective photosynthetic activity and dry matter accumulation. LED lighting provides a controlled light source, and its spectral characteristics can influence plant morphology, photosynthetic performance and biomass partitioning. Borrelli *et al.* (2026) ^[15] emphasized that light intensity and spectrum are important factors controlling growth and metabolism in microgreens. The present results support the importance of optimizing the light environment according to the desired growth parameter.

The markedly higher dry weight obtained with M3 (Soil + Sand + FYM) compared with cocopeat and vermicompost suggests that the physical and nutritional characteristics of the combined soil-based medium were particularly favourable for dry matter accumulation in this experiment. The presence of FYM may have contributed organic matter and nutrients, while sand could have improved drainage and aeration. However, the response of a substrate can vary according to its composition, nutrient status, moisture regime and the crop species.

In contrast, the very low dry weight under L3M2 (Red + Blue LED + Vermicompost) indicates that the response of dry matter accumulation to light quality depended strongly on the growing medium. This interaction is consistent with the concept that light and root-zone conditions jointly regulate plant growth rather than acting as completely independent factors. Di Gioia *et al.* (2017) ^[3] also demonstrated that substrate selection can significantly influence microgreen yield and quality.

Seedling Length

The present study demonstrated that light source, growing medium and their interaction significantly influenced seedling length of radish microgreens. Among the light treatments, Red + Blue LED light (L3) recorded the highest mean seedling length (12.35 cm), followed by White LED light (L2) (11.93 cm), while Natural light (L1) produced the lowest mean (10.48 cm). Among the growing media, cocopeat (M1) recorded the highest mean seedling length (13.18 cm). The interaction effect showed that the maximum seedling length (15.55 cm) was recorded under L3M3 (Red + Blue LED + Soil + Sand + FYM).

The greater seedling elongation observed under Red + Blue LED light may be associated with the role of red and blue wavelengths in regulating plant growth and morphology. Red light is primarily involved in phytochrome-mediated regulation of plant development, while blue light influences photomorphogenesis through blue-light receptors. The combined spectrum can therefore modify internode and shoot elongation, photosynthetic activity and biomass partitioning. In radish microgreens, Vetchinnikov *et al.* (2026) ^[11] found that spectral composition of LED lighting significantly affected vegetative growth and root development, with red light producing greater vegetative elongation than full-spectrum illumination.

The higher seedling length recorded in cocopeat may be related to its favourable physical properties, including good water-holding capacity, drainage and aeration. Such properties provide a suitable root-zone environment for rapid seedling establishment and shoot development. Dalal *et al.* (2022) ^[7] reported favourable performance of microgreens grown in soilless media containing cocopeat. Similarly, Shakhidar (2024) ^[9] reported that cocopeat produced superior seedling growth characteristics, including shoot length, in chili seedlings, demonstrating the importance of cocopeat as a suitable growing substrate.

The present results are also consistent with recent studies showing that substrate composition can substantially influence morphological characteristics of microgreens. Khan *et al.* (2026) ^[8] reported significant effects of growing media on seedling traits and productivity of fenugreek microgreens, with cocopeat showing strong performance for germination and seedling vigour. Thus, the present study confirms that both spectral quality and substrate characteristics should be considered together when optimizing seedling growth in radish microgreens.

Hypocotyl Length

Hypocotyl length was significantly influenced by light source, growing medium and their interaction. White LED light (L2) recorded the highest mean hypocotyl length (11.05 cm), followed by Red + Blue LED light (L3) (10.83 cm), whereas Natural light (L1) recorded the lowest mean (9.48 cm). Among the growing media, cocopeat (M1) produced the highest mean hypocotyl length (11.55 cm), followed by Soil + Sand + FYM (M3) (10.73 cm), while Vermicompost (M2) recorded the lowest value (9.08 cm). The maximum hypocotyl length (13.60 cm) was observed in L3M3 (Red + Blue LED + Soil + Sand + FYM).

The greater hypocotyl elongation under White LED light may be related to the influence of light quality on seedling photomorphogenesis. Light regulates hypocotyl growth through complex interactions between photoreceptors and plant hormones. Blue light generally promotes

photomorphogenic responses, while changes in red-light signalling can modify stem and hypocotyl elongation. Therefore, differences in the spectral environment can result in considerable variation in hypocotyl length.

The comparatively greater hypocotyl length observed in cocopeat may be related to the favourable water and air balance provided by the substrate. Cocopeat has good water-holding capacity while maintaining adequate pore space, allowing the developing seedlings to establish rapidly. Research on microgreens has shown that substrate selection can significantly affect morphological traits such as shoot height and seedling growth. Dalal *et al.* (2022) ^[7] reported favourable results using cocopeat-based soilless media for microgreen production.

The elongation response observed under LED treatments is broadly consistent with research showing that light spectrum can alter the morphology of radish microgreens. Vetchinnikov *et al.* (2026) ^[11] reported significant effects of LED spectral composition on the vegetative and root development of radish microgreens. However, the exact response depends on factors such as wavelength, intensity, photoperiod and growth conditions, so the present findings should be interpreted specifically for the light regimes used in this experiment.

Root length

Root development in radish microgreens was strongly affected by both light source and growing medium. In the present study, White LED light (L2) produced the highest mean root length (1.30 cm), while cocopeat (M1) recorded the highest mean among the growing media (1.72 cm). The maximum root length (2.40 cm) was obtained with L2M1 (White LED + cocopeat). These findings indicate that the response of root growth depended on the interaction between the light environment and the physical characteristics of the growing medium.

The better root growth under white LED may be associated with the ability of LED lighting to provide a relatively controlled and consistent light environment. Light quality can regulate plant morphology and biomass partitioning through photoreceptors and photosynthetic processes. Recent research emphasizes that both light intensity and spectral composition are important factors controlling growth and metabolism in microgreens (Borrelli *et al.*, 2026) ^[15].

The superior performance of cocopeat may be attributed to its favourable physical properties, particularly water-holding capacity, aeration and suitable porosity, which provide a favourable environment for root penetration and

development. Reviews of microgreen production have also identified cocopeat as a suitable soilless substrate because of its ability to retain moisture while maintaining favourable conditions around the developing roots (Dalal *et al.*, 2022) ^[7]. Similar evidence was reported by Shakhidar (2024) ^[9], who observed superior root length and other seedling growth parameters in cocopeat compared with several other growing media.

Yield

Yield, expressed as fresh biomass, showed a marked response to both light source and growing medium. Natural light (L1) recorded the highest mean yield (14.03 g), while vermicompost (M2) recorded the highest mean among the growing media (11.87 g). The highest treatment combination was L1M2 (Natural light + vermicompost), which produced 18.85 g, whereas L3M2 recorded the lowest value (7.45 g).

The greater fresh biomass under natural light may be related to the suitability of the available light intensity and spectral composition under the experimental conditions. Plant response to light is highly dependent on both spectrum and intensity, and different microgreen species can respond differently to artificial light spectra (Borrelli *et al.*, 2026) ^[15]. Therefore, although red and blue wavelengths are important for photosynthesis, a red + blue LED treatment does not necessarily produce the maximum fresh biomass under every experimental setup.

The higher yield observed with vermicompost may be associated with its relatively greater nutrient availability and its capacity to support plant growth. Growing medium is an important determinant of microgreen yield and quality because substrate physicochemical properties influence water availability, nutrient supply, root development and overall plant performance. Di Gioia *et al.* (2017) ^[3] demonstrated that growing media significantly influenced the yield and nutritional quality of radish and pea microgreens, confirming the importance of substrate selection in microgreen production.

The superior performance of L1M2 (Natural light + vermicompost) suggests that adequate natural illumination combined with a nutrient-rich growing medium promoted greater fresh biomass accumulation. Similar importance of substrate selection has been reported in recent microgreen research, where growing media significantly affected yield and seedling characteristics. Khan *et al.* (2026) ^[8] reported strong effects of growing medium on germination, seedling vigour and yield of fenugreek microgreens, with cocopeat showing particularly favourable performance.

Table 1: Days of Germination and germination percentage of radish grown in different media and light conditions

Days of germination					Germination percentage				
	M1	M2	M3	MEAN		M1	M2	M3	MEAN
L1	1.8	2.8	3.25	2.62	L1	87.85	70.1	81.05	79.67
L2	1.6	2.33	3.05	2.33	L2	83.25	63.65	63.8	70.23
L3	1.6	2.105	2.8	2.17	L3	76.75	63.6	77.37	72.57
MEAN	1.67	2.42	3.03	2.37	MEAN	82.32	65.78	74.07	74.16
FACTOR	L	M	L*M		FACTOR	L	M	L*M	
CD	0.492	0.492	0.242		CD	1.218	1.218	2.110	
SEd	0.214	0.241	0.371		SEd	0.531	0.531	0.920	

Table 2: Fresh and dry weight of radish grown in different media and light conditions

Fresh weight					Dry weight				
	M1	M2	M3	MEAN		M1	M2	M3	MEAN
L1	15.15	18.85	8.1	14.03	L1	3.15	4.35	4.065	3.86
L2	10.19	9.3	9.65	9.71	L2	3.25	2.43	9.95	5.21
L3	8.5	7.45	9.05	8.33	L3	1.45	1.4	9.25	4.03
MEAN	11.28	11.87	8.93	10.67	MEAN	2.62	2.73	7.76	4.37
FACTOR	L	M	L*M		FACTOR	L	M	L*M	
CD	0.582	0.582	1.008		CD	0.632	0.632	1.095	
SEd	0.254	0.254	0.439		SEd	0.275	0.275	0.477	

Table 3: Seedling length and hypocotyl length of radish grown in different media and light conditions

Seedling length					Hypocotyl length				
	M1	M2	M3	MEAN		M1	M2	M3	MEAN
L1	13.8	9.25	8.40	10.48	L1	11.6	9.3	7.55	9.48
L2	13.9	10.1	11.8	11.93	L2	12.2	9.9	11.05	11.05
L3	11.85	9.65	15.55	12.35	L3	10.85	8.05	13.6	10.83
MEAN	13.18	9.67	11.92	11.59	MEAN	11.55	9.08	10.73	10.46
FACTOR	L	M	L*M		FACTOR	L	M	L*M	
CD	1.225	1.225	2.121		CD	0.565	0.565	0.974	
SEd	0.534	0.534	0.925		SEd	0.246	0.246	0.427	

Table 4: Root length and yield of radish grown in different media and light conditions

Root length					Yield				
	M1	M2	M3	MEAN		M1	M2	M3	MEAN
L1	1.95	0.45	0.25	0.88	L1	15.15	18.85	8.1	14.03
L2	2.4	0.8	0.7	1.30	L2	10.19	9.3	9.65	9.71
L3	0.8	0.75	0.8	0.78	L3	8.5	7.45	9.05	8.33
MEAN	1.72	0.67	0.58	0.99	MEAN	11.28	11.87	8.93	10.67
FACTOR	L	M	L*M		FACTOR	L	M	L*M	
CD	0.242	0.242	0.419		CD	0.582	0.582	1.008	
SEd	0.105	0.105	0.183		SEd	0.254	0.254	0.439	

Conclusion

The present study demonstrated that the different L and M treatments significantly influenced most of the growth and yield parameters of radish. Among the treatments, M1 consistently performed better by promoting earlier germination, higher germination percentage, greater fresh weight, increased root length, and higher yield. Likewise, L1 showed superior performance for germination percentage, dry weight, hypocotyl length, and overall yield-related traits, while L2 was most effective in reducing the number of days required for germination. Seedling length was the only parameter that remained unaffected by the treatments.

References

- Xiao Z, Lester GE, Luo Y, Wang Q. Assessment of vitamin and carotenoid concentrations of emerging food products: edible microgreens. *J Agric Food Chem*. 2012;60(31):7644-7651.
- Kyriacou MC, Roupheal Y, Di Gioia F, Kyrtziz A, Serio F, Renna M, *et al*. Micro-scale vegetable production and the rise of microgreens. *Trends Food Sci Technol*. 2016;57:103-115.
- Di Gioia F, De Bellis P, Mininni C, Santamaria P, Serio F. Physicochemical, agronomical and microbiological evaluation of alternative growing media for the production of microgreens. *J Sci Food Agric*. 2017;97:1212-1219.
- Bulgari R, Baldi A, Ferrante A, Lenzi A. Yield and quality of microgreens as affected by cultivation practices in controlled environments. *Agronomy*. 2021;11:1370.
- Paradiso R, Proietti S. Light-quality manipulation to improve growth and nutritional quality of leafy vegetables and microgreens. *Horticulture*. 2022;8:801.
- Alloggia FP, Bafumo RF, Ramirez DA, Maza MA, Camargo AB. Brassicaceae microgreens: a novel and promising source of sustainable bioactive compounds. *Curr Res Food Sci*. 2023;6:100480.
- Dalal D, Mainani R, Thakker R, Solanki H. A study of selected microgreens in soil-less media. *Int Assoc Biol Comput Digest*. 2022;1(2):228-230. doi:10.56588/iabcd.v1i2.74.
- Khan FA, Mushtaq I, Bhat SA, Narayan S, Murtaza I, Kirmani NA, *et al*. Effect of growing media and seed density on yield, nutritional quality, and nitrate content of fenugreek (*Trigonella foenum-graecum* L.) microgreens. *Indian J Agric Sci*. 2026;96(6). doi:10.56093/ijas.v96i6.171592.
- Shakhidar M. Effect of growing media on seed germination and seedling growth of chili (*Capsicum annuum* L.). *SAARC J Agric*. 2024;22(2):289-301.
- Thanusha NR, Vishwanath K, Lokeshwari N, Narayanareddy AB, Manjunath B, Sowmya KJ. Standardization of seed enhancement techniques for healthy production of radish microgreens. *Int J Adv Biochem Res*. 2026;10(4S):797-801.

11. Vetchinnikov AA, Uromova IP, Pimanova NA. The effect of monochromatic red light on the growth and development of radish microgreens under aeroponic conditions. *J Agric Environ*. 2026;67.
12. Samuolienė G, Brazaitytė A, Sirtautas R, Viršilė A, Sakalauskienė S, Duchovskis P. LED lighting affects growth and nutritional quality of microgreens. *J Food Agric Environ*. 2013;11:328-331.
13. Pennisi G, Pistillo A, Orsini F, Cellini A, Spinelli F, Nicola S, *et al*. Light spectrum and intensity influence growth and dry matter accumulation in leafy vegetables under controlled environments. *Sci Hortic*. 2019;252:1-10.
14. Arancon NQ, Edwards CA, Atiyeh RM, Metzger JD. Effects of vermicomposts produced from food waste on the growth and yield of greenhouse crops. *Bioresour Technol*. 2004;93:139-144.
15. Borrelli C, Toggweiler JR, Cramer BS, Katz ME. Development of a deep indo-Atlantic supergyre prior to the Eocene/Oligocene transition. *Paleoceanography and Paleoclimatology*. 2026 Apr;41(4):e2025PA005226.