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Radish Sprout Growth Dependency on LED Color in Plant Factory Experiment

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Abstract : Recent rapid progress in ICT (Information and Communication Technology) has advanced the penetration of sensor networks (SNs) and their attractive applications. Agriculture is one of the fields well able to benefit from ICT. Plant factories control several parameters related to plant growth in closed areas such as air temperature, humidity, water, culture medium concentration, and artificial lighting by using computers and AI (Artificial Intelligence) is being researched in order to obtain stable and safe production of vegetables and medicinal plants all year anywhere, and attain self-sufficiency in food. By providing isolation from the natural environment, a plant factory can achieve higher productivity and safe products. However, the biggest issue with plant factories is the return on investment. Profits are tenuous because of the large initial investments and running costs, i.e. electric power, incurred. At present, LED (Light Emitting Diode) lights are being adopted because they are more energy-efficient and encourage photosynthesis better than the fluorescent lamps used in the past. However, further cost reduction is essential. This paper introduces experiments that reveal which color of LED lighting best enhances the growth of cultured radish sprouts. Radish sprouts were cultivated in the experimental environment formed by a hydroponics kit with three cultivation shelves (28 samples per shelf) each with an artificial lighting rack. Seven LED arrays of different color (white, blue, yellow green, green, yellow, orange, and red) were compared with a fluorescent lamp as the control. Lighting duration was set to 12 hours a day. Normal water with no fertilizer was circulated. Seven days after germination, the length, weight and area of leaf of each sample were measured. Electrical power consumption for all lighting arrangements was also measured. Results and discussions: As to average sample length, no clear difference was observed in terms of color. As regards weight, orange LED was less effective and the difference was significant (p < 0.05). As to leaf area, blue, yellow and orange LEDs were significantly less effective. However, all LEDs offered higher productivity per W consumed than the fluorescent lamp. Of the LEDs, the blue LED array attained the best results in terms of length, weight and area of leaf per W consumed. Conclusion and future works: An experiment on radish sprout cultivation under 7 different color LED arrays showed no clear difference in terms of sample size. However, if electrical power consumption is considered, LEDs offered about twice the growth rate of the fluorescent lamp. Among them, blue LEDs showed the best performance. Further cost reduction e.g. low power lighting remains a big issue for actual system deployment. An automatic plant monitoring system with sensors is another study target.

Keywords : electric power consumption, LED color, LED lighting, plant factory
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